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

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A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE

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SATURDAY, JANUARY 7, 1928.

CONTENTS.

Chemistry as a Career.

A GREAT deal is being said and written at the present time about the teaching of science and the prospects of careers for trained specialists in its numerous branches. The serious teaching of science is no longer confined to a few schools, for it is now widely accepted that even the properly educated layman should possess some knowledge of the general principles of physics, chemistry, and biology. An indication of the educational trend may be discerned, for example, in the recent provision of magnificent laboratories at Clifton College (NATURE, June 11, 1927, p. 871), and in the curricula of the remodelled City of London School, in which "general science, including biology, will be taught on the classical side, physics-with-chemistry on the modern side, while on the science side limited specialisation in physics, chemistry, and biology will be possible" (NATURE, Dec. 24, 1927, p. 936).

Although, apart from occasional conflicts between the claims of physical and biological science, it may be comparatively easy to cater in the secondary schools for the future layman in science, the potential specialist presents a difficult problem to headmasters and parents. At what age can a boy's aptitude for a particular branch of science be judged? How is he to be enabled to demonstrate that aptitude? How far should he be allowed to specialise at school in the field concerned? To what extent can a would-be specialist in science count upon a satisfactory career? These are some of the more insistent questions which press for an answer; and we may briefly consider them in this place, particularly in so far as they affect the profession of chemistry.

The provision of answers to the first two of them

is a matter for the secondary schools; for, given a reasonably broad basis of secondary school education in science, there should be little difficulty in diagnosing aptitude before the boy is ready to enter the university.

Coming to the third query, and focussing attention upon chemistry, we cannot escape the impression that there is a current tendency in certain secondary schools to carry specialisation very far—perhaps too far—with apt pupils. This tendency, in turn, appears to be largely a response to the increasingly difficult examination papers which determine the award of entrance scholarships from the schools to some of the universities. The lot of the master who is preparing boys for chemistry in such examinations cannot be a particularly happy one; for, besides covering the old inorganic field, he has to bear in mind that the papers may deal mainly with physical chemistry; moreover, examiners do not hesitate upon occasion to include questions in organic chemistry which might well give pause to a second-year university student in that special branch of the subject.

It is not surprising, therefore, that many of the precocious specialists who have carried the study of chemistry so far in a limited time should possess little or no knowledge of biology, and that others should be regrettably deficient in English, mathematics, and other fundamental subjects. The discovery of a particular aptitude in a pupil is always welcome, and a judicious fostering of the favoured subject is essential; nevertheless, at school, and in the earlier years at the university, a pupil should be restrained from inordinate specialisation until he has secured the necessary basis of a well-proportioned general education. There is much to be said for the adoption of a broader test of intelligence and merit than the specialised examinations which are now so often imposed upon candidates for entrance scholarships to the universities.

Any query dealing with the prospects of a satisfactory career for pupils or undergraduates who are inclined to adopt chemistry as a profession is bound to raise complex issues. First of all, how is a satisfactory career to be estimated? Even if the simple quotation of a possible salary at a given age be accepted as sufficient, the question remains exceedingly difficult to answer. Perhaps the greatest stumbling-block in a discussion of this kind lies in the fact that chemistry provides a multitude of diverse professions rather than a single homogeneous profession. As a minor result of the War, few intelligent laymen are likely at the present day to confuse the so-called 'scientific chemist' with the pharmacist, or apothecary (why, by the way, cannot this honourable old name be resuscitated?); many, indeed, might even succeed in attaching such distinguishing adjectives as 'academic,' 'research,' 'analytical,' and 'industrial,' to the term 'chemist.' However, the very title of 'chemist' is so misleading in the British Empire that the Registration Committee of the British Association of Chemists has recently replaced it by the term 'chemical practitioner.'

A preliminary indication of the scope of the profession is afforded by the fact that candidates for the fellowship of the Institute of Chemistry may qualify in any one of the following eight branches: inorganic, physical, organic, agricultural, or general chemistry; the chemistry (including microscopy) of foods and drugs, and of water; biochemistry; and chemical engineering. This, however, is only the beginning of the classification. A glance at the *Journal of the Society of Chemical Industry* is sufficient to reveal that an industrial chemist may specialise in any one of twenty-three arbitrarily selected sections, and many of these sections may be subdivided almost indefinitely. Some of the great chemical industries centre, indeed, around a single material, or a group of allied materials, such as sulphuric acid, alkalis, ceramics, metals, glass, petroleum, alcohol, cellulose, cane-sugar, fats, paints, leather, india-rubber, medicinal chemicals, dyes, explosives, etc. Add to these considerations the fact that the industrial chemist—irrespective of the particular manufacture in which he is interested—may be occupied with any combination of duties comprehended under such labels as 'research,' 'analysis,' 'control,' 'administration,' and many others, and one begins to realise the innumerable ramifications of the chemical profession.

It is thus apparent at the outset that this profession possesses as many diversities as the British Empire, and that it provides scope for all sorts and conditions of chemists. Just as a Fijian would not feel at home in Labrador, so would a chemist who has specialised in the alkali industry experience a certain sense of strangeness if required to conduct research work on the constitution of a new alkaloid. Moreover, it is quite as difficult to legislate effectively for the complex corporation of chemists as for the complex racial association of the British Empire. That is why chemists, in spite of the beneficent activities of the Institute of Chemistry, are unable to safeguard the interests of their profession in a generally acceptable manner. The Institute publishes, however, a comprehensive list of official appointments which are, or may be, held by chemists, under the title of "Official Chemical Appointments"; and it is specially con-

cerned with the creation of such posts as well as with the education and registration of professional chemists competent to fill them. Its 5300 fellows and associates represent many aspects of chemical science and practice, and they form just as unified a professional organisation as is found in similar institutions of civil and mechanical engineers or of medicine.

Specialisation is, however, the penalty that has to be paid for progress. If, therefore, a young man resolves whole-heartedly—in colloquial phrase—to 'take up chemistry,' his decisions are by no means at an end. Under modern conditions he has to specialise again—this time within the subject, and possibly in one or more of the branches recognised by the Institute of Chemistry. Eventually, he may favour academic, analytical, or industrial work. In the first contingency—in the absence of striking powers—his promotion is likely to be slow, and he may be heading for the forties before he achieves even a modest competency. If he succeeds in securing a good footing in analytical practice, or, better still, in industrial chemistry, his progress is likely to be far more rapid, particularly if he possesses adaptability and personality. In making his crucial decisions he will look for guidance to his university teachers, who should maintain the closest possible touch with the leaders in industrial chemistry.

At the present time, while opinion is practically unanimous upon the very great difficulty of finding openings in chemical industry for men of second-class attainments, and for women chemists of even the highest qualifications, there are two distinct currents of feeling regarding the prospects for trained men of undoubted first-class ability.

On one hand, there is talk of a 'glut of chemists,' as an aftermath of the War; and there is little doubt that some chemists in Great Britain have been forced to abandon their profession since 1918, owing to the difficulty of securing satisfactory appointments. Communications from disillusioned or disgruntled chemists appear at frequent intervals in the technical press. One reads of a letter offering a wage of 1*s*. 2*d*. per hour to a graduate with three years' industrial experience, in a district where an unskilled labourer receives 1*s*. 7*d*. per hour. A correspondent complains (NATURE, Mar. 19, 1927, p. 432) that a lecturer in organic chemistry is paid at the rate of a dock labourer; another refers to an advertisement in which "a chemist, bacteriologist, 'medicolegalist,' organiser, lecturer, etc., is offered the princely salary of £400 per annum."

On the other hand, it has recently been stated in an authoritative chemical publication that "chemists are not worse paid than other professional men, and . . . that in the majority of cases they are paid as much as they are worth. Those who call attention to the low salaries offered to junior chemists will find the same feature in other professions. . . . It took us several years to realise how much more valuable and how much better remunerated is the knowledge of affairs and of men than the knowledge of a science, or of law, or of history or literature. . . . The supply of the clerk, the book-man, the man educated in schools and universities exceeds the demand." That the last statement does not apply at present to the trained chemical specialist of first-class ability is evident from the categoric pronouncements of prominent leaders in the British chemical industry, to the effect that the supply of properly qualified chemists is inadequate. Here one may interpolate that the qualifications should include a sound general education, a first-class honours degree, or its equivalent, in chemistry, together with a couple of years' training in research.

Thus, Sir Alfred Mond is reported in the *Times* of Dec. 13 to have stated that

"there was a definite shortage of scientific men in this country, and that was hindering research work. In his own company the number of men of the kind they wanted was far below the number they could absorb, and they had decided to approach headmasters with a view to selecting bright boys when still at school. Those boys would be assured that, if they would go through a university and obtain first-class degrees, they would not have to look for a job, but would be found one in his organisation, with remunerative salaries, at the moment they were ready to come. The company hoped in that way to do something from the beginning to make science a career, just as the Bar or medicine was now. They wanted a much greater co-ordination between the leaders in science in the universities and those who wanted the taught material. They wanted a conference at an early date so that those who were teaching could be told the directions in which their pupils would find work of advantage both to themselves and to those by whom they were employed."

Periodical conferences of this kind would undoubtedly be of value in correlating supply and demand and in providing opportunities for discussing other problems. For example, the cost of a training which includes five or six years at a university is naturally a serious consideration to many parents, and Sir F. D. Lugard in a letter to the *Times* of Dec. 17 makes the interesting suggestion that "there are probably many boys at our public schools who have shown a marked aptitude for science, and have borne a

character for steady application to study, and would gladly agree to repay their university expenses by deductions from their subsequent salaries, if those expenses were provided in the first place by a firm which offered prospects of scientific research." It may be mentioned that a scheme of this general character was adopted some years ago with marked success by a certain enlightened and efficient chemical corporation in Australia.

Such opinions as those quoted above form a refreshing contrast to the narrow views of many of the uninformed laymen who have hitherto so often found themselves in nominal control of chemical enterprises. A good deal of the dissatisfaction to which reference has been made has probably been engendered by the unenlightened and conservative tendencies of the business man of the old school, who has been apt to regard the chemist in his factory in much the same light as the maid-of-all-work in his home. Under the new regime, the young chemist who enters a scientifically organised chemical corporation, with trained chemists in the highest administrative positions and on the board of control, will not suffer from the disadvantages which have so discouraged his predecessors. Provided that he is efficient, he will enjoy security of tenure, with, let us hope, an adequate pension provision; he will obtain the diverse experience which only a large organisation can offer; and the elastic system under which he finds himself will permit of his particular abilities being utilised to the best advantage.

To sum up this aspect of the discussion, it appears that at present, owing largely to the stimulating effect exerted upon the British chemical industry through the formation of Imperial Chemical Industries, Ltd., the prospects in this industry are decidedly promising for the new generation of properly qualified chemists. The directors of this great organisation are taking broad and patriotic views, and it is devoutly to be hoped, in the interests of Great Britain and the Empire at large, that their efforts to establish the British chemical industry upon an unassailable footing will be crowned with success. It should be the aim of the secondary schools and universities to aid in diverting into this vitally important group of key industries an adequate proportion of the best brains of the nation. That the realisation of this ideal will bring a fitting reward to the man of proved first-class ability is certain, especially if he combines with his expert knowledge of chemistry a *flair* for research, economics, administration, or business management. J. R.

Eastern Adepts and Western Science.

The Mysterious Kundalini (the Physical Basis of the "Kundali (Hatha) Yoga" according to our Present Knowledge of Western Anatomy and Physiology). By Vasant G. Rele. With a Foreword by Sir John Woodroffe (Arthur Avalon). Pp. xi + 112 + viii + 4 plates. (Bombay: D. B. Taraporevala, Sons and Co., 1927.) 3.8 rupees.

THE chief interest of this book, for most readers of NATURE, will consist in the description of the modification at will of certain physiological processes by a Yogi of Bombay. The Yogi demonstrated his powers before the Bombay Medical Union, and also before the students of a medical college (name of the college not given) and a few guests. On the latter occasion the author, who possesses the diplomas of F.C.P.S. and L.M. and S., and who is described by Sir John Woodroffe in his foreword as "a competent man of science," was selected, along with another doctor (unnamed), "to judge the truth of his statements," and was "told to report to the students what we actually saw and felt."

The Yogi, when told to stop his right pulse, took a deep breath and made a forcible expiration; whereupon for the first two or three seconds the pulse was very much accelerated; then came a slowing, and then a stoppage, which lasted for more than two minutes with the interposition of two or three beats at the end of the second minute. During this time his hand and fingers were "a bit shaky," and there was some twitching in his fingers; the pulse on the other side was normal, and the muscles of the arms and forearms were quite soft and pliable. The pulse on the left side, and the temporal pulse, could also be stopped at will. "When the radial pulse of one hand was stopped, the circulation in the whole arm was stopped, but when the pulsation in the temporal artery was made to stop, the carotid artery was still beating, showing thereby that the checks used by him were above the brachial artery in one case and above the carotid in another."

The heart beats, as heard by the stethoscope, could also be stopped. After the same process of deep breathing and forced expiration the heart slowed and stopped; "the duration of complete stoppage of the beat of the heart was for six seconds by the watch." When the Yogi was examined by X-rays, before the two observers and eight other medical men of repute, and told to stop the beating, his heart contracted so that its apex was about two-

thirds of an inch internal to its normal position; the apex beat was inaudible, but the rhythmic contraction of the heart was still present; the beats, recorded on a cardiograph (reproduced), were much smaller in amplitude (about two-thirds of the normal, as shown on the tracing) and less frequent (60 per minute).

This Yogi also showed "some rare feats of archery, such as splitting of hair and thread by an arrow darted at them from a distance of about 15 to 20 feet. He broke an iron chain three-eighths of an inch in thickness by a mere pull of his body; one jerk, and crack went the chain in two pieces." Physically he is described as being slender in body, legs long and thin, and calf muscles showing insufficient physical exercise.

The Yogis are adepts of the science of yoga, by which the embodied spirit, jivátma, which is a part of the universal spirit, paramátma, is made to become one with the universal spirit by certain physical and mental exercises; yoga is the "union or linking together of man with God." The necessary physical and mental exercises are arranged in eight steps; the physical exercises are concerned with posture and regulation of the respiration. The author states that all the physical practices of yoga are directed towards bringing the sympathetic under [conscious] control, and that this control is effected through the plexuses of the autonomic nervous system. Leaving aside the Yogi's feats of skill and strength, the author's explanation of the modifications of the circulation is that these are due to an acquired conscious control of the sympathetic nervous system. But "the ultimate aim of the Yogi, in the various practices, is not to acquire and manifest the various supernatural powers, which only come to him on his onward march of getting himself absorbed with the Infinite."

According to the Tantric manuals, the stimulation of the 'chakras,' which the author identifies with the sympathetic plexuses, is always through 'Kundalini'; by establishing the control of the will over Kundalini we can subjugate the whole of the autonomic nervous system. But, though numerous interpretations have been given, Kundalini has always been a mystery; the author identifies her (the feminine is apparently correct) with the vagus nerve, which has connexions with the several plexuses of the sympathetic in the thorax and abdomen, and more particularly with the right vagus. The control is obtained by practising certain 'catches' (Bandhá) and attitudes (Mudrá) during the process of Pránáyáma, the fourth of the eight steps in the training of the Yogi. The author gives a full account of the various steps, and especially of the physical exercises, by which yoga is attained, and illustrates this by a number of photographs. But though the various practices of yoga appear simple and easy of achievement on paper, they are all to be learnt at the feet of the master; "it is of paramount importance that the instructions should be received by a student from an adept."

A few words of criticism may be added. The author does not discuss the Yogi's feats of skill and strength, yet some notice must be taken of these also. If the description of the splitting of a hair, or even of a thread, by an arrow from a distance of 15 to 20 feet is to be taken literally (and if not, the value of the whole account is much depreciated), it would seem probable that either trickery on the part of the performer, or an abnormal mental condition of the spectators, must come into the reckoning. Again, we are not told who supplied the iron chain that was broken by "one jerk" of this physically poorly developed adept.

The author would presumably explain the stoppage of the radial pulse, produced at some point above the brachial (that is, by occlusion of the subclavian or axillary artery), by a localised contraction of the musculature of the vessel wall occasioned by a voluntary impulse passing along the sympathetic fibres. But it seems improbable that even the most powerful stimulation of the sympathetic—even an experimental stimulation—could cause complete occlusion of the larger arteries; it is to be remarked, too, that a graphic record of the pulse was not taken; possibly, if this had been done, pulsation might have been found to be still present, as in the case of the heart. To forestall criticism, moreover, we ought at least to have been assured that there was no possibility of anything being concealed in the axilla against which the axillary artery could be compressed, and that the subject did not possess cervical ribs which in some posture, for example, when the shoulder was depressed, could exercise compression on the subclavian. A diminution in the temporal pulse might conceivably be brought about by the compression of the external carotid from inside, by some hard body in the throat; at least, such possibilities should be definitely excluded. The effect of forced respiratory movements on the heart is well known; we seem to remember that the earlier editions of Huxley's "Lessons" stated that the heart-beats could be stopped temporarily by strong sudden inspiratory or expiratory efforts with nostrils and

mouth closed—with an added note, however, that the experiment was not free from danger.

The author's claims on behalf of the Yogi can thus not be accepted until there is evidence of the application of a more rigid criticism. The book has, however, a distinct value as describing and illustrating for western readers the physical training of the Yogi, and as an attempt at interpreting in modern terms the difficult pseudo-anatomical descriptions of the Tantric texts.

J. STEPHENSON.

British Deer.

Hunting and Stalking the Deer : the Pursuit of Red, Fallow, and Roe Deer in England and Scotland. By Lionel Edwards and Harold Frank Wallace. Pp. xi + 274 + 48 plates. (London : Longmans, Green and Co., Ltd., 1927.) 63*s*. net.

WHILE the sumptuous volume on deer-stalking and stag-hunting whereof Mr. Lionel Edwards and Mr. Frank Wallace are joint authors forms a notable addition to the literature of field sports, for the field naturalist it has a strain of melancholy, inasmuch as it records marked degeneration in the noblest of our native land fauna—*Cervus elaphus*. "It is curious," observed Mr. Walter Winans in his recent work, "Deer-breeding for Fine Heads" (London, 1913), "that Scottish stags are at the present time the worst in Europe." It would be curious, indeed, if they were not so, having regard to the conditions of climate and food supply which they have to encounter in winter. By nature and original habit the red deer is a woodland animal, only resorting to the hilltops in summer heat to escape the torment of flies and to browse on the flush of upland grass, but ever returning to the woods for shelter and food in winter. Now that man has felled the forest and claimed all the low ground for his industry and crowded habitation, the red deer are confined throughout the year to storm-swept wastes at high altitudes. The term 'deer forest' remains only to connote some of the bleakest and most treeless tracts in North Britain. The real wonder is that British red deer have not deteriorated still further from the magnificent creatures that roamed the Caledonian forest of yore, whereof the bones and antlers exhumed from peat-mosses and tidal estuaries prove to have been no whit inferior to animals of the same species now inhabiting the Carpathians, the Caucasus, and certain well-wooded English parks.

Two such antlers lie before the present writer. They are not a pair; one with seven points has part of the skull attached and measures 37 inches along the outer curve and $7\frac{1}{4}$ inches in circumference between brow and bay. The other is a cast horn, 38 inches long, with only six points remaining, the brow tine having been broken off; the bay tine is of the extraordinary length of $20\frac{3}{4}$ inches. These antlers are among very many others recovered from the alluvium in the estuary of the Cree in the work of drawing out of the clay huge oak trunks, wreckage of the Pleistocene ice.

As indicated by the title of their book, the authors treat of deer almost exclusively from the sportsman's point of view; but Chaps. xxvi. and xxvii. contain some interesting notes upon the habits of red deer, of which not the least remarkable is the readiness with which they take to the water and the distance to which they will swim, even when not pursued. They cross freely from isle to isle of the Hebrides, and an instance is recorded of a stag being captured in Kilbrannan Sound four miles at sea, "apparently swimming for Arran, which is twelve miles distant from the mainland" (p. 132).

In view of the great number of deer killed every year in Great Britain, it is strange in how little general esteem venison is held as food. Gourmets appreciate it; but in most houses it is taboo in the servants' hall. Sportsmen have come to prize a good 'head' more highly as a trophy than a fat haunch as a delicacy. Indeed, a great part of the volume under notice is occupied with a discussion of the antlers of the red stag, with long lists of detail in their dimensions and variety.

"The chief reason," writes Mr. Wallace, "why the horns of the *Cervidæ* present so many features of interest lies in their never-ending variety. Place twenty of the finest heads of any other species of game alongside one another, and whether they be kudu, sable, ibex, or the great sheep, you will notice very little difference. . . . No two heads of red or roe deer . . . are alike even to a casual eye, and so to the study of their horns attaches a peculiar interest" (p. 95).

The authors make no reference to what is, after all, the most remarkable feature in the antlers of deer, namely, that alone among Ungulates the Cervidæ grow solid horns and cast them annually. The giraffe and rhinoceros also carry solid horns, but a single pair of these, like the hollow horns of oxen, goats, and antelopes, serve them throughout life for offence, defence, and ornament; whereas the far heavier armature of a red stag has to be fashioned afresh, with considerable pain and irritation, each summer, only to be

cast off in the following spring. The consequent waste of material in a herd of deer is considerable, especially among reindeer, whereof both sexes carry palmate antlers. Among the remains referred to above as recovered from the estuary of the Cree is a pair of red stag's antlers weighing exactly 18 lb.

Purpose in the waste of such fine armature baffles conjecture, but there is no doubt about the purpose for which it was grown.

"Deer, as is well known, are great fighters, and when with the hinds a stag leads a pretty strenuous life. . . . I doubt if a big beast with a large number of hinds gets any sleep at all for days, one might almost say weeks, on end. Watchful rivals are for ever hanging on the flanks of his harem ready to dash in and cut out a stray hind or two if their master's alertness is relaxed for a moment. Towards the end of October, worn to skin and bone, with bloodshot eyes, completely exhausted, he can no longer display his former activity, and smaller beasts may evade his weakened fury."

The volume is well and profusely illustrated, the coloured plates by Mr. Lionel Edwards being very beautiful. HERBERT MAXWELL.

Quanta.

Handbuch der Physik. Herausgegeben von H. Geiger und K. Scheel. Band 23: Quanten. Redigiert von H. Geiger. Pp. ix + 782. (Berlin: Julius Springer, 1926.) 57 gold marks.

IT is little more than a generation ago since Planck first formulated his quantum theory to explain the observed distribution of intensity of black-body radiation in its dependence on frequency and temperature, and so introduced the discontinuity idea into the description of natural processes. Meanwhile, the new theory has thrown out its feelers into practically every branch of physics, and developed with such amazing rapidity that it appears both fitting and natural that a special volume of the "Handbuch der Physik" should be devoted to it. Even so, not all the applications of the quantum theory are embodied in the present volume. Subjects such as the statistical applications of the theory, its relation to chemistry and to molecular structure, and certain aspects of the theory of band spectra have been relegated to their appropriate volumes. Furthermore, the epoch-making developments of quantum mechanics by Heisenberg, Born, Jordan, Dirac, L. de Broglie, Schrödinger, and others, are not included, but will doubtless receive their due share of attention in later volumes of the 'Handbuch.'

The editor has been particularly fortunate in his choice of contributors, all of whom are in the forefront of the branches on which they write. In its production, too, the book is of exemplary clearness; the paper is good, the diagrams clear, and the photographic reproductions bring out even the finer detail. Copious references to the literature occur at the foot of almost every page, an index is included, and nothing of importance appears to have been overlooked.

Chap. i. is more than the word chapter conveys. In a space of somewhat less than three hundred pages, W. Pauli, Jr., gives a complete statement of the quantum theory, which is masterful in its brevity. The underlying ideas are presented with remarkable clearness, and the experimental developments of the subject are everywhere kept in view. We can perhaps pay no higher tribute to the chapter than to state that it reaches the same high order of excellence as the author's well-known article on relativity in the "Encyclopædia of the Mathematical Sciences," which, at the instigation of Prof. Sommerfeld, was reprinted in separate book form. In three sections Dr. Pauli deals successively with the general principles of the quantum theory, the theory of the spectrum of atoms with a single electron, and with the spectra of atoms with more than one electron. Even in its more difficult parts the theoretical treatment is remarkably lucid, and we venture to express the hope that this article by Dr. Pauli may also be printed separately in book form and made available in English. A slight misprint occurs on p. 173 (footnote) in the spelling of Guthrie! Spectral notation is badly in need of standardisation, and is a constant source of confusion even to specialists. In this chapter Dr. Pauli has done his best to preserve clearness in this respect, for he devotes p. 278 to a statement of the term and quantum number notations as used by Sommerfeld, Landé, and by himself. His own notation has been arrived at after consultation with Sommerfeld and Hund, and it is to be hoped that co-operation will soon be exercised and uniformity attained through the medium of an international convention.

One of the most remarkable and striking features of atomic physics is the accuracy with which the various fundamental constants are known. The second chapter, comprising a theoretical and an experimental section, is concerned with the evaluation of Planck's constant h, and gives a critical and very valuable summary of the results. R. Ladenburg concludes that the best value of h in the present state of knowledge is $(6{\cdot}55 \pm 0{\cdot}01) \times 10^{-27}$ erg sec.

The absorption and scattering of X-rays is dealt with by W. Bothe in Chap. iii., and it need scarcely be said that the subject is ably and authoritatively presented, for the author himself has contributed in no mean measure to the work done in this field. Both theory and experiment are treated, and many useful numerical data are included. The older work is proportionately discussed, and more recent work (directional distribution of photoelectrons, Compton effect, etc.) is described in a clear and well-balanced manner. A brief appendix on the energy measurement of the rays is not only of theoretical interest, but also of importance in radiological practice.

H. Kulenkampff gives in Chap. iv. a full account of the continuous X-ray spectrum, the laws of its excitation, the energy distribution in the spectrum, as well as polarisation effects and the azimuthal distribution of intensity. The chapter contains much useful information, both experimental and theoretical, and is a valuable critical survey of the subject.

The fifth chapter owes its origin indirectly to the War, when the author, P. Pringsheim, spent the period of his unfortunate internment in Australia in the collection of material for his well-known book on "Fluorescence and Phosphorescence," in which he gratefully acknowledges the help afforded him by Profs. Lyle, Pollock, and Wellisch in procuring the necessary literature. The chapter is entitled "The Excitation of Emission by Radiation," and deals fully with resonance radiation, the disturbance of resonance radiation by collisions, the fluorescence and phosphorescence of organic compounds, the fluorescence of inorganic molecules, and crystal phosphors. This new and up-to-date treatment of a rapidly developing subject is most welcome, and Prof. Pringsheim has performed his task admirably.

Photochemistry is one of those border-line sciences which cannot be regarded as the prerogative of physicists. Too detailed an account of it is thus scarcely called for even in a handbook of physics. On the whole, we feel that W. Noddack has been judicious in the selection of his material, and the essential facts are presented clearly and well arranged in the forty pages of Chap. vi. In one or two instances, however, he has erred on the side of brevity, especially in the section on the effects of corpuscular rays. The latest reference to the action of α-particles in promoting chemical reaction is of pre-War date, whereas much valuable work has been done during the last few years, notably by S. C. Lind.

Our knowledge of atomic structure has made vast strides since the classical experiments of Franck and Hertz, and much of the progress made has resulted from the application of their method of retarding potentials in work on the "Excitation of Quantum Jumps by Impact." This is the title of Chap. vii., excellently written by J. Franck and P. Jordan, and it is one of the most valuable in the book, both in its clear statement of theory and in its presentation of experimental method. The authors deal with slow electrons, critical potentials and energy levels, the probability of excitation and ionisation, and kindred topics. The treatment is not only critical, but also delightfully lucid and complete. It is based on the authors' well-known book on the same subject.

Our Bookshelf.

Mikroskopische Physiographie der Mineralien und Gesteine: ein Hilfsbuch bei mikroskopischen Gesteinsstudien. Begründet von H. Rosenbusch. Band 1: *Die petrographisch wichtigen Mineralien und die Methoden ihrer Untersuchung.* Fünfte, neu bearbeitete Auflage von E. A. Wülfing und O. Mügge. Zweite Hälfte: Spezieller Teil. Fünfte, erweiterte Auflage von Prof. Dr. O. Mügge. Pp. xv + 555 - 814 + Tafeln 21 - 35 + 17 Tabellen. (Stuttgart: E. Schweizerbart'sche Verlagsbuchhandlung, 1927.) 33 gold marks.

THIS is the concluding instalment of the second half of the first volume of the classical work of Rosenbusch, which is a necessary part of the equipment of every student of petrology. It forms part of the fifth edition, the first after the death of the master. The fact that Prof. Mügge is responsible for it is a sufficient guarantee that the standard of the work has been maintained and that it has been brought thoroughly up-to-date.

The 'special' half of the volume deals with the physical, above all the optical, characters of the different rock-forming minerals by which they can be recognised. As much space as ever is devoted to the determination of the position of soda lime felspars in the continuous series from albite to anorthite. The use of the theodolite stage for the purpose had been already very clearly explained in the first or 'general' part.

An elaborate table for reference in identifying the different minerals presents some novel features. There is a separate category for minerals soluble in water. The biaxial minerals are not classed according to their crystallographic systems but according to their chemical nature. Whether this arrangement will help to facilitate the recognition of minerals remains to be tested by experience. The crystallographic system is indicated by Roman numerals, and it is rather disturbing at first to find that IV. means an orthorhombic mineral and not a tetragonal one, and VI. triclinic, not hexagonal.

The beautiful reproductions of mineral photographs remain one of the most attractive features of the book, and their number has been considerably increased. J. W. E.

(1) *Laboratory Manual in General Microbiology.* Prepared by the Laboratory of Bacteriology and Hygiene, Michigan State College. Third edition. Pp. xxvi+472. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1926.) 17*s.* 6*d.* net.

(2) *Les Microbes.* Par Prof. P. G. Charpentier. Avec un atlas de photomicrographies de P. Jeantet. (Bibliothèque générale illustrée, tome 5.) Pp. 77+59 planches. (Paris: F. Rieder et Cie, 1927.) 16·50 francs.

(3) *Dictionary of Bacteriological Equivalents: French-English, German-English, Italian-English, Spanish-English.* By William Partridge. Pp. xi+140. (London: Baillière, Tindall and Cox, 1927.) 10*s.* 6*d.* net.

(1) DESIGNED as a guide to students and teachers of general microbiology, this volume deals with general morphological and cultural methods, the physiology of micro-organisms and applied microbiology. The last named is subdivided to include air, water and sewage, soil, dairy and plant sections. Animal diseases and immunity, and an appendix dealing with special media, stains, etc., are added. Each part is arranged in a series of exercises with instructions, questions, and a list of references.

It is possible that this volume might prove of value in outlining a course for students in general microbiology, since much useful material is included. The new classification of the Society of American Bacteriologists is not used in the book.

(2) Prof. Charpentier, in his small volume, aims at conveying to the lay mind some knowledge of microbes both useful and harmful to man. Well-known examples are used and described in an easily readable and interesting manner. A large number of photomicrographs are given at the end.

(3) As the author states, this little book of 140 pages is intended to serve as a supplement to the general dictionary. All the foreign words included have, for the most part, been taken from the bacteriological literature of the country concerned. In all, about 7800 words are dealt with, of which 2400 are French, 2600 German, 1200 Italian, and 1600 Spanish. Many of the words are not found in ordinary dictionaries.

The Elements of Telephone Transmission. By H. H. Harrison. Pp. vii + 147. (London: Longmans, Green and Co., Ltd., 1927.) 5*s.* net.

SINCE Heaviside developed the theory of the transmission of electric and magnetic waves in long distance telephone circuits, vast improvements have taken place in the technique of the construction of telephone lines. As Heaviside assumed that his readers were thoroughly familiar with mathematical theory, he omitted many essential steps in his proofs, and this makes it no easy matter to follow his reasoning. The ordinary telephone engineer who uses Heaviside's somewhat complicated formulæ would probably be unable to prove them. In general, also, the engineer has little grasp of the physical processes which operate on a long telephone circuit. Most of the books on the subject are of a very advanced character. We therefore welcome an addition to the scanty literature which is suitable for the elementary student.

The reader will find this book a good introduction to the standard text-books on the subject. It is divided into four chapters, the first being a purely mathematical introduction dealing mainly with the elementary calculus. Engineers seem to think that there is some special virtue inherent in writing j for $\sqrt{-1}$ and calling it an operator. We prefer to use the Greek letter iota, ι, for $\sqrt{-1}$ and D for an operator. We know that this has been the custom at Cambridge for many years.

The United States of America: Studies in Physical, Regional, Industrial, and Human Geography. By Prof. A. P. Brigham. Pp. x+308. (London: University of London Press, Ltd., 1927.) 8*s.* 6*d.* net.

PROF. A. P. BRIGHAM is already well known as an authority on various geographical aspects of the United States, and those who were stimulated by his lectures in London and Oxford in 1924 will be glad to know that they in turn have stimulated the lecturer to prepare this well-proportioned and illuminating book.

Besides the students of the later secondary and the earlier university years for whom the work is specifically intended as a text, there must be a wide circle of readers who have wished for a trustworthy account—not too long, and not too technical—of the United States and its varied inhabitants as they are to-day. They need look no further: for here they will find a panoramic survey of all the leading facts; a summary which is masterly in its balance, and in its freedom from the cramped terseness of many small works on large subjects; and an outlook which is sane and unprejudiced. The author has attempted to write for both sides of the Atlantic. In Great Britain his book will be welcomed as making a notable contribution to the literature of a subject which deserves to be far better understood than it is. The book is beautifully illustrated, and is produced at a price that does credit to the enterprise of the publishers.

A Course of Volumetric Work for Day and Evening Students of Pure and Applied Chemistry. By E. Clark. Pp. vi+146. (London: Sir Isaac Pitman and Sons, Ltd., 1927.) 4*s.* 6*d.* net.

THE subjects dealt with are standard solutions, acidimetry and alkalimetry, silver nitrate, permanganate, iodine, and dichromate, and a few unclassified estimations. The principles of the methods are well explained and careful directions are given for performing the experiments and calculations. The book is suitable for use in evening classes and also for university students of intermediate standard. In both cases the work of the teacher will be simplified by the careful explanations given. All the points which offer difficulties have been dealt with and the book may be recommended as distinctly better than most existing works of its size and scope.

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.*]

Flame and Combustion.

PROF. H. S. TAYLOR, in a letter to NATURE of May 21, directed attention to work going on in his laboratory and continued in Sweden by Dr. Bäckström (*Medd. K. Nobel Inst.*, 6, 15, and 16, 1927). Dr. Bäckström has found that the photochemical oxidation of benzaldehyde in the liquid state is a chain reaction, and since the effect of inhibitors is the same for the photochemical as for the thermal reaction, the latter is almost certainly a chain reaction (*J.A.C.S.*, **49**, 1460; 1927). In our work on the combustion of hydrocarbons below their igniting temperatures, the effect of inhibitors (such as phenol or aniline) on the gaseous oxidation appears to be similar to their effect on the oxidation of benzaldehyde in the liquid state. Therefore, probably, the mechanism of oxidation is the same.

We are led, therefore, to the following general view of gaseous combustion. Reaction will commence when a sufficiently energetic molecule of fuel combines momentarily with an energetic oxygen molecule. A temporary peroxide in a high energy state is thereby formed. Among the several possible changes which may result, starting with a hydrocarbon, a breakdown into an aldehyde and a water molecule is quite a likely one. These molecules would possess not only the initial energy of activation but also the reaction energy, and on their next encounter with other fuel molecules (or oxygen molecules) could communicate sufficient energy to enable combination to occur and so start a reaction chain. Such a mechanism would explain why the initial stages of combustion are so much influenced by concentration. For example, a small quantity of acetaldehyde added to pentane makes little difference to the igniting temperature of the pentane, although the aldehyde alone ignites at a lower temperature. The reaction chains facilitating the oxidation of the aldehyde alone, cannot be started to the same extent in the mixture, as the collisions with the hydrocarbon molecules communicate insufficient energy to activate the latter.

The main significance of a reaction chain mechanism as regards ignition, is that a comparatively rare occurrence becomes a frequent occurrence locally; centres of high energy are thus established which, if diffusion is prevented, become centres of ignition. It is clear that some of the molecules may become deactivated by loss of energy as radiation; (chemiluminescence with pentane is visible 200° below the igniting temperature). Photochemical oxidation, however, is probably insignificant compared with the thermal reaction, and we have found illumination makes no appreciable difference to the igniting temperature, though it has been observed to affect the rate of reaction at considerably lower temperatures (Bennett, *Trans. Farad. Soc.*, **23**, 295; 1927). The upper limit for excitation of molecules would be given by the ionisation of the molecule, though often dissociation occurs before ionisation. Where dissociation does not take place and as the reaction proceeds more and more rapidly and the temperature rises, the chances of reaching higher energy states become greater and there is every probability that some ionisation occurs. In my view this is one of the later stages of combustion and not the essential primary step; the combination of a fuel molecule with an oxygen molecule is the essential initial process. Combustion naturally will be most intense in the regions of high ionisation, because there the most highly active particles are to be found. In the flame itself ionisation, for the same reasons, is intense.

Prof. Taylor mentioned the effect of the organic radicals with which the metal in an antiknock compound is associated. Our experiments showed that this effect was secondary (*Jour. Petrm. Techn.*, **13**, 244; 1927). These radicals would certainly influence to some extent the oxidation processes which are going on in the locality of the 'antiknock' molecule. Thus, ether added to petrol tends to prevent the inhibitory effect of lead tetraethyl by forming with it a fairly stable oxidation product, but I found no such effect to occur with nickel carbonyl and ether-petrol mixtures; nickel probably does not form a similar compound. The effect of an 'antiknock' is mainly that of an inhibitor of oxidation and it does not assist combustion as some have suggested, though its result may be to obtain the kind of combustion required.

The 'autocatalysis' in the initial stages of combustion to which I have referred is a 'joy to the antiknock soul,' because it provides a mechanism which can be readily slowed down by the breaking of the reaction chains. This, together with the point established in the papers cited that the antiknock acts in a high state of oxidation which can be taken to a lower state and then regenerated, seems to account satisfactorily for many of the facts.

I am afraid that the above remarks are not in terms to be appreciated by Prof. Armstrong. I should like to achieve his approval by interspersing a few 'hydrones,' but so few people appreciate their charms that I can scarcely be blamed for failing to invoke them, having not that power over words which Prof. Armstrong enjoys and with which he enlivens us.

ALFRED EGERTON.

Clarendon Laboratory, Oxford.

Artificially-induced Metamorphosis in Echinoderms.

IN 1922 (*Biol. Bulletin*, **43**, p. 210) I propounded a theory as to the mechanism of metamorphosis in sea-urchins based upon the study of dedifferentiation in the larvæ. The Echinoid pluteus responds very readily to various unfavourable conditions by dedifferentiation. Starvation, lack of oxygen, overcrowding, and poisoning with very dilute potassium cyanide or salts of heavy metals, causes the arms to shrink and eventually to be resorbed, and the body to round up and contract; at the same time the gut may dedifferentiate considerably.

I assumed that in normal development the weight of the growing Echinus rudiment would eventually carry the larva down from the optimum conditions of food and aeration near the surface, to the bottom. The conditions here, being unfavourable for the larval tissues, would cause them to begin dedifferentiation. The Echinus rudiment, not being similarly susceptible (largely, it was suggested, owing to its cells and organs not presenting so much relative surface), would then be able more successfully to compete for food materials with the larval tissues. The balance, once tilted, would swing right over in its favour, and the larval organs, once dedifferentiation had begun, would speedily be altogether resorbed.

During the last two summers, thanks to the courtesy of Prof. E. W. MacBride, who annually raises numbers of Echinus plutei to metamorphosis, I was able to put this hypothesis to experimental test.

A number of late larvæ were selected from the plunger-jars where they were being reared, and divided into five classes according to the size of their Echinus rudiment (the most advanced specimens, with incipient resorption of the tips of their arms, were rejected). A number of representatives of each class were then replaced in the plunger-jars; another similar set were placed in sea-water, changed frequently, in small vessels; and a third set were exposed to the agency chosen to induce dedifferentiation.

The most successful agency was found to be very dilute mercuric chloride, from one two-millionth to one three-millionth molar. With such solutions, the results were perfectly definite. In less than twenty-four hours, above 90 per cent. of surviving specimens (more than 70 per cent. of total number) of larvæ with moderate to large Echinus rudiments, but with no trace of arm-resorption, had completely metamorphosed or were in the middle of metamorphosis; while only 6 per cent. of the two sets of controls had done so. None of the experimental animals remained fully larval (*i.e.* without any visible alteration such as arm-resorption, etc.); while nearly 70 per cent. of the controls did so. The majority of the control specimens in the plunger-jar had not metamorphosed after ten days.

One of the artificially metamorphosed Echini lived for eight days in spite of the absence of proper food. The fact that many died in one to two days may be compared with the high mortality in artificial (thyroid-induced) metamorphosis in amphibian larvæ. Doubtless, attention to precise strength of solution and length of exposure would (again as in Amphibia) much reduce the mortality.

Further, just as high doses of thyroid given to very small tadpoles give disharmonic results in metamorphosis (resorption of tail and gill system before proper limb size can be attained), so here larval dedifferentiation in stages when the Echinus rudiment was small (about half its final larval diameter) produced disharmonic metamorphosis, the result being a mere spherical lump with no or very slight indications of tube-feet, etc.

The fact that metamorphosis can be precociously caused by inducing larval dedifferentiation is presumptive evidence that larval dedifferentiation is the primary cause of metamorphosis in Nature. At any rate, the criticism (Pérez, *Année Biol.*, **4** (pt. 2), p. 16; 1923) that since dedifferentiation is a pathological phenomenon, it therefore can have nothing to do with a normal process like metamorphosis, is shown to be without foundation. So far as I am aware, this is the first case of experimentally-altered time of metamorphosis in any group of marine invertebrates, the recorded cases being confined to Amphibia, Tunicates, and Insects.

J. S. HUXLEY.

King's College, London,
Nov. 15.

Golgi Bodies in Plant Cells.

THE interesting letter of Prof. Bose, in NATURE of Dec. 3, on the Golgi apparatus of plant cells, may serve us as reason for discussing shortly the present position of our knowledge of this branch of cytology. The last ten years' work has enabled animal cytologists to show that the classic Golgi apparatus of nerve cells is a highly specialised structure, and that the true primitive Golgi body is in the form of a chromophile (osmiophile, argentophile) cortex and a chromophobe medulla, the whole usually granular in nature, except when the various elements form a close mass around the centrosome, in a juxta-nuclear position. In oogenesis these granules usually multiply rapidly and their centres become vacuolated and occupied by fatty materials forming the vitellus of the egg. In gland secretion the same phenomenon often happens. In spermatogenesis, in all animals investigated, the Golgi bodies secrete a bead which becomes attached to the nucleus to form the acrosome.

Now in plant cells, Guilliermond and his school have homologised the well-known plant canalicular system, with the net-like Golgi apparatus of nerve cells. The two structures superficially resemble each other. Moreover, as Guilliermond (and now Prof. Bose) has shown, this canalicular system in plants sometimes has the power of reducing silver, and osmic acid, as has the Golgi apparatus of nerve and other animal cells.

Recently Parat has extended the vacuolar conception of the plant 'Golgi apparatus' to animal cells, and has claimed that the vacuoles in eggs, first described, I believe, by Dr. Ludford and myself, and more recently investigated, among others, by Dr. Rodgers Brambell and Miss Shana King, and the vacuoles in gland and other cells (Ludford, Nassonow, Bowen), are the true Golgi apparatus, and homologous with the plant canalicular system. The Russian (Nassonow), the American (Bowen), and the Belgian (Duesberg), and the leading English workers, all seem to regard the cortex of the animal vacuole as the homologue of the nerve cell Golgi apparatus. The vacuole is usually regarded either as the derivative (English school) or the associate of the true Golgi cortex (osmiophile, argentophile). To the non-cytologist this can be explained by thinking of the intracellular granule as an orange. British workers regard the skin as the homologue of the nerve cell Golgi apparatus, its contents as the derivative of the cortex. Parat and Guilliermond would regard the inside as the true Golgi apparatus, and the cortex—and here they fall—as a modified mitochondrial structure!

Amidst all these discussions, Dr. Charles Walker provides curious relief, by waking up nearly thirty years after Golgi discovered this intra-cellular organella, and claiming that this structure, which can be seen *intra vitam*, is merely an artefact. Be it noted that Dr. Walker (*Proc. Roy. Soc.*, 101, 1927) does not quote the botanist, Löwschin, who previously 'showed,' about twelve years ago, that one could manufacture mitochondria *which even divided*, by mixtures of different lecithin, albumen, and salt solutions.

Löwschin's papers are rarely quoted nowadays, and deserved better treatment from Dr. Walker. Curiously enough, Parat, exponent of the vacuolar Golgi apparatus, quotes the paper of Moore and Walker on mammalian spermatogenesis as evidence for the veracity of his theory! It was really Moore and Walker who discovered the "Golgi apparatus" in animal spermatogenesis!

Now Prof. Bose, following Guilliermond and his school, has demonstrated the canalicular system in mushroom cells. Like Guilliermond, he calls these canaliculi the Golgi apparatus. For years the work of Guilliermond's school has proved an embarrassment to the zoological cytologist. We could not but believe that bodies, so universal in animal cells (as universal as the nucleus itself), would not have real prototypes in the plant cells. Parat's rocket-like flash across the cytological sky also proved a temporary embarrassment, and has put several promising men on the wrong track.

Now, however, the recent paper by Bowen comes as a relief from the confusion of French cytology. Bowen (*Biol. Bull.*, **53**, 1927) claims that there are *three* categories of cell inclusions in plant cells, *besides the*

canaliculi: Structures resembling the invertebrate Golgi bodies; secondly, the well-known plastids; and thirdly, the mitochondria. Bowen gets the canaliculi, too. Moreover, and this is crucial, Bowen shows that in mosses his supposed Golgi bodies form the acrosome of the sperm *as in animals*.

Now, in view of Bowen's work, I feel that Prof. Bose's claim that the mushroom cell canaliculi are Golgi bodies, must be rejected. I believe that until Prof. Bose and other such workers follow these bodies through the life cycle of the plants they are studying, and demonstrate what they do in gametogenesis and in the general cell life of the plant, that such work as published by Prof. Bose is a waste of time. If Prof. Bose expects other cytologists to accept the view that what reduces silver and osmium in the cell must be Golgi bodies, he is much mistaken.

J. BRONTË GATENBY.

Trinity College, Dublin,
Dec. 5.

The Density necessary to produce the Nebulium Spectrum.

THE chief lines of the nebular spectrum have been identified by I. S. Bowen with forbidden transitions in the atoms of singly ionised nitrogen and singly and doubly ionised oxygen (NATURE, **120**, 473; Oct. 1, 1927). The life of an atom in the metastable state is very long compared to that of the other excited states, and the transfer to another state is accomplished by collisions of the second kind. Bowen argues that in the nebulæ, the density being extremely low and hence a long interval of time between impacts, the atoms in metastable states would return to normal states spontaneously with the emission of radiation. From spectroscopic data he has computed the frequency and frequency differences for N II, O II, and O III, and finds agreements with the chief nebular lines. A. Fowler has since computed the frequency differences, using data not available to Bowen, and finds even better agreement with the nebular lines (NATURE, **120**, 582, 617; 1927).

It remains to be seen whether a nebular spectrum can be produced when the density of a mixture of oxygen and nitrogen becomes small enough. The production of densities in the laboratory comparable with those in the nebulæ seems to be impossible with the present technique, and it is necessary to look to celestial phenomena in which the predominating physical change is that of decreasing density. The novæ offer just such an example, for in these objects there is apparently the expulsion of a shell of gas, and at some time in the life of this shell there originates from it the characteristic lines of the nebular spectrum.

To obtain the density of the shell of gas when it reaches the nebular stage it is necessary to know the original density and radius of the shell, which is probably the atmosphere of the star, the velocity of the shell, and the interval from outburst to the nebular stage. These data are available only in the case of Nova Aquilæ 3, which had a spectrum of type A and an absolute magnitude of $+2{\cdot}7$ before outburst. This indicates that the star belonged to the main sequence and, hence, one may make a good estimate of its radius and of the density of its atmosphere, about 6×10^5 km. and 10^{-9} grams per c.c., respectively. The velocity corresponding to a displacement of half of the width of the emission lines is taken as the rate of expansion of the shell. For Nova Aquilæ 3 this is about 1700 km./sec. (Hubble and Duncan, *Astroph. Jour.*, **66**, 59; 1927.) The N_1, N_2 lines were recognised in the spectrum of the nova about nineteen days after the outburst. Assuming that the shell was moving out with a constant thickness, the density at the time of the appearance of the nebular spectrum is about 10^{-17} grams per c.c. This density compares well with the mean densities of from 10^{-18} to 10^{-20} grams per c.c. obtained for the nebulæ.

For other novæ the densities in the shells at the time of nebular stage can be obtained in terms of the original densities and radii of the shells. The results for nine novæ are as follows:

Nova.	Density.
Nova Aurigæ . .	$3{\cdot}2 \times 10^{-20}\ \rho_0 r_0^2$ grams/c.c.
Nova Geminorum 1 .	7·7
Nova Persei 2 . .	2·2
Nova Lacertæ . .	2·3
Nova Geminorum 2 .	8·5
Nova Aquilæ 3 . .	12·7
Nova Cygni 3 . .	5·5
Nova Ophiuchi . .	2·4
Nova Pictoris . .	1·3

ρ_0 = original density, r_0 = original radius.

It is rather surprising that there should be such little variation in the coefficients of $\rho_0 r_0^2$. The constancy would seem to indicate that the novæ originate from stars of similar physical conditions and that there is a limiting density above which the conditions are unfavourable for the production of the nebular spectrum.

Until more is known of the pre-nova history, the objects will have to be treated statistically. Assuming that the original stars belong to the main sequence, and again using the density 10^{-9} grams per c.c. and the radius 6×10^5 km., the mean density at which the nebular spectrum appears is $1{\cdot}8 \times 10^{-17}$ grams per c.c.

C. T. ELVEY.

Dearborn Observatory,
Evanston, Illinois,
Nov. 30.

Amendments to the International Rules of Zoological Nomenclature.

UPON unanimous recommendation by the International Commission on Zoological Nomenclature, the International Zoological Congress, which met at Budapest, Hungary, Sept. 4-9, 1927, adopted a very important amendment to Article 25 (Law of Priority), which makes this Article, as amended, read as follows (*italicised type represents the amendments*; Roman type represents the old wording):

Article 25.—The valid name of a genus or species can be only that name under which it was first designated on the condition:

(*a*) That (*prior to January 1, 1931*) this name was published and accompanied by an indication, or a definition, or a description; and

(*b*) That the author has applied the principles of binary nomenclature.

(*c*) *But no generic name nor specific name published after December 31, 1930, shall have any status of availability (hence also of validity) under the Rules, unless and until it is published either*

(1) *With a summary of characters (seu diagnosis; seu definition; seu condensed description) which differentiate or distinguish the genus or the species from other genera or species;*

(2) *Or with a definite bibliographic reference to such summary of characters (seu diagnosis; seu definition; seu condensed description). And further,*

(3) *In the case of a generic name, with the definite unambiguous designation of the type species (seu genotype; seu autogenotype; seu orthotype).*

The purpose of this amendment is to inhibit two

of the most important factors which heretofore have produced confusion in scientific names. The date, Jan. 1, 1931, was selected (instead of making the amendment immediately effective) in order to give authors ample opportunity to accommodate themselves to the new rule.

The Commission unanimously adopted the following resolution :

(*a*) It is requested that an author who publishes a name as new shall definitely state that it is new, that this be stated in only one (*i.e.* in the first) publication, and that the date of publication be not added to the name in its first publication.

(*b*) It is requested that an author who *quotes* a generic name, or a specific name, or a subspecific name, shall add at least once the author and year of publication of the quoted name or a full bibliographic reference.

The foregoing resolution was adopted in order to inhibit the confusion which has frequently resulted from the fact that authors have occasionally published a given name as ' new ' in two to five or more different articles of different dates—up to five years in exceptional cases.

The three propositions submitted by Dr. Franz Poche, of Vienna, failed to receive the necessary number of votes in Commission to permit of their being recommended to the Congress. Out of a possible 18 votes for each proposition, Poche's proposition I. received 9 votes, II. received 6 votes, and III. received 7 votes.

Zoological, medical, and veterinary journals throughout the world are requested to give to the foregoing the widest possible publicity in order to avoid confusion and misunderstanding.

C. W. STILES,
Secretary to Commission.
United States Public Health Service,
Washington, D.C.

Salivary Secretions of Blood-sucking Insects in Relation to Blood Coagulation.

MOST blood-sucking insects at the time of biting inject into their host an irritant which causes a skin reaction, generally a wheal, more or less conspicuous and itching in relation to the habituation of the host to the particular parasite. Although these injections are of such great importance in the transmission of disease, their purpose has in no case been properly elucidated hitherto. Macloskie forty years ago suggested that the salivary secretion of mosquitoes prevents the blood from clotting on the way to the stomach, but the work of Nuttall and Shipley (1903), and of Schaudinn (1904), threw doubt on this theory. Cornwall and Patton (1914) proved the presence of an anticoagulin in the salivary glands of several blood-sucking insects and ticks, and also showed that a neutralising coagulant enzyme sometimes existed in the stomach.

Dr. H. M. O. Lester, of this Tsetse Investigation, has found that the tsetse-flies, Glossina, have both an anticoagulin in the salivary secretion and a coagulin in the mesenteron, and, after studying the behaviour of these enzymes *in vitro*, has come to the conclusion that their influence on the coagulation of blood is similar to that of antikinase and kinase respectively. The anticoagulin thus differs from the anticoagulant enzyme of the leech, Hirudin, which is said to be an anti-thrombin.

We have proved that Macloskie's theory, if applied to the tsetse-fly, is correct. The entire salivary glands of *G. tachinoides* may be removed by a very simple operation without killing the fly and often without causing appreciable shock. Flies from which the glands are thus removed draw blood normally for a time, causing no wheal on the most susceptible skin, and may survive for long. There is never any regeneration of the glands. One fly lived for 58 days, taking 26 meals of human blood and producing 4 healthy larvæ, while others survived to 14 days. Sooner or later the flies choke, or sometimes get convulsions, and can no longer draw blood. It is then found that the lumen of the proboscis and the œsophagus are occluded by clot, and generally the capacious crop is also full of firmly clotted blood. In the case of the tsetse-fly, therefore, the injection of salivary secretion into the host is not a necessary preliminary to feeding but rather in the nature of an accident, because the secretion mixes with the indrawn blood at the very tip of the proboscis, so that a certain amount inevitably escapes into the tissues of the host.

The amount of secretion mixed with the blood is enough to delay the coagulation of mammalian blood for 2-3 hours at least, but the coagulin of the mesenteron is so powerful that in a matter of seconds it has neutralised the anticoagulin and formed a small clot at the posterior end of the meal. The main function of this clot appears to be that it puts a brake on to the fluid meal and holds it in the proper region of the gut while digestion begins. LL. LLOYD.

The Tsetse Investigation,
Azare, via Bauchi,
Nigeria, N.P.,
Nov. 16.

The Thermal State of the Earth's Crust.

THE product of the rate of increase of temperature with depth in the earth's crust into the thermal conductivity of the surface rocks gives the rate of loss of heat from the interior. When allowance is made for the residual effects of the original heat, this gives a most important datum concerning the rate of generation of heat below, and hence, if the radioactivity of the rocks is known, to an estimate of the thickness of the radioactive layer. Hitherto it has been good enough, in discussions of this problem, to adopt mean values of the temperature gradient, the conductivity, and the radioactivity. It has now, however, become worth while to allow for variation of conductivity with depth, and to attend more to details in the vertical distribution of radioactive matter. When this is done as well as is at present possible, the agreement of the results with those obtained from the study of near earthquakes is practically perfect (*Gerlands Beiträge z. Geophysik*, **18**, 1-29; 1927).

The next step towards understanding the earth's thermal state is to find out why the observed temperature gradient varies from place to place; the mean for North America, for example, is substantially less than for Europe. This may be attributed to a different thickness of the radioactive layers, or to different percentages of radioactive matter in them. But these questions cannot be effectively discussed without an additional datum that has not yet attracted the attention of observers, namely, the conductivity of the uppermost layer (usually sedimentary). The actual temperature gradients are measured in this layer, and we cannot find the rate of conduction of heat to the surface without a knowledge of its conductivity. Conductivities of sedimentary rocks are given in some of the standard physical tables, but these refer to dried specimens, and the effective conductivity of the same rocks *in situ* is probably considerably higher on account of the part played in transferring heat by water in the interstices. Further, there is no known reason why it should not vary from place to place.

If any experimenter is willing to collect samples of the rocks from the principal borings and mines where temperature gradients have been measured, being careful to retain any moisture they may contain, and to determine their conductivities, he will achieve a great service to geophysics.

HAROLD JEFFREYS.

St. John's College, Cambridge.

The Aston Dark Space.

SIR J. J. THOMSON'S comment in the November *Philosophical Magazine* upon the similarity between the non-luminous layers which cover cold surfaces in a high-frequency electrodeless discharge, and the intensely dark region within the cathode dark space and immediately adjacent to the cathode of a Geissler discharge, discovered by Dr. F. W. Aston in 1907, points to a fresh way for finding the respective contributions of positive ions and electrons to the current in the latter case. Both have the appearance of the positive ion sheaths which have recently become important through their application by Langmuir to the theory of exploring electrodes. Since there is good evidence that the fall of potential across the Aston dark space is the ionisation potential of the gas, the current density of positive ions can be calculated by inserting in Langmuir's equation for a plane collector the appropriate observed thickness of the layer, and when compared with the total current density, this will give the required information, without, of course, affording any idea as to exactly how the electrons are produced at the metal surface.

Unfortunately, the Aston dark space can be seen in only a few gases, and the experimental data by which any theory of its origin can be tested are meagre. Langmuir's analysis does, however, explain why its thickness is independent of pressure, if the effect of collisions made by the positive ions in traversing the sheath can be neglected, and also why its thickness is approximately inversely proportional to the square root of the current density, on the assumption that the relative contributions of the two types of carriers do not depend on the total current. Somewhat similar ideas seem to have been first proposed by Prof. Günther-Schulze in 1925, to explain why it does not appear in heavy gases, where it should theoretically be too thin to be seen. As regards numerical agreement, we do not feel justified in saying more at present than that the quantities involved are of the right order of magnitude, but we feel that the conception of a space-charge sheath on the cathode, separating it from the main cathode dark space, does at least partly remove the somewhat arbitrary distinction between this electrode and any other type of collector which had to be made previously.

K. G. EMELEUS.
N. M. CARMICHAEL.

Queen's University of Belfast,
Dec. 3.

Use of the Term 'Self-Adaptation' in Biology.

THE letter from Mr. A. G. Lowndes, published in NATURE of Dec. 24, raises a question of great and increasing importance. We all know that the old controversy between materialism and vitalism has entered on a new phase, and a decision is once more in the balance. It is, therefore, premature to clear our biological language of all terms savouring of vitalism, more especially as materialism has definitely failed to account for certain well-defined phenomena of development. The modern tendency is distinctly against ignoring mental phenomena, and making a sharp line of demarcation between humanity and the rest of the world of life. Biologists with a philosophic training prefer to explain unknown things in terms of the known, and nobody can deny that mental processes are much more amenable to cognition than any material processes whatever. We know what we mean by the term 'self-adaptation,' and we have no reason to exclude the animal world, or even the vegetable kingdom, from the working of a process familiar to our own experience.

Materialistic biology has had its day, and has done useful work in clearing the ground of mystical conceptions. Paracelsus, the first materialist, proclaimed man to be a chemical compound. In doing so, he killed at one blow all the demons and spirits which had encumbered the art of medicine. There is no necessity now to hug obsolete bio-chemical theories for fear that if we yield an inch to the vitalists the hosts of pandemonium will be let loose upon us. We can, therefore, give due regard to the psychological factor which, on any philosophically sound view, must be co-extensive with life.

E. E. FOURNIER D'ALBE.

47 Brentway,
Finchley,
London, N.3.

Imperial Agricultural Research.

ONE may hope it will not be assumed by readers of the editorial in NATURE of Oct. 15 (p. 539) that anything approaching complete failure has attended the efforts of the trustees of the Science and Industry Endowment Fund to attract post-graduate students to the biological services of the Commonwealth Government. It is true that no candidate of sufficient standing came forward for the first scholarship offered in mycology. Possibly the trustees made a mistake in insisting on first-class final honours and definite proof of capacity for research, though it will be a pity if it is found necessary to lower the standard. There are, however, quite a number of graduates at present in training abroad in other branches of work, including three in entomology, two in food preservation, two in forest products, and one (recently appointed) in plant pathology. In addition, three are gaining experience in fuel research. So far no studentships in genetics have been offered.

A. C. D. RIVETT.

Commonwealth Council for Scientific
and Industrial Research,
314 Albert Street, East Melbourne,
Nov. 23.

'Greasy' Burettes.

BURETTES employed in volumetric analysis to contain standard acid usually present, after short use, a greasy appearance, and considerable inaccuracy in measurement may result from the adherence of small drops of the solution to the surface of the glass above the liquid.

The necessity for frequent cleansing with a brush may be obviated by the addition of a minute trace of saponin to the standard acid, and, provided that the amount added be very small, and the solution not unduly shaken, there need be no inconvenience due to frothing.

A burette containing decinormal hydrochloric acid, thus treated, has been in use for several weeks, without any necessity for cleansing, and the device is no doubt capable of more general application to other solutions.

W. LOWSON.

Chemistry Department,
The University, Leeds.

New Data on Alcohol and Duration of Life.[1]

By Prof. RAYMOND PEARL and AGNES LATIMER BACON.

IN "Alcohol and Longevity" (New York: Knopf, 1926) Pearl presented life tables embracing some 5248 persons, living and dead, from the working-class population of Baltimore, divided into groups according to the extent and regularity of their alcohol consumption during life. The life tables demonstrate that, so far as could be judged by the sample of lives: "the moderate drinking of alcoholic beverages did not shorten life. On the contrary, moderate steady drinkers exhibited somewhat lower rates of mortality and greater expectation of life than did abstainers. This superiority is not great in the male moderate drinker, and may not be significant statistically. But it certainly gives no support to the almost universal belief that alcohol always shortens life, even in moderate quantities."

The purpose of the present paper is to report briefly some additional evidence bearing upon these results, which has been gained from a new and entirely independent set of data. For some time past we have been engaged in the study of the autopsy records of the Johns Hopkins Hospital. The first 7500 of the autopsy protocols have been abstracted and the information they contain has been transferred to cards for statistical study. The general statistical characteristics of this material, and the incidence of cancer in it, have already been reported by us.[2] Besides the strictly pathological records from the autopsy protocols there was also set down on each working card certain information derived from the clinical history of the patient filed in the archives of the Johns Hopkins Hospital. Among other items there was transferred to the card whatever information existed in the clinical history regarding the use of alcoholic beverages by the patient. Omitting the cases in which there was no information in the history regarding alcohol habits (of which there were 3906), and those in which the statements made on the point were so lacking in precision as to make it impossible to conclude more than that the person had at some time in life used some alcohol as a beverage (of which there were 42), we have the number of cases shown in Table I. of persons twenty years or more of age at the time of death, in which the information recorded is believed to be critically accurate.

TABLE I.

Group.	Abstainers.	Moderate Drinkers.	Heavy Drinkers.
Male white . .	239	713	418
Male coloured [3] .	85	435	340
Female white .	119	66	10
Female coloured [3]	75	95	23
Total . .	518	1309	791

There are thus 2618 persons for whom we have definite records as to alcohol consumption, on one hand, and age at death on the other hand. These persons are derived from all classes of society. They include rich and poor, labourers and loafers. As a group they are far less homogeneous than the group studied in "Alcohol and Longevity." One thing that they have in common, however, is that they died in the Johns Hopkins Hospital and were there 'autopsied.' The statements which they made as to their alcohol habits were given to the hospital physician under whose care they were, as a part of their medical history. It was information given in some sense 'under the fear of death.' They were persons who had come into the hospital because they were ill and hoped to be cured, or at least benefited by medical or surgical treatment. In such circumstances they were likely to tell the truth as they knew it regarding their alcoholic habits. Anyone who is ill and hopes to be made better, will try to be as exact as possible about a habit which both he and the physician believe may have a significant bearing upon his present state, the method of treatment to be adopted, and the prognosis. Indeed his eager desire to put the physician in possession of all the facts which may possibly have a bearing upon his case often leads to a garrulity over details which sorely tries the patience of the clinician.

The rubrics 'abstainer,' 'moderate drinker,' and 'heavy drinker,' have precisely the same meaning here as the same terms did in "Alcohol and Longevity" (see pp. 72, 73 of that book for the definitions of these terms used in classifying the material in that study and in this one).

Table II. gives the distributions of the ages at death (and autopsy) of the 2618 persons included in Table I.

As we have already pointed out in the papers cited above, a hospital population is always a selected one, and the 'autopsied' proportion represents a still further selection. But we know of no reason to suppose that any of the selective factors operating under these premises are such as, *per se*, to affect differentially the distribution of ages at death of those persons in an 'autopsied' hospital population who have been previously abstainers, as distinguished from those who have been moderate drinkers, or of these in turn from those who have been heavy drinkers.

In Table III. are given the simple biometric constants for the age distribution of Table II., the centring points used being those previously given by Miner.[4]

From the data here presented the following points are to be noted:

1. As compared with a general population, the part of an 'autopsied' population here discussed is,

[1] Papers from the Statistical Department of the Johns Hopkins Hospital (No. 10), and from the Institute for Biological Research of the Johns Hopkins University.

[2] Pearl, R., and Bacon, A. L., Biometrical Studies in Pathology. IV. Statistical Characteristics of a Population Composed of Necropsied Persons, *Arch. of Path. and Lab. Med.*, vol. 1, pp. 329-347, 1926. V. The Racial and Age Incidence of Cancer and other Malignant Tumors; *Ibid.* vol. 3, pp. 963-992, 1927.

[3] Meaning persons of pure negro blood, or mixed negro and white in any proportion.

[4] Miner, J. R., "The Centering Points of Distributions by Age at Death," *Amer. Jour. Hyg.*, vol. 5, pp. 102-105, 1925.

as a whole, inferior in mean duration of life. This has been shown in an earlier paper (*loc. cit.*) to be true of the Johns Hopkins Hospital autopsies as a whole. In this respect, and also in the respect that the mean age at death of the females is lower, generally speaking, than that of the males (instead of higher as in the general population), the part of the autopsy material here dealt with appears to be a fair sample of the total 'autopsied' population from which it is drawn. In other words, the cases for which information is available as to alcoholic habits appear not to be sensibly differentiated in other respects from the rest of the 'autopsied' group.

TABLE II.

Group.	Age at Death.							
	20-29.	30-39.	40-49.	50-59.	60-69.	70-79.	80-89.	90-99.
Male whites :								
Abstainers . .	39	35	45	50	35	31	4	..
Moderate drinkers	84	117	151	184	117	54	6	..
Heavy drinkers .	38	95	105	102	66	11	1	..
Male coloured :								
Abstainers . .	31	12	17	13	9	2	1	..
Moderate drinkers	112	100	92	76	39	14	2	..
Heavy drinkers .	55	76	91	75	33	9	..	1
Female white :								
Abstainers . .	16	26	31	24	18	4	..	..
Moderate drinkers	7	18	13	14	12	1	..	1
Heavy drinkers .	1	4	2	3	..	..	..	..
Female coloured :								
Abstainers . .	17	17	19	15	5	1	1	..
Moderate drinkers	22	24	27	15	4	3	..	..
Heavy drinkers .	6	8	4	3	2	..	..	..

2. The coloured persons in this experience have lower mean ages at death than the corresponding groups of white persons. Again the result is in agreement with the autopsy experience as a whole, as previously reported, and with general population figures. The negro seems always to be a poorer life risk than the white, under American urban conditions.

3. There is no significant difference between abstainers and moderate drinkers, in respect of mean age at death, in any of the four groups. In two groups (male white and female coloured) the mean for the abstainers is slightly higher than that for the moderate drinkers, while in the other groups the opposite condition appears. With the exception of the male coloured group, the mean age at death of the heavy drinkers is lower than that for either abstainers or moderate drinkers.

4. What the present material shows, in short, is that in the first 34 years of operation of the Johns Hopkins Hospital, all of those patients in its experience over twenty years who came to autopsy and were known to have been moderate drinkers (as defined in " Alcohol and Longevity ") died at approximately the same average age as did all of those patients over twenty years of age who came to autopsy and were known to have been total abstainers. Thus material from a totally different source, collected by entirely different persons with no possible thought of its use in the present connexion, representing a different portion of the general population, and of a high degree of critical accuracy, essentially confirms the main conclusion of the former study, embodied in " Alcohol and Longevity." *This autopsy material gives no evidence that moderate drinking shortens life.*

We intend to make detailed studies of the pathology of the different organ systems of the body in this material, classified according to drinking habits.

TABLE III.

Group.	Mean Age at Death (Years).	Standard Deviation (Years).	Coefficient of Variation.	Difference in Mean Ages at Death (Years).
Male white :				
Abstainers	50·05±0·72	16·43±0·51	32·83±1·12	Abstainer—moderate =0·34±0·80
Moderate drinkers . . .	49·71±0·36	14·44±0·26	29·04±0·56	Abstainer—heavy =2·41±0·83
Heavy drinkers . . .	47·64±0·42	12·70±0·30	26·66±0·66	Moderate—heavy =2·07±0·55
Male coloured :				
Abstainers	41·30±1·12	15·34±0·79	37·14±2·17	Heavy—abstainer =3·54±1·22
Moderate drinkers . . .	42·45±0·46	14·18±0·32	33·40±0·84	Heavy—moderate =2·39±0·66
Heavy drinkers . . .	44·84±0·48	13·10±0·34	29·21±0·82	Moderate—abstainer =1·15±1·21
Female white :				
Abstainers	46·40±0·83	13·35±0·58	28·77±1·36	Moderate—abstainer =0·92±1·44
Moderate drinkers . . .	47·32±1·18	14·17±0·83	29·95±1·91	Moderate—heavy =5·10±2·75
Heavy drinkers . . .	42·22±2·48	9·73±1·47	23·05±3·65	Abstainer—heavy =4·18±2·62
Female coloured :				
Abstainers	42·67±1·04	13·38±0·74	31·35±1·89	Abstainer—moderate =1·26±1·36
Moderate drinkers . . .	41·41±0·87	12·54±0·61	30·28±1·61	Abstainer—heavy =3·12±2·11
Heavy drinkers . . .	39·55±1·84	12·17±1·21	30·78±3·34	Moderate—heavy =1·86±2·04

The Glozel Investigations.

THE report of the International Commission on Glozel appointed by the Institut d'Anthropologie, appeared on Dec. 23 as a special supplement of the *Revue Anthropologique*. It describes the investigations carried out by the Commission on the ground and the results of an examination of the objects previously found.

The Commission's verdict is unanimous, and it is unfavourable. The objects examined at Glozel cannot be regarded as ancient. M. Peyrony appends a report, in which he recants his former opinion in favour of their genuine character. The criticisms of previous visitors are fully corroborated. The Commission directs attention to the unsystematic character of the digging, to which Mr. Crawford has already referred, the haphazard excavations giving the ground the appearance of having been shelled. Dr. Morlet stated that this was due to the fact that visitors had been allowed to excavate where they pleased as a pledge of good faith, and also that the antiquities were apt to occur in veritable nests.

Two trenches were dug by the Commission, one on the east and one on the west. Nine objects in all were found, including a 'brick' with alphabetiform signs, a ceramic 'idol,' which crumbled to pieces when touched, and a stone ring. Precautions were taken to prevent tampering when the Commission was not on the ground; but it is significant that loose earth usually preluded a find. Dr. Morlet stated that this was generally the case.

The Commission came to the conclusion that the objects had been 'introduced' to the point at which they were found, and at no ancient date. It was clearly evident that a clod of earth had been taken out and replaced after the 'brick' had been inserted in the place in which it was found. Of the objects previously found, mostly from the oval pit first discovered, some may be genuine, others may be ancient, but if so there is nothing to show when they were introduced. The remainder exhibit anomalies which would be difficult to explain if they were really genuine.

It was scarcely to be expected that the champions of Glozel would take the report of the Commission lying down. Immediately on the publication of the report, says the Paris correspondent of the *Times*, in the issue of Dec. 27, MM. Salomon Reinach, Loth, and Esperandieu published a manifesto in which they compared the Commission to the Inquisition and the verdict to the condemnation of Galileo. Dr. Morlet, notwithstanding the fact that his personal sincerity and integrity had been fully endorsed by the report, has also lost no time in counter-attacking. He criticises the composition and procedure of the Commission, but his reply speedily resolves itself into an attack on MM. Begouen and Capitan, and an accusation against two other members, in one case of tampering with the ground, in the other of scratching with a penknife a stone on which a reindeer was drawn. Of this, which is in the right Glozelian manner, perhaps the less said at the present stage the better.

Although it is improbable that we have heard the last of Glozel, the resources of a laboratory, and especially an analysis of the material which is said to be evidence of cremation, from which the Commission was precluded, would no doubt deal it a final blow, but one which in the opinion of most field archæologists is unnecessary.

In *Discovery* for January, M. Salomon Reinach expounds his reasons for accepting the Glozel finds as genuine. Excepting M. Reinach's own letters in the *Times*, we believe this is the first occasion on which one of the French protagonists in the controversy has had an opportunity in England of supporting the genuineness of the discovery. On the general question, M. Reinach relies on the number of the objects found, and is of the opinion that the manufacture of these three thousand antiquities is beyond the energy and powers of any forger. The inscriptions, he maintains, present certain features, such as the absence of the letter B, which would be beyond the knowledge of any but a specialist. In his view, previous discoveries, including those of Lartet, Christy, and Piette, as well as the inscriptions from Alvao in Portugal, all lead up to those at Glozel, which should not, therefore, have come as a surprise. Apparently, the survival of the reindeer in the obscure period between the palæolithic and the neolithic is to be accepted as a fact, and its representation here not regarded as evidence against the genuine character of the discovery.

In the meantime, however, M. Dussaud, curator of the Louvre Museum, in repeating his charges against the Fradins of 'faking' the finds, argues that their number and character does not preclude the possibility of forgery. He points out that Lequeux, who is now in prison for fraud in connexion with finds from Spiennes and Morocco, produced very nearly as many. Nor was the knowledge required beyond the reach of young Fradin, for books had been lent him by M. Clément. Of the first three bricks handed to Dr. Morlet, two had been treated in the furnace which existed on the site; but this was afterwards recognised by M. Franchet, an expert in ceramics, as dating from the sixteenth century. M. Camille Jullian remains unshaken in his view that the finds are genuine, but the stock in trade of a Gallo-Roman magician. He has proceeded further with the translation of the tablets and explains the Phœnician characters as an example of the practice of using Hebrew and other foreign characters in magical formulæ.

The absence of the mouth in the human faces represented at Glozel has led P. Hippolyte-Boussac of the Institut d'Egypte to ask why this feature should frequently be absent in primitive

carvings, drawings, and other representations of the human form. In *La Nature* for Dec. 15, he points out that although, according to certain views, the numerous figurines found in or near burials stood for a tutelary goddess of the tomb, and the absence of the mouth may be emblematic of the silence of death, it does not explain why that rather than any other feature should be left out. He reviews a number of examples, and in particular pictures by the aborigines of Australia in which it is omitted. These he seeks to connect with an animistic train of thought such as that which placed a Wingless Victory before the Propylæum at Athens—wingless in order that she might not leave the city. By analogy the sepulchral and other figures are represented without a mouth to prevent them from talking. Obviously, P. Boussac's suggestion has no bearing on the genuine character of the Glozel figures, and wisely he refrains from committing himself on the point.

The Development Commission.[1]

THE report recently issued by the Development Commissioners for the year ended Mar. 31, 1927, is mainly a series of summaries of work in progress at the centres of agricultural research assisted from the Development Fund, and as such is a convenient source of reference. The part relating to fisheries is much shorter, but indicates the activity in sea and other investigations. Another useful reference is the list of publications for 1926–27 : (*a*) relating to researches carried out at agricultural research institutes aided from the Development Fund, (*b*) published by advisory officers, (*c*) relating to researches carried out at fisheries laboratories aided from the Development Fund. These reports indicate that the Development Commission is expected to supervise a field that includes animals, plants, soils, economics, on to the welfare of the countryside, and even provision of harbours and the widening of roads.

The Development Fund now contributes a little more than £400,000, mainly to agricultural research. That this sum, large though it be, is inadequate for its aims is evident from a perusal of the report. Fortunately, in a period of national stringency, other sources have come into being to meet the increasing demands of research. The original Development Fund required in that year an addition of £200,000, voted by Parliament, £60,000 more than the previous year. Supplementary to this is a Special Fund provided by the Corn Production Acts (Repeal) Act, 1921, by which the original fund is doubled. This was limited to a five-year period and has now ceased, and new arrangements are outlined. More recently two other sources of contributions have come into being, the Empire Marketing Board for research into problems connected with production and marketing in Great Britain and overseas, and the International Education Board established by Mr. John D. Rockefeller, Jr., in 1923.

These new sources for grants are evidently handling large sums, and their relation to the Development Fund is discussed at some length. A case given in the report, the development of the Animal Breeding Research Department at Edinburgh, illustrates the position : the Development Fund contribution was £16,000, the International Education Board gave £30,000, the Empire Marketing Board £10,000, and a generous donor £10,000. The same applies to other large research institutes, so that great post-War developments have been possible. At the same time, the whole structure seems needlessly complex, and it looks as if a large amount of energy were expended on administration and finance rather than on actual research.

The recent progress of animal research is a feature of the period of the report. The large equipment necessary has been provided from the various sources indicated. The scope of the work may be seen by the reports from some of the larger centres ; at Cambridge, animal nutrition and animal pathology ; at the Rowett Institute, Aberdeen, composition of pastures and the influence of iodine ; at Edinburgh, animal breeding and animal diseases. On the plant side, the grants cover many investigations on nutrition, breeding, and pathology. A recent development is the study of fruit, its culture and preservation, as conducted at Long Ashton, East Malling, and other research institutes, largely assisted by the Empire Marketing Board.

The scheme for advisory officers, provided for by the Development Fund for fifteen years, is reviewed at some length (pp. 89-109). The grants to eighteen centres total about £60,000, not including special grants for equipment, etc. It is now suggested that as the centres become better staffed with county organisers, the function of the advisory officer might be better described by the term local research officer. Why not use the simple word ' adviser,' which suggests advice, and allow ' officer ' to lapse, since it suggests something in the way of inspection or detection ?

The grants under the heading of fisheries and harbours are only a small part of the State contributions, but they have encouraged a number of special investigations, including those on haddock, herring, and various shell-fish.

A number of smaller grants have been made for the encouragement of rural industries, as a contribution to the larger movement for development of the countryside. A review of the position points out that, with motor transport and broadcasting, village life is not so isolated as formerly ; hence the need for revision of schemes. Much of the present work must be experimental, but there is need for concentration so as to bring the efforts under the control of some more centralised organisation than at present.

[1] Development Commission. Seventeenth Report of the Development Commissioners for the year ended Mar. 31, 1927. (London : H.M. Stationery Office, 1927.) 3*s*. net.

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Pay will be admissible in accordance with an age scale, *e.g.*: Age 23 years: Rs. 300 per calendar month plus overseas pay of £20. 29 years: Rs. 600 per calendar month plus overseas pay of £30. Overseas pay is admissible only to an officer of non-Asiatic domicile.

Further particulars and forms of application may be obtained (upon request by postcard) from the SECRETARY TO THE HIGH COMMISSIONER FOR INDIA, General Department, 42 Grosvenor Gardens, London, S.W.1. Last date for receipt of applications: January 21, 1928.

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Vacancy expected on group Rubber Plantations for SCIENTIFIC OFFICER. Suitable candidate must possess sound knowledge of Botany (structural and physiological) of Honours standard, and must be sufficiently acquainted with mycology and genetics to assist estates in disease and selection work. Field experiments and laboratory research chief part of duties. Occasional Touring.

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New Results on Cosmic Rays.[1]

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THE cosmic radiation is defined as that small portion of the ' penetrating radiation ' which is of cosmic origin. The main purpose of this paper is to present a preliminary report upon some very recent work which throws new light upon the properties of these extraordinary rays, and shows that still harder ones exist than had heretofore been found, rays capable of penetrating 190 feet of water, or about 16·7 feet (5 metres) of lead, before being completely absorbed.

Since doubts have been expressed so late as last summer by some of the foremost of living physicists as to whether or not there are any rays which have as yet been definitely proved to be of cosmic origin, and since up to this moment different observers of undoubted credentials, such as Swann,[2] Hoffmann,[3] Kolhörster, and ourselves differ in some cases as much as eight- or tenfold in our estimates of the intensity of the cosmic radiation if it exists, our first task will be to present very briefly the nature of the evidence up to the time of these experiments, and then to see how the new results supplement this evidence.

This procedure will have the further advantage of presenting a very beautiful illustration of the slow, step-by-step process by which most advances in science are made, each experimenter building on the past, but pushing on, if he is fortunate, a little beyond where his predecessors had gone, until presently the world finds itself in the full glory of a new conception of Nature without having been conscious of any particular instant at which the dawn came. Since the days of Greek mythology, very few discoveries have sprung full-grown out of the brain of anyone.

[1] Substance of an evening discourse, with additions, delivered by Prof. Millikan at Leeds, on Sept. 2, during the meeting of the British Association.

[2] Swann, *Phys. Rev.* (**29**, 372; 1927), finds the ionisation due to such rays on the summit of Pike's Peak to be 0·75 per c.c. per sec. per atmosphere, while we found them in the same place to be close to 5 ions.

[3] Hoffmann, *Ann. der Physik* (**82**, 413; 1927), finds the ionisation at sea-level 0·29 per c.c. per sec. on the assumption, taken from Kolhörster's 1926 findings (*Zeit. f. Physik*, **36**, 147; 1926), that the absorption coefficient is invariant and of value $\mu H_2O = 22 \times 10^{-3}$ cm.$^{-1}$. We, on the other hand (*Phys. Rev.*, **28**, 851; 1926), found the absorption coefficient definitely variable (the rays therefore inhomogeneous), and the ionisation at sea-level 1·4 ions.

EARLY WORK ON COSMIC RAYS.

A starting point in the study of the very ' penetrating radiations ' near the earth's surface was made in 1903 when these rays were brought to light and named by McLennan,[4] Rutherford,[5] and their collaborators, who found that the rates of discharge of electroscopes could be very markedly reduced by surrounding them with successive screens of lead several centimetres thick, thus showing that rays existed in the atmosphere capable of penetrating such thick screens, and therefore appropriately named the ' penetrating radiations.'

The next important step was taken by the Swiss physicist Gockel,[6] who in 1910 first took an enclosed electroscope in a balloon to a height of 4500 metres and found, contrary to expectation, that the radiation was higher at this altitude than at the surface, a fact which at once suggested that all of it, at least, was not of terrestrial origin, but that a part of it came into the earth's atmosphere from above, an idea which had been put forward by O. W. Richardson[7] so early as 1906.

During the next four years, Hess[8] in Austria and then Kolhörster[9] in Germany made other flights like Gockel's, checked his results and rendered them more *quantitative*, Kolhörster taking balloon readings up to 9000 metres, and finding the discharge rate decreasing slightly up to about 1000 metres and then increasing, until at 9000 metres it was some seven times as great as at the surface—more accurately, 80 ions more than at the surface, since it was this difference which he reported rather than the readings themselves.

The War put a stop for a while to further advances, but in the fall of 1921 and the spring of 1922, Millikan and Bowen[10] took the next important step by building and sending up recording electroscopes

[4] McLennan and Burton, *Phys. Rev.*, **16**, 184; 1903.
[5] Rutherford and Cooke, *Phys. Rev.*, **16**, 183; 1903.
[6] Gockel, *Phys. Zeit.*, **11**, 280; 1910.
[7] Richardson, NATURE, **73**, 607; **74**, 55; 1906.
[8] Hess, *Phys. Zeit.*, **12**, 998; 1911; and **13**, 1084; 1912.
[9] Kolhörster, *Phys. Zeit.*, **14**, 1153; 1913; and *Verh. d. Deut. Phys. Ges.*, July 30, 1914.
[10] Millikan and Bowen, *Phys. Rev.*, **22**, 198; 1923; and **27**, 353; 1926.

in sounding balloons to a height of nearly 10 miles—15,500 metres—more than nine-tenths of the way to the top of our atmosphere, measured by the fraction of the air left below. These flights checked the results of the European observers in indicating an increasing discharge rate up to that height, though the new observed rate was very much less than had been computed from the afore-mentioned observations up to 9000 metres; thus showing that the 'penetrating rays,' *if they came from above*, were actually more penetrating than had been supposed up to that time. Since if the rays come in from above, the ionisation inside airtight electroscopes must increase exponentially, that is, geometrically with the distance of rise toward the top of the atmosphere, these very high flights were, and are now, especially significant. They place very certain and very definite upper limits upon the absorption coefficients of the rays entering the atmosphere, if there are in fact such rays.

The fact, however, that the total discharge of the electroscopes in these flights was but about one-fourth what it should have been from the absorption coefficients, computed on the cosmic ray hypothesis from the data of Hess and of Kolhörster, suggested some other cause for the phenomenon. For up to this time the increasing rate of discharge with altitude was the sole phenomenon upon which the hypothesis of rays of cosmic origin rested. But other alternatives were possible, and had indeed been suggested; such, for example, as radioactive particles of unknown origin spread through the upper regions of the atmosphere. Such an alternative could be tested definitely by making *direct measurements* of the coefficients of absorption of the penetrating rays rather than attempting to compute these coefficients as had heretofore been done, on the assumption that the rays entered the atmosphere from above. For if the rays were of radioactive origin, they would not be expected to be appreciably harder than those of the known radioactive substances such as thorium D or radium C.

The next step was taken during summer of 1923, when Kolhörster[11] in Europe and Millikan and Otis[12] in America independently made the first direct absorption measurements with materials other than the atmosphere itself—the former in Alpine glaciers and in shallow bodies of water at sea-level, the latter in thick lead screens carried to the top of Pike's Peak—for the sake of throwing new light on the possible origin of the penetrating rays.

[11] Kolhörster, *Sitz. Ber. d. Preuss. Akad.*, **34**, 366, Dec. 20, 1923.
[12] *Phys. Rev.*, **23**, 778; April 1924. Also **28**, 851; 1926.

Kolhörster reported as a result of his glacier experiments an absorption coefficient of 0·25 per metre of water, or about half that previously found, namely, 0·55, thus eliminating the discrepancy between the findings from his balloon flights and our sounding balloon experiments. He states in the paper describing this work that his experiments prove definitely the existence of gamma rays of about one-tenth the absorption coefficient of the hardest known gamma rays (4·1 per metre of water),[13] but speaks with reserve about their origin. He says, after discussing various alternatives, that "one inclines more and more of late to the view that the penetrating rays are a phenomenon the origin of which is to be sought in the cosmos."[14]

Millikan and Otis, on the other hand, concluded from their new Pike's Peak absorption data that if any of the penetrating rays which they found on the Peak were of cosmic origin they had to be more penetrating, or less strong, than corresponded even with the reduced values now found by Kolhörster, namely, 2 ions at sea-level, absorption coefficient 0·25 per metre of water. The mean coefficient of the radiation which they found on Pike's Peak was but slightly less than that of thorium D, and a large part of it was certainly of local origin. They brought to light in these experiments no new evidence for the existence of rays of cosmic origin. Indeed, up to 1925, there appears from the literature to have been no feeling of certainty in any quarter that the existence of rays of cosmic origin had been proved. The increase in ionisation in closed vessels up to nearly 10 miles was an undoubted fact, and Kolhörster's glacier experiments were favourable to the cosmic ray interpretation; but the possibilities of the radioactive contamination of a glacier are not small, nor do its irregular shape and proximity to land masses adapt it well to trustworthy absorption-coefficient measurements. Further, Hoffmann[15] in Germany, with an extraordinarily fine technique, had in 1925 pronounced against the existence of rays of cosmic origin. Also in America, Swann[16] was convinced that the work of himself and his collaborators with the ionisation in vessels at pressures up to 75 atmospheres was incompatible with the cosmic ray interpretation of the penetrating radiation.

[13] Radioactivity, *Bull. Nat. Res. Council*, Kovarik and McKeehan, p. 114, 1925.
[14] "Neuerdings neigt man immer mehr der Ansicht zu, die Höhenstrahlung als eine Erscheinung aufzufassen, deren Ursprung im Kosmos zu suchen ist." Again: "Da für die erstere Auffassung der Höhenstrahlung als einer aus den höheren Atmosphärenschichten stammenden bisher keinerlei direkte Andeutung gefunden wurde, so sprechen die augenblicklichen Verhältnisse mehr zugunsten einer kosmischen Erklärung."
[15] Hoffmann, *Phys. Zeit.*, **26**, 40, 669; 1925.
[16] Downey, *Phys. Rev.*, **20**, 186; 1922. Fruth, *Phys. Rev.*, **22**, 109; 1923.

Observations in Mountain Lakes.

In 1925, however, Millikan and Cameron got unambiguous evidence from their own point of view of a penetrating radiation which had to be of cosmic origin. It was indeed weaker and more penetrating than had corresponded to preceding estimates, having an ionising power at sea-level of but 1·4 ions per c.c. per sec., an absorption coefficient which became as small as 0·18 per metre of water, and a definite spectral distribution, the longest wave-lengths found having a value, computed from A. H. Compton's formula, $\lambda = 0{\cdot}00063$ A, the shortest 0·00038 A. This last is but one-thirtieth the wave-length of the very hardest gamma rays.

These experiments consisted in sinking sealed electroscopes in deep, high-altitude, snow-fed lakes, and thus finding, to take a particular case, that the ionisation in Muir Lake (altitude 11,800 ft. or 3590 m.) decreased steadily with depth from 13·3 ions per c.c. per sec. at the surface to 3·6 ions at 60 ft. (18 m.) below the surface, below which point there was no further measurable decrease with instruments of such sensibility as were being used. *This was the first time the zero of an electroscope—the reading with all external radiations completely cut out—had been definitely determined, and the results accordingly began to show that it was possible to make with certainty determinations of the absolute amount of the penetrating radiation.*

Up to the point to which we have thus far described the experiment, it proved merely either the existence at the surface of the lake of a penetrating radiation so hard as to be able to penetrate 60 ft. (18 m.) of water before becoming completely absorbed, or else a very strange distribution of radioactivity in the water of the lake.

Next, by taking similar readings in another deep, snow-fed lake, 300 miles farther south and having an altitude 6700 ft. (2060 m.) lower, *we found a similar curve, but with each reading displaced just six feet upward.* But six feet of water was exactly the equivalent in absorbing power, where the mass absorption law holds, of the layer of atmosphere lying between the altitudes 11,800 ft. (3590 m.) and 5100 ft. (1530 m.).

This experiment, supplemented by later similar findings in other lakes, therefore proved definitely three things :

First, that the effects in Muir Lake had not been due to any radioactivity which happened to be distributed in the water in a particular way.

Second, that the source of the rays was not at all in the layer of atmosphere between the two altitudes, for this layer acted in every particular like an absorbing blanket, having precisely the absorption that it should have *if the rays came in wholly from above.*

Third, that in different localities 300 miles apart, north and south, the rays were *exactly* alike at the same altitudes.

These facts, combined with the further observation made both before and at this time, that within the limits of our observational error the rays came in equally from all directions of the sky, and supplemented finally by the facts that the observed absorption coefficient and total cosmic ray ionisation at the altitude of Muir Lake predict satisfactorily the results obtained in the 15·5 km. balloon flight, *all this constitutes pretty unambiguous evidence that the high altitude rays do not originate in our atmosphere, very certainly not in the lower nine-tenths of it, and justifies the designation 'cosmic rays,'* the most descriptive and the most appropriate name yet suggested for that portion of the penetrating rays which come in from above. We shall discuss just how unambiguous the evidence is at this moment after having presented our new results.

These represent two groups of experiments, one carried out in Bolivia in the High Andes at altitudes up to 15,400 ft. (4620 m.) in the fall of 1926, and the other in Arrowhead Lake and Gem Lake, California, in the summer of 1927.

Penetrating Radiation in the High Andes.

The experiments in the High Andes had four prime objectives as follows : (1) To see whether in lakes in the southern hemisphere the altitude-ionisation curve would coincide with that found in lakes in the northern hemisphere. This curve was particularly sensitive in the very high altitude lakes obtainable in the High Andes, and the spectral distribution found in 1925 could be more accurately tested. If the northern hemisphere and the southern hemisphere curves coincided, it would go a long way toward eliminating the possibility that the rays are generated by the incidence of high-speed beta rays on the very outer layers of our atmosphere—about the only hypothesis which could put the source of these rays in the last tenth of the air about the earth. For such beta rays would be expected to be influenced by the earth's magnetic field so as to generate stronger radiation over the poles than over the equator. In Lat. 17° S. we should be completely screened from such pole effects, particularly if we could get into suitable high altitude pockets in the mountains.

(2) To obtain further crucial tests of the C. T. R. Wilson hypothesis that these rays may be due to the integration of the effects of the impact in the earth's atmosphere of electrons endowed with many millions of volts of energy acquired in thunderstorms. Lakes in suitable pockets in the High Andes would be completely screened from such effects. Also, a comparison of the rays found in thunderstorm areas with those found in large regions like California which are comparatively free from thunderstorms might furnish check observations upon this point. (3) By determining, as outlined above, the zero readings of new electroscopes to obtain new checks on our value of the ionisation due to the cosmic rays at sea-level, a quantity upon which as yet there have been wide divergences between the results of different experimenters. (4) To get into suitable pockets or valleys in very high mountains where the rays are three or four times as intense as at sea-level, and there to make more trustworthy tests on directional effects in cosmic rays—in particular to see whether the Milky Way is more or less effective than other portions of the sky in sending these rays into the earth.

On all these four points we obtained, despite unfortunate accidents with two of the electroscopes, satisfactory and definite information.

As to (1), we obtained on the surface of Lake Titicaca (alt. 12,540 ft. or 3822 m.) readings which corresponded very nicely with similar ones taken at Muir Lake, California. Also in Lake Miguilla, near Caracoles, Bolivia (alt. 15,000 ft. or 4500 m.), we obtained readings which fell satisfactorily on the extrapolated Muir Lake curve. If, then, there are any geographical differences in the altitude-ionisation curve, they are beyond the limits of our present observational technique.

As to (2), Lake Miguilla is a small lake surrounded on all sides by mountains several thousand feet high. It would be completely shielded from rays having their origins in thunderstorms anywhere on the earth. Further, off the coast of Central America we took a long series of readings in the wireless room on shipboard on a night on which a brilliant display of lightning was going on along the coast, and we compared the results with readings taken on the California coast, which is almost entirely free from thunderstorms, without bringing to light the slightest difference. The C. T. R. Wilson hypothesis is therefore quite definitely eliminated.

As to (3), we took the zeros of two of our electroscopes by sinking them to sufficient depths and then made an elaborate series of sea-level observations on the ship all the way from Mollendo, Peru, to Los Angeles. *We found no variation in sea-level reading with geographical position,* and but slight differences between the ionisations in different

FIG. 1.—Lake Miguilla, Bolivia. Altitude, 15,000 ft. (4500 m.) about 2000 ft. long, 700 ft. wide, and 175 ft. deep.

instruments, though they had volumes nearly in the ratio 1 to 2 and different sorts of walls. The mean value of the sea-level ionisation thus directly observed was but a few tenths of an ion above the mean of the sea-level cosmic ray ionisations given by the two curves of our preceding report. These curve-values were 1·4 for electroscope No. 1, and 1·6 for electroscope No. 3—mean value 1·5, which is thus checked approximately, though not yet accurately (see below), since the ionisation due to the radioactive matter in the air above the ocean must be very small. The main uncertainty in this present value 1·5 for the sea-level ionisation lies in the determination of the capacities of the electroscopes, and in uncertainties in the effect of electroscope walls. Upon the latter effect we shall make a later report.

As to (4), we took two long series of observations, each lasting three days, at an altitude of 15,400 ft. (4620 m.) in a deep valley from which the Milky Way was in sight for a period of 5 or 6 hours and then practically out of sight for another 6 hours. The value of the cosmic rays which entered our electroscopes in this valley was 3·6. *We could deiect no difference at all in the value of the readings when the Milky Way was overhead and when it was out of sight.* Our error in the mean values of these readings could scarcely be more than 0·1 ion. Even if we double this estimate so as to have a wide factor of safety, we may conclude at least that the Milky Way exerts no influence upon the cosmic rays which it is yet within the power of the instruments used to detect, and that this should mean that the rays coming from the direction of the Milky Way are not 6 per cent. greater or less than are those coming from the portion of the heavens at right angles to the Milky Way. This is in agreement with our preceding less discriminating measurements, and also with recent very careful work at sea-level by Hoffmann and Steinke,[17] who can find there no directional effect in cosmic rays at all; but it is at variance with results reported by Büttner [18] and by Kolhörster.[19]

This present work was, however, done under quite as favourable conditions as have ever been used. It is very important to obtain unambiguous evidence upon this point. No entirely trustworthy conclusions about the origin of the rays can be drawn until it is settled. As yet, the case for a favoured region from which the rays come does not seem to have been established, but more sensitive tests can be made and will be made in the near future.

[17] Steinke, *Zeit. f. Phys.*, **42**, 570; 1927.
[18] Büttner, *Zeit. f. Geophys.*, **2**, 190; 1926.
[19] Kolhörster, *Naturwissenschaften*, **14**, 936; 1926.

Observations in Californian Mountain Lakes.

The object of the new group of experiments at Arrowhead and Gem Lakes, begun early in 1927, was to use an increased electroscope sensibility and an increased accuracy in the determination of the electroscope constants, for the sake of introducing greater precision into cosmic ray determinations and placing the whole subject upon a more strictly quantitative basis.

As already indicated, different observers are still wide apart on the absolute value of the ionisation, though a considerable group of us now find it to be between one and two ions at sea-level. This, however, can scarcely be called quantitative agreement. But this could scarcely be expected, since no observers except ourselves have thus far been able to determine the zeros of their instruments; so that all values of ionisations except ours must be regarded as estimates rather than measurements. Our own values suffer from rather large uncertainties, possibly 10 per cent., though probably less, in the determination of the capacities of our electroscopes.

As to mean absorption coefficients, Kolhörster and ourselves are now in reasonable agreement, but no one except ourselves had until very recently brought to light the inhomogeneity of the rays, though the latest results by Hoffmann and Steinke lead them to support provisionally our findings and to suggest that in the mixture of cosmic rays some may exist even harder than the hardest brought to light by us. These we found to have an absorption coefficient equal to 0·18 per metre of water, which corresponds, if computed by Compton's equations, to a wave-length 0·00038 A, or an equivalent generating potential of 32,600,000 volts. Hoffmann,[20] in order to explain his latest sea-level readings, assumes components of hardness corresponding to a wave-length, computed in the same way, of 0·00029 A, or an equivalent generating potential of 41,000,000 volts.

We began in the fall of 1926 to build new electroscopes of greater sensibility to the cosmic rays in the hope of determining the intensities of these rays more precisely and studying their *spectral distribution* more discriminatingly; in particular, we wished to test for the presence of still harder rays than could be brought to light by the sensibility of our preceding instruments; for there were theoretical reasons for suspecting that still harder rays might exist. These electroscopes will be

[20] Hoffmann. *Ann. der Phys.*, **82**, 417; 1927.

described in detail in more technical papers. Suffice it to say here that we can now measure the capacities of our electroscopes to a few parts in a thousand (0·791 electrostatic unit is the capacity of the instrument with which the following results have been obtained), and that we are now using eight times the sensibility to cosmic rays that we have heretofore employed; so that at sea-level we have in our electroscope 11 cosmic ray ions to play with instead of 1·4, and at Muir Lake about 40 instead of 5.

In carrying out experiments with this electroscope in Gem Lake last summer, the ionisation at the surface of the lake was 33·6 per c.c. per sec., and it decreased with depth of immersion, *regularly and very smoothly, to a zero value of* 2·6. *But this*

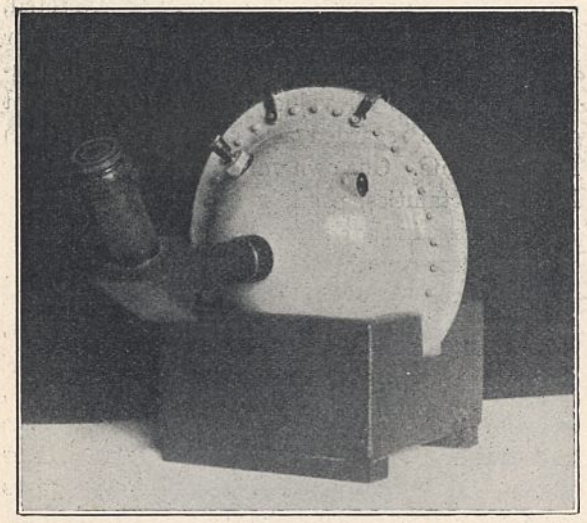

FIG. 2.—The type of electroscope sunk to depths of 164 ft. before its readings became constant at 2·6 ions/c.c./sec. Readings at surface, 33·6 ions/c.c./sec.

asymptotic value of the ionisation–depth curve was only reached at a depth of 164 *feet* (50 m.) instead of at about 54 feet (16·2 m.) as in our preceding 1925 Arrowhead experiments. This does not represent a discrepancy between the two sets of results. It means only that the ionisation ordinates of the curve have now been multiplied eightfold by the increased sensibility. In spite of this, the series of ionisation–depth readings taken with the new electroscope falls much more smoothly upon the curve, that is, shows less scattering, than was the case before; so that by improvements in technique the actual sensibility has been multiplied considerably more than eightfold. It is this increased sensibility and precision of measurement alone which is responsible for the fact that at depths between 54 ft. and 164 ft. ionisation is now clearly shown which was before masked by observational uncertainties.

Taking into account the absorption of the atmosphere above Gem Lake, which is the equivalent of 7·45 metres of water, *the new experiments reveal rays so penetrating as to pass through* 57 *metres* (190 *ft.*) *of water, or* 5 *m.* (16·7 *ft.*) *of lead before being completely absorbed.*

The new curve can be analysed for spectral distribution much more reliably than has been heretofore the case; but it is very satisfying that, analysed by the method before used, the portion in the neighbourhood of the elevation of Arrowhead yields precisely the same coefficient as did the former curve in the same region, namely, 0·23 per metre of water, while *the lowest part of the curve yields the coefficients* 0·1 *per metre of water, so that we have here brought to light rays nearly twice as penetrating as those heretofore found by us.* Computed as before, the shortest wave-length is now 0·00021 A, the equivalent generating potential of which is 59,000,000 volts, very considerably higher than the estimates made by Hoffmann.

Our total curve now extends from an absorption coefficient of $\mu = 0{\cdot}25$ per metre of water to $\mu = 0{\cdot}1$, or in equivalent wave-lengths computed as heretofore, 0·00053 A to 0·00021 A, *a range of between one and two octaves.* If the computations are made by Dirac's formula,[21] which is probably more trustworthy than Compton's, the relative values do not change, but the absolute frequencies or energies are increased about 30 per cent.

The cosmic ray sea-level ionisation in this electroscope, reduced to atmospheric pressure, is the same that we published before for electroscope No. 1, namely, close to 1·4 ions per c.c. per sec., and the error here should be, for this electroscope, less than 1 per cent.

The Source of Cosmic Rays.

What can now be said with reference to the possible source of these extraordinary rays? Their penetrating power alone—or frequency, computed by whatever formula—obviously requires that they correspond to changes of some sort taking place within the nucleus itself, since no extra nuclear charges can possibly be associated with anything like such energies. The simplest hypothesis is that to which we directed attention in our 1925 paper, namely, that these rays are produced by direct encounters between the nuclei of atoms and high-speed electrons. It is true that the mere potential energy of separation of the electron from the nucleus is not enough in the case of the light atoms, without a larger disappearance

[21] Dirac, *Proc. Roy. Soc.*, **109**, 206; 1925.

of mass than there is as yet reason to suppose takes place. Our most energetic rays heretofore found corresponded, it will be remembered, very closely to the energy change—loss of mass—accompanying the union of four atoms of hydrogen into one atom of helium, but the new measurements give rays of practically double this energy, but still only about one-fifteenth of that to be expected from the complete transformation into radiation of the energy of separation of the positive and negative electrons; so that *there is as yet no direct experimental ground for supposing that this last sort of annihilation of mass occurs.*

If, however, there are processes widely distributed throughout the universe by which electrons become endowed with many millions of volts of energy—C. T. R. Wilson calls upon thunderstorms on the earth as one such process—then there is no difficulty in calling upon the encounters between such electrons and the nuclei of atoms, however light, to act as sources of the observed rays. We shall not here attempt to list possible causes for such high-speed electrons, but if we postulate their existence the cosmic rays follow at once. For from the best of spectroscopic evidence the astronomer now populates interstellar space with not less than one atom per cubic inch. Furthermore, from the ionised state of the calcium atoms which are found in interstellar space, Eddington [22] estimates that the temperature of space, defined by the mean kinetic energy of agitation of the atoms and electrons therein found, is about 15000° C., *i.e.* higher than the surface temperature of the sun or of that of most of the stars.

Again, no radiations of the sort here considered, if generated in the interiors of stars, could possibly get out, since they follow the mass absorption law, and according to the foregoing experiments are all absorbed in a thickness of 190 ft. of water. This thickness might be multiplied many, many fold before getting through the merest outer skin of a star. The mass equivalent of this thickness will be reached by going out in any direction to a distance of 10^9 light-years, on the assumption that space is studded with one atom per cubic inch. These considerations, if correct, indicate that the directions of the sun or the stars are not likely to differentiate themselves from other directions as sources of these rays, and all observers are agreed that the sun at least does not so differentiate itself.

If, however, high-speed electrons are postulated as a source of these rays, why not let these high-speed electrons be the rays themselves? Why assume short ether waves at all? The answer is that we know experimentally that through the photo-electric process the same energy can be interchanged without loss between ether waves and electrons. Also, according to Ellis's results, these quantum laws are followed quite as well in nuclear as in extra nuclear changes. The degradation of the energy into heat, however, takes place primarily when the energy is in the electronic carrier. In other words, the absorption coefficient of beta rays is a hundred or more times greater than that of ether waves of the same energy; so that electrons set into motion by the Compton process or otherwise, very rapidly degrade the energy when it gets into them in any locality; but its transport through space in the concentrated form (which corresponds to high penetrating power) must take place when it is in the form of ether waves.

It is therefore quite futile to postulate as the source of the observed rays the bombardment of the air in the outer tenth of our atmosphere by high-speed electrons of the same maximum energy. If such high-speed electrons could enter the top of our atmosphere in sufficient quantity, they would indeed produce just such rays as we observe; but the difficulty is *that they would have been doing so all through space*, and it would be the ether waves with their high penetrating power rather than the high-speed electrons with their relatively low penetrating power which would reach our atmosphere in quantity. It would be only in case the high-speed electrons were in the main generated relatively near us, as in the sun or nearer stars, and had not yet had space, before reaching the earth, to have their energy dissipated into heat or transformed into the more penetrating rays, that this argument would be invalid.

But *this last case is precisely the one that has been eliminated by our failure to find that the sun has any appreciable influence upon this radiation.* For if the direction of the sun stood out above other directions in the heavens as one in which high-speed beta rays were superabundant, it would, of necessity, also be a direction in which the cosmic rays were generated in abnormal abundance. It seems quite impossible then, on this theory of their origin, to limit the source of the rays to the upper tenth of our atmosphere or to any astronomically near-by regions.

Cosmic Origin.

Again, the foregoing considerations as to the distance from the earth at which the rays originate

[22] Eddington, "Stars and Atoms," p. 69 (Oxford Press, 1927).

apply with ever greater force to any hypothesis involving either spontaneous or induced nuclear changes not associated with electron impacts; for matter in the upper tenth of our atmosphere must upon any such hypothesis be endowed with properties entirely unlike any which matter just a little closer to us or more remote from us possesses.

Now while matter in remote regions of the universe may well be assumed to be endowed with properties which do not manifest themselves on earth, it would be a violation of the principle of minimum hypothesis to assume that a thin ring of matter just beyond us has properties which matter neither more remote nor more near possesses. We can see no possible way, then, of assigning to the rays any other than a cosmic origin; and if the Milky Way does not differentiate itself from other parts of the sky as a source of the rays—and our experiments thus far have failed to find any such differentiation—then *the rays must come, in the main, from beyond the Milky Way, i.e.* either from the spiral nebulæ, if these are uniformly distributed throughout the heavens, or else from 'the cloud in space.'

From the results of our 1927 experiments, we are now for the first time able to compute with a fair degree of confidence the total energy per sq. cm. per sec. that flows into the top of the earth's atmosphere in the form of the cosmic rays. It comes out $3{\cdot}1 \times 10^{-4}$ ergs cm.$^{-2}$ sec.$^{-1}$, or just one-tenth the total energy coming into the earth's atmosphere in the form of star light and heat.

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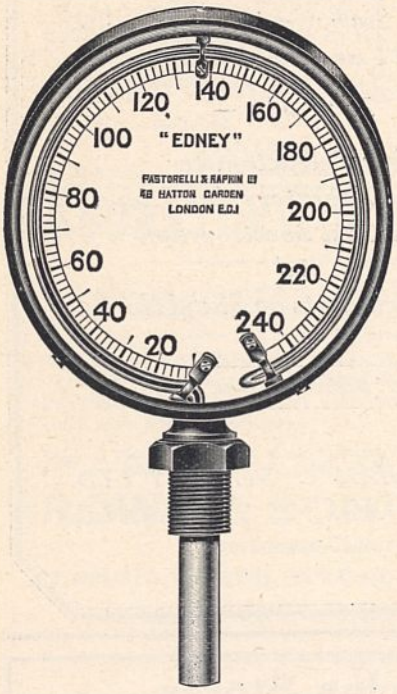

Fig. 1. VERTICAL PATTERN
Front view.

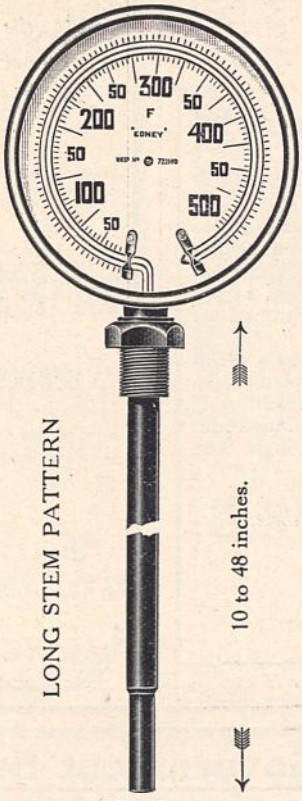

Fig. 3.

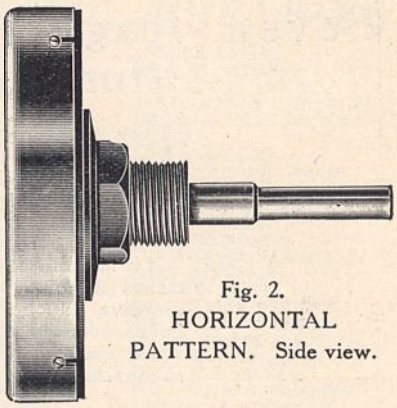

Fig. 2.
HORIZONTAL
PATTERN. Side view.

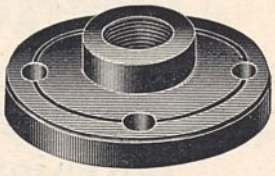

Fig. 6.
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„ 4. „ 3.	**LONG STEM PATTERN,** with **either vertical or horizontal** dials. Any Range up to 400° **F.**, 4-inch dial 18″ stem **32s.** 24″ stem **36s.** 36″ stem **40s.** 48″ stem **44s.**		
	„ „ „ 6-inch dial 18″ „ **38s.** 24″ „ **42s.** 36″ „ **46s.** 48″ „ **50s.**		
„ 5. „ 3.	Ranges up to 600° or 800°, 4-inch dial 18″ „ **36s.** 24″ „ **40s.** 36″ „ **44s.** 48″ „ **48s.**		
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With 4 Plates and numerous Illustrations in the Text.

N.B. **In consequence of so many papers being submitted to the Philosophical Magazine it has been found impossible to secure publication as speedily as could be wished. It has, therefore, been decided to again issue two Supplementary Parts during the year 1928 at the price of 10s. each. The Subscription for 1928, including the two Supplementary Parts, is £5, post free to any part of the world. There will be six double numbers as in 1927.**

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Obituary.

PROF. MILTON WHITNEY.

BY the death on Nov. 11, at the age of sixty-seven years, of Milton Whitney, soil science loses one of its most striking and original personalities. His work extended over nearly forty years, and throughout the whole period he was noted for the freshness of his outlook and the novelty of his deas. He first came into prominence in 1892, when, as professor of geology and soil physics at the Maryland Agricultural College and physicist to the Experiment Station, he published an interesting paper, "Some Physical Properties of Soils in Relation to Moisture and Crop Distribution," in which he examined a number of soils of known productiveness and showed that their agricultural properties are closely related to the texture of the soil as revealed by mechanical analysis. The physical properties of the soil, especially the texture, regulate its temperature, moisture content, and air supply, or, as he called it, with the love of analogy which characterised all his writings, the 'climate' of the soil, and he argued that the significance of these physical properties in determining the distribution and yield of crops must therefore be of the same order as that of climate in the ordinary sense of the word. In short, these physical factors are the predominant factors in soil fertility. He thus broke completely away from the idea currently accepted at that time that fertility is mainly a matter of chemical composition of the soil. The American workers were prepared for this insistence on the physical properties, as W. H. King had already at Madison been carrying on important physical studies, and there were no active soil investigators in Great Britain to controvert the position even if they had wished to do so.

This and other papers marked out Whitney as a man of ideas, and when the United States Department of Agriculture set up its Soil Bureau in 1894, Whitney was put in charge. Among his early studies here was one on the tobacco soils of the United States, showing the close connexion between the quality of the crop and the texture of the soil. High quality or 'wrapper' tobacco was produced on soil containing much sand and little clay, while low quality or 'filler' tobacco was grown on heavier soils containing more clay and silt. Other crops showed similar relationships with soil composition, and Whitney regarded his thesis as so well established that, in the great soil survey of the United States then being organised, he used mechanical analysis as the basis of classification. The scheme has, in point of fact, been altered, but it served a very useful purpose.

Before long it appeared that mechanical analysis alone would not suffice to explain all the phenomena of fertility. For example, in the survey of Florida, two widely different soils, the good 'pinelands' and the barren 'hammock soils,' had the same mechanical analysis, yet obviously could not be classed together. Whitney tried electrical methods of soil moisture determination in the soil *in situ*, but without much result: he was led, however, to recognise the importance of the soil solution in the nutrition of the plant and, in conjunction with Cameron, brought out a paper in 1903 on the chemistry of the soil in relation to crop production, in which the principles of physical chemistry were for the first time applied to the soil.

The subject was so novel that most investigators were not prepared for it, and some of the deductions were so startling that they gave rise to a vigorous controversy—the first there had been in soil science for many years. The centre of it was Whitney and Cameron's statement that the soil solution, which is the proper food of plants, is of the same order of composition and concentration in all soils, and therefore all soils, fertile and infertile, are equally well supplied with plant food: fertilisers do not feed the plant, but act in some other way. The controlling factor in soil fertility was in some cases physical, but in some at least it was the presence of toxic substances in the soil. This led to the study of the organic substances in the soil by Schreiner and Shorey, and the isolation of dihydroxystearic acid and other poisonous substances from certain infertile soils.

The controversy is now over, and it is known that the soil solution does vary in composition and in concentration in different soils and in different seasons in the same soil. But the great value of Whitney's work remains unchallenged: he widened the range of the subject and enriched it with ideas and analogies which, if not themselves entirely sound, nevertheless make the investigator stop and think.

E. J. RUSSELL.

MR. W. C. F. NEWTON.

THE death of Mr. W. C. F. Newton, on Dec. 22, at the age of thirty-two years, takes away a young worker of rare quality in a field that has been but sparsely cultivated in Great Britain—cytology and its bearing upon genetics. Newton was a student at the Birkbeck College, but his course was interrupted by war service (he received the Mons medal) and he did not take his degree until 1921. With a scholarship from the Department of Scientific and Industrial Research, he continued to work at the Birkbeck under Dame Helen Gwynne-Vaughan, and began to investigate the chromosomes of Galtonia, a paper on which appeared in the *Annals of Botany* for 1924.

In 1922, Bateson, who had long been on the look-out for a cytologist, invited Newton to join the staff of the John Innes Horticultural Institution, and there he continued to work. Much time was not given to him, for he had to undergo a severe operation in the summer of 1926, and was in hospital while he corrected the proofs of his paper (*Jour. Linn. Soc.*, 1927) on the chromosomes of Tulipa and allied genera. This paper contains some incidental mention of the improvements in technique he had introduced, methods of fixing and staining which are now in general use, though, as

they had been freely communicated in talk, it is forgotten that they originated with Newton. Newton came back to the laboratory in 1927, and resumed his work on tetraploid hybrids, among them *Digitalis ambigua* × *purpurea* (produced by B. H. Buxton) and *Primula kewensis*. Around the latter hybrid many misconceptions had arisen, which by the perfection of his technique he succeeded in removing, finally reconciling its peculiar cytological and genetical behaviour.

Newton had not finished with Tulipa, a genus abounding with problems, providing the sort of material most apt for his thesis, that cytological relationships provide the real key to systematics. But the study of tulips has lost within a short space both Dykes, who had given years to the collection and morphological examination of the species, and now Newton, who was seeing his way to bring order out of the confusion. He was also occupied with colour inheritance in poppies and an interesting sex problem in Silene, until in the late autumn the recurrence of his malady laid him aside. But he never lost either his interest or his courage, and within a few days of his death, in a state of pitiful weakness, he would still discuss his problems and suggest the lines on which further work was needed.

Such was the man, a true *passionné* (pour faire quelquechose de grand il faut être passionné), soft-voiced and gentle, almost austere in manner until his humour broke out, but rigorous for himself and carrying his high laboratory standards into the other walks of life and learning. Death has dealt hardly with the men whom Bateson gathered round him at one time or another, and Newton bade fair to carry on in a quite different fashion that inspiration and stimulus which had so characterised his chief. A. D. H.

Mr. Henry Edmunds.

HENRY EDMUNDS, who died at Hove on Nov. 18, at the age of seventy-four years, was one of the pioneers of electric lighting. He was born at Halifax in 1853. At the age of twenty-four he introduced electric lighting by Jablochkoff candles into America. He then returned to introduce the Farmer-Wallace system of electric lighting into England. The Brush Electric Lighting Co. appointed him its first engineer, and so early as 1879 he did much to popularise the Brush system of lighting in Great Britain.

In conjunction with Sir Joseph Swan, Edmunds installed incandescent lamps in H.M.S. *Inflexible* and the Atlantic liners *City of Richmond* and *Servia* in 1881, and in 1885 he became a partner in the firm of Messrs. W. T. Glover and Co., of Manchester, the cable manufacturers. He was a personal friend of Mr. T. A. Edison, and brought the first phonograph to England. An account of this invention was published in the *Times* in January 1887. He was also associated with the late Mr. Augustus Stroh in the manufacture of phonographs. Amongst electrical engineers, however, he is best known by his connexion with the cable manufacturing industry. He founded the Cable Manufacturers' Association, which is an early and successful example of co-operative working.

Edmunds was also one of the earliest of the pioneers of cycling and motoring in England. In 1898 he brought from Paris a De Dion motor tricycle and trailer, which at the time excited great public interest. It is also interesting to recall that he introduced Mr. C. S. Rolls to Mr. Royce, a meeting which led to the formation of the Rolls Royce Company. He had a very interesting personality and will be missed by many friends.

HERR JULIUS BAUMANN, deputy-director of the Verein für chemische und metallurgische Produktion in Aussig-Karlsbad and extra-ordinary professor of technical chemistry at the University of Innsbruck, died on Aug. 17. Born in Hungary in 1859, Baumann studied for a time at Prague, but soon relinquished the idea of an academic career and devoted his energies to chemical industry, in which he became recognised as one of the leading personalities in Austria.

PROF. PAUL GROTH, of the University of Munich, the well-known crystallographer and author of "Die physikalische Krystallographie," died recently at the age of eighty-five years. His discovery in 1870 of morphotropy, or change in crystalline form due to the replacement of hydrogen by other atoms or groups, was largely responsible for stimulating investigations into the structure of atoms.

WE regret to announce the following deaths:

Surgeon Rear-Admiral Sir Percy Bassett-Smith, K.C.B., C.M.G., a past president of the Royal Society of Tropical Medicine and Hygiene, on Dec. 29, aged sixty-six years.

Mr. R. B. Buckley, C.S.I., formerly chief engineer to the Government of Bengal and author of "Irrigation in India," on Dec. 19, aged eighty years.

Mr. W. H. Dines, F.R.S., distinguished for his work on the physics of the upper air, on Dec. 24, aged seventy-two years.

Mr. S. W. Fairchild, of the firm of Fairchild Brothers and Foster, manufacturing pharmaceutical chemists, who founded the Fairchild scholarships and prizes for pharmaceutical students in Great Britain and Ireland and in the United States, on Nov. 13, aged seventy-five years.

Prof. Georg Fendler, until recently chemical director of the new research institute for foodstuffs in Berlin, on Sept. 11, aged fifty-four years.

Mr. H. A. Grueber, late keeper of the Department of Coins and Medals at the British Museum and for many years honorary secretary of the Royal Numismatic Society, on Nov. 21, aged eighty-one years.

Mr. J. B. Hill, until 1922 geological adviser to the Ministry of Health and formerly of the Geological Survey of Great Britain, on Dec. 18, aged sixty-five years.

Dr. William R. Orndorff, professor of organic and physiological chemistry at Cornell University, on Nov. 1, aged sixty-five years.

Prof. Hugo Strache, director of the Institute for fuel technology at the Technische Hochschule in Vienna and a leading authority on gaseous fuels, on Nov. 4, aged sixty-two years.

News and Views.

ONE of the most interesting features of the Leeds meeting of the British Association was undoubtedly the evening discourse by Prof. R. A. Millikan on "Cosmic Rays," which we are privileged to publish, with additions, as a special supplement to this issue. The fact that an electroscope would gradually lose its charge even when surrounded by considerable thicknesses of metal had been known for many years, and a good deal of experimental work was done in the early days of the subject, without any very positive results, to discover the origin of this 'spontaneous' ionisation. The difficulty is, of course, that radioactive materials are very widely disseminated in minute quantities, and the possible presence of such material in the electroscope walls, and in the plates used to screen the instrument, was a continual source of uncertainty and confusion. The first advance in the subject was secured when Gockel made balloon ascents with an enclosed electroscope in 1910, and found that the rate of discharge became appreciably greater as the altitude increased, thus suggesting that part of the effect, at any rate, was due to penetrating radiation coming through the atmosphere from extra-terrestrial sources. These results were confirmed and extended by Millikan and Bowen, among others, in 1921. In his more recent experiments, Millikan, who has pursued the subject with all his well-known vigour and skill, has been using, as his absorbing material, the water of snow-fed lakes in the high mountains of California and Bolivia, material which he finds to be exceptionally free from radioactive contamination.

BY sinking electroscopes into the depths of these mountain lakes, Millikan is able to measure not only the absorbability of the radiation in water, but also the actual fraction of the whole effect which is due to radiation from extra-terrestrial sources. This amounts to 1·4 ions per c.c. per second at sea-level. From the nature of the absorption curves he is able to analyse, more or less satisfactorily, the extra-terrestrial or cosmic radiation, and from the absorption coefficients, assuming that the ordinary relation between wave-length and absorption holds in this part of the spectrum, to deduce the wave-lengths of the cosmic rays. According to Millikan's latest results, the most penetrating of the cosmic rays has a wave-length of only 0·00021 A, a wave-length far shorter than the shortest of the γ-radiations from any known radioactive material, and corresponding to a generating potential of nearly sixty million volts. By working at different times of day and in two hemispheres, Millikan has shown that the radiation is not due to the impact of high-speed electrons on the outer layers of the atmosphere; neither does it come from any particular direction in space. Its intensity is the same no matter to what portion of the heavens the electroscope is exposed. It is not in the stars that we must look for its origin; its birthplace is either in the great nebulæ, or in that very rarefied matter which pervades all space. Even so, its existence seems to postulate phenomena unknown terrestrially. The excitation voltage demanded, sixty million, is not only far greater than anything possible in the extranuclear system of the atom: it is also far greater than the voltages we are accustomed to associate with the nucleus itself, which are generally of the order of two or three million volts.

MILLIKAN points out that the most penetrating of the rays which he has so far detected has only about one-fifteenth of the energy to be expected from the mutual annihilation of an electron and a proton, and thinks that *as yet* the cosmic rays do not provide direct evidence of the transformation of matter into radiation in outer space. On the other hand, much of the radiation is of the quality which might be expected from the conversion into radiation of the mass which is lost when four hydrogen atoms condense to form an atom of helium. These results are full of interest, and it seems as if here again we have a subject where a careful watch on Nature's laboratories in the heavens might enable us to supplement the obvious deficiencies of our own.

THE list of New Year honours includes the names of the following men of science and others associated with scientific work:—*Baronet*: Major-General Sir Richard Havelock Charles, Sergeant Surgeon to H.M. the King, a past president of the Royal Society of Tropical Medicine and Hygiene. *K.C.V.O.*: Sir Frank Baines, until lately Director of Works, H.M. Office of Works. *Knights*: Prof. Jahangir Cooverjee Coyajee, professor of political economy and philosophy in the Presidency College at Calcutta; Mr. F. G. Hallett, Secretary of the Joint Examining Board, Royal College of Physicians of London and Royal College of Surgeons of England; Brigadier-General H. B. Hartley, fellow and tutor of Balliol College, Oxford, and member of the Chemical Warfare Committee; Dr. E. H. Pascoe, Director of the Geological Survey of India; Principal C. Grant Robertson, Vice-Chancellor and Principal of the University of Birmingham; Dr. T. E. Stanton, Superintendent of the Engineering Department, National Physical Laboratory; Mr. A. E. Aspinall, secretary of the Imperial College of Tropical Agriculture, Trinidad. *C.M.G.*: Major R. G. Archibald, Director of the Wellcome Tropical Research Laboratories, Khartum; Mr. O. T. Faulkner, Director of Agriculture, Nigeria.

SIR DAWSON WILLIAMS is retiring this month from the editorship of the *British Medical Journal*, after completing his thirtieth year in that office and seventeen years previously in the editorial department of the journal. He is being succeeded by Dr. N. G. Horner, who has been assistant editor for the past eleven years and previously served on the staff of the *Lancet* in a similar capacity. The *British Medical Journal* was first issued as the weekly organ of the Association in 1857, and it has continuously grown in importance with the Association, which is now in its ninety-sixth year and has a membership of nearly 34,000. The Association was established for the

promotion of the medical and allied sciences and the maintenance of the honour and interests of the medical profession. Its organisation and its journal show what can be done to foster fellowship and promote progress among members of a profession widely scattered and with diverse interests. Sir Dawson Williams had to steer his bark through some troubled seas caused by the introduction of the National Insurance scheme and the War, and the success with which he did so is represented in the high character of the contents of the journal and the continued progress of the Association. He goes into retirement with most cordial good wishes of all who know his work and influence.

AN important step towards developing an efficient organisation for the scientific study of the difficulties besetting primary industries has been taken by the Commonwealth Council for Scientific and Industrial Research. It has been decided to establish a strong entomological section which, as was announced in our issue of Nov. 26 last, will be under the control of Dr. R. J. Tillyard, at present Assistant-Director of the Cawthron Institute, New Zealand. Dr. Tillyard will commence his new duties at the beginning of March. It is proposed to erect central laboratories and insectaries at Canberra and sub-stations in various parts of the continent. Provision will be made not only for a permanent supporting staff, but also for post-graduate students who may desire to specialise in entomological research work under Dr. Tillyard's guidance.

IT is estimated that insect pests cost Australia as much as £10,000,000 in a bad year, the blow-fly alone, in its ravages on sheep, accounting for £4,000,000. Attention will largely be concentrated upon the problem of blow-fly control by means of parasites, but at the same time active work will be carried on to secure control of buffalo fly (Lyperosia), lucerne flea (Smynthurus), thrips, and underground grass grub (Oncopera). Noxious weeds also cost Australia large sums annually. The success which is attending the attempt to eradicate prickly pear by means of Dactylopius, Cactoblastis, and other insects, encourages the hope that St. John's Wort, Skeleton weed, Paterson's curse, and other widely spread plants, may be brought under control. The necessity for hastening prickly pear eradication is being recognised, since there are numerous native insects which may parasitise the beneficial ones, particularly the valuable Cactoblastis, and reduce their efficiency. St. John's Wort covers nearly a quarter of a million acres of splendid land in the north-west of Victoria and is rapidly spreading into the fertile areas of Gippsland. A sub-station to deal with it will be established shortly. It is hoped that close association with the Imperial Bureau of Entomology, with Rothamsted, and also with the Cawthron Institute, will be maintained in all this work.

THE amount of energy that is duplicated, and, in so far as duplication is unnecessary, therefore wasted, in the preparation of annual analytic indexes to biological literature, has long been the subject of protest, suggestion, and not very effective remedial experiment. It is interesting, and some may find it hopeful, to learn that the International Institute of Intellectual Co-operation, which is working under the League of Nations, is making a fresh attempt to introduce order and co-ordination. A meeting of editors of the chief biological bibliographies was convened at the Institute in Paris last April, and passed several resolutions which have recently been approved by the assembly of the League of Nations. The chief recommendations are these: That editors of journals publishing original work in biology should supply, through a central organisation, enough copies of each paper for distribution to the bibliographic bodies concerned. That an author's abstract, averaging from three to five per cent. of the original paper, should be published with each paper. For purposes of distribution or exchange of scientific contributions, the bibliographic publications must be classed, and the following groups are suggested: General biology; zoology; systematic zoology; botany; systematic botany; genetics; physiology; anatomy and embryology; microbiology and parasitology.

THE scheme was sketched out when only one number of *Biological Abstracts* had appeared, and its importance could not be estimated. This may entail modifications, but meanwhile the Institute of Intellectual Co-operation desires to have the views of biologists, and in particular of the editors of bibliographic journals. Suggestions, which will be welcomed, should be addressed to the Director of the Institute, 2 Rue de Montpensier (Palais-Royal), Paris, I. The most valuable proposal, if it can be carried out, is the distribution of papers to the relevant bodies. The difficulty of seeing the literature is the greatest obstacle to all bibliography. The compulsion of authors to furnish abstracts will, if enforced, be splendid—for the authors. Many authors cannot produce abstracts of their own papers, and often succeed in giving marvellously little information. But *Biological Abstracts*, if it continues, will give us more than we need in this direction, at least for readers of English. That points to two difficulties. It is sometimes suggested that every scientific worker should be able to read English, French, German, Italian, and Spanish; but how many can? *Rivistas*, *Revues*, and *Berichte* will still be called for. Then the bulk is so enormous that special subjects will in self-defence organise their own bibliographies; though perhaps they would do better to produce analytic indexes such as the *Zoological Record*. Again, many periodicals would collapse did they not give reviews and abstracts of recent publications. The question of bibliography is part of the larger question of scientific publication, and those who discuss it must take human nature largely into account.

WITH great enthusiasm and assiduity Mr. W. Rodier continues to urge the adoption of his method of exterminating rats, rabbits, and other polygamous pests. In a recent circular he cites the success which has attended the method, now widely adopted for the

increase of wild stock, of killing males and sparing all females, and suggests that the reverse process, killing females and sparing males, will have the opposite result of reducing the stock. It is obvious that the slaughter of females must reduce progeny, but it cannot be assumed that the sparing of the males will hasten the process under ordinary conditions. Nor is it evident that where pests have increased in spite of the killing of both sexes, the sparing of the males would have transformed the increase into a decrease. The Rodier method can be successful only where the numbers of females are so reduced relatively to the males that male competition interferes with successful breeding. This is likely to take place only in delimited areas where the immigration of females from outside and the emigration of males can be prevented, and where, moreover, intensive trapping has reduced the sex proportions to the requisite critical point of interference. These conditions are not easily attained.

THE Central Cotton Committee of Russia has published a volume in Russian on "Locusts and Grasshoppers," by B. P. Uvarov (Library of Cotton Industry, vol. 8, Moscow, 1927; pp. 305). The book presents a comprehensive account of the morphology, anatomy, physiology, development, and behaviour of locusts and grasshoppers in general; further, ecology, natural enemies, and causes of periodic mass appearances and of migrations of the insects in question are discussed in detail. Description and critical discussion of technique and organisation for the control of locusts and grasshoppers conclude the general part of the book, and succeeding chapters are devoted to a discussion of all the more important Russian species, with particular reference to their ecology and bionomics. A list of more than 300 references to literature, in ten different languages, is appended. We understand that an enlarged English edition of the book is to be published shortly in Great Britain.

MARCONI short wave-beam services are now in operation to Rio de Janeiro and Buenos Aires. Brazil and the Argentine are thus in direct communication with London. The beam service operates both to and from Rio, but at present Buenos Aires has no beam aerials and so it has only a one-way service. In the near future, however, the two-way beam service will be completed. The success of the beam services is now assured. The Australian Prime Minister has said that they have attracted 45 per cent. of the Pacific Cable Co.'s traffic from Australia alone, as well as what they have taken from other cable routes. During the week ending Dec. 3, the total number of words carried over the four British Empire circuits was at the rate of considerably more than 40 million words a year. The beam services with New York, Rio, and Buenos Aires are expected to be equally great. The beam transmitting stations for the North and South American services are situated at Dorchester and are operated by 'remote control' by the signalling keys in London. The receiving station is at Somerton, about thirty miles from Dorchester. These services are normally worked at about 150 words per minute, but much higher speeds can be attained. The only limit to the speed appears to be that introduced by the recording apparatus. It is possible to vary the width of the beam. In this way the Rio stations can handle traffic from Paris and Berlin as well as London. Receiving aerials are now being built near Paris, but they have not yet been begun in Germany. When the final arrangements are completed there will be seven Marconi beam services operated from Dorchester and Somerton: two to the United States, two to South America, two to Japan and the Far East, and one to Egypt.

THE Society for Experimental Biology held its London meeting at the Imperial College of Science on Dec. 21–22. The very full programme of papers and demonstrations included a symposium on certain aspects of tissue culture, in which Dr. G. P. Wright, Mrs. B. Holmes, Dr. H. B. Fell, and Dr. Canti took part. In connexion with this, microscopic demonstrations were given by Miss S. F. Cox on the effects of X-rays of different wave-lengths on mitosis in tissue cultures, by Dr. Fell on the development of the isolated otocyst of the chick embryo, by Mr. F. G. Spear on the effects of low temperature upon mitosis *in vitro*, and by Miss D. H. Strangeways on monocytes and fibroblasts in tissue culture. Profs. MacBride and Huxley discussed problems in connexion with the metamorphosis of echinoderm larvæ and dedifferentiation under certain conditions; Capt. Diver gave an unusual study of the variation in webs of the spider *Epeira diadema* and another species. Dr. C. M. Yonge described the mechanism of feeding and digestion in Septibranchs, including deep-sea forms, and Dr. G. C. Robson discussed the variation of the radula in the Octopus and in Peristerna. Mr. E. A. Spaul described further experiments on the comparative quantitative effects of thyroid and pituitary in producing metamorphosis in Amphibians. Mr. J. T. Cunningham described experiments on the effects of ligature of the vas deferens and the vasa efferentia in mammals. Miss M. A. Tazelaar gave an account of experiments with eggs of the frog and the hen, in which the two poles or the two sides of the young embryo were subjected to different temperatures. Mr. R. Snow described the transmission of inhibition to bud growth through dead stretches of stem, while papers were presented by Dr. A. Walton and Mr. J. A. Hammond on the mechanism of impregnation and spermatozoan movement in the rabbit and the experimental production of small litters. The meetings concluded with the exhibition in the Imperial Institute cinema of a remarkable film showing the growth, division, and other activities of living cells in a tissue culture from the periosteum of the chick embryo, by Dr. Canti. The behaviour of cells in a culture of Jensen's rat sarcoma was also shown, as well as the effects of irradiation on the living cells. The next meeting of the Society will probably be held at Oxford in April.

IN consequence of the increased activity in oil-field investigation in Australia, and following the appointment of Dr. W. G. Woolnough as Commonwealth geological adviser, the services of Mr. Frederick Chapman, of the National Museum, have been lent to the Commonwealth for a year as Government palæontologist.

PROF. E. W. BROWN, professor of mathematics in Yale University, New Haven, has been elected an

associate of the Royal Academy of Belgium, and M. Armand Renier, director of the geological services of Belgium, and Prof. Lucien Hauman, professor of botany in the University of Brussels, have been elected *correspondants* of the Academy.

THE Ministry of Health has issued a memorandum (Memo. 122 A/T.) showing under various heads the cost per patient per week at certain residential institutions for the treatment of tuberculosis during the year ended Mar. 31, 1927. A mass of information has been collected, analysed, and tabulated which should be of the greatest value to authorities and other bodies who administer tuberculosis sanatoria.

IN preparation for the meeting of the International Commission on Illumination in America in September next, the technical committees of the Commission met at Bellagio, Lake Como, in September 1927, to discuss forty-six papers which had been prepared. The problems of eliminating glare in industrial lighting, motor headlights, street lighting, and signal glasses received much attention. Copies of a brief report of the meetings can be obtained from the Secretary of the Commission at the National Physical Laboratory, Teddington.

THE annual report for 1926–27 and *Proceedings* of the first session of the Merseyside Aquarium Society has been received. This Society was formed in Sept. 1926 with the object of helping those interested in aquatic life. Several good lectures have been given and excursions organised, the president being Dr. James Johnstone, professor of oceanography in the University of Liverpool. We note that "negotiations are at present being conducted by a sub-committee with a view to space being reserved in the course of development of the Wallasey sea front for a Public Aquarium, and in the event of these being successful the Committee trust that they will have the hearty support of members in the always arduous task of collecting funds for the establishment and equipment of the Institution."

MESSRS. Wheldon and Wesley, Ltd., 2 Arthur Street, W.C.2, have just sent out Catalogue, New Series, No. 20, of recent purchases by them of books on zoology, botany, and the physical and mathematical sciences. Upwards of a thousand books and serials are listed.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: An executive secretary to the Library Association—The Hon. Secretary, Library Association, Public Library, Buckingham Palace Road, S.W.1. (Jan. 12). An established analytical chemist in the scientific research and experimental department of the Admiralty at the Royal Naval Cordite Factory, Holton Heath—The Secretary to the Admiralty (C.E. Branch), Whitehall, S.W.1 (Jan. 16). A mycologist in the agricultural department of the Government of Burma—The Secretary to the High Commissioner for India, General Department, 42 Grosvenor Gardens, S.W.1 (Jan. 21). Two chemists in the agricultural department of Nigeria, primarily for work on vegetable oils and nuts, *e.g.* palm nuts, ground nuts, shea nuts, etc.—The Private Secretary (Appointments), Colonial Office, 2 Richmond Terrace, S.W.1 (Jan. 31). A pathologist (morbid anatomy and hæmatology only) at the Royal Prince Alfred Hospital, Sydney, Australia—Hospital Agents, c/o J. W. Vickers and Co., Ltd., 24 Austin Friars, E.C.2 (Feb. 1). A professor of public health at the London School of Hygiene and Tropical Medicine—The Academic Registrar, University of London, South Kensington, S.W.7 (Feb. 16). A reader in chemistry at Bedford College for Women—The Academic Registrar, University of London, South Kensington, S.W.7 (Feb. 17). Civilian education officers in the Educational Service of the Royal Air Force—The Secretary, Air Ministry, Adastral House, Kingsway, W.C.2. A live stock officer for the department of agriculture, Kenya Colony—The Private Secretary (Appointments), Colonial Office, 2 Richmond Terrace, S.W.1.

Our Astronomical Column.

COMETS.—Skjellerup's comet passed perihelion on Dec. 18 and is now rapidly receding from sun and earth; as it remains close to the sun in the sky, its further observation will be very difficult.

Encke's comet should be visible with moderate instruments in January and February. The following ephemeris for 0^h is from the *B.A.A. Handbook*:

	R.A.	Decl.	log *r*.	log Δ.
Jan. 10.	$22^h\ 46{\cdot}4^m$	N. 3° 51′	9·987	0·023
18.	22 51·2	3 45	9·920	9·997
26.	22 54·7	3 16	9·837	9·958
Feb. 3.	22 52·6	N. 1 38	9·731	9·903
11.	22 34·6	S. 3 16	9·605	9·836

Perihelion is on Feb. 19·7. After Feb. 11 the comet is too near the sun for observation. On its emergence it will be visible only to southern observers.

RECENT DISPLAY OF THE AURORA BOREALIS.—Judging from the character of the Greenwich magnetograph traces, reports given in the press of the appearance of the aurora borealis on Dec. 26 and 27 are without foundation. Mr. C. Leaf, observing at Cambridge, states, however, that on Dec. 28 "a short-lived but well-marked display was observed here to-night. At $19^h\ 30^m$ G.M.T. the sky was clear, but at $20^h\ 00^m$ a bright oblong glow was visible low down in the north. Its colour was pale primrose and dark sky was visible below it, except at its western end, where a pale white band reached down to the horizon in the north-west. By $20^h\ 05^m$ the glow in the north had entirely vanished, and only a few faint and fluctuating bands in the north-west lasted till $20^h\ 15^m$, after which time the sky was entirely clear."

Mr. Leaf's observations are confirmed in an interesting manner by the Greenwich declination traces. On the evening of Dec. 28, after several undisturbed days, a sharp wave occurred in declination, commencing at $19^h\ 55^m$, reaching a maximum displacement of 21′ eastwards by $20^h\ 12^m$, returning nearly to normal by $21^h\ 30^m$ with slight agitation continuing until 4^h on Dec. 29. At the time of the aurora, a stream of spots was about 20° west of the sun's central meridian. These spots reached a considerable but brief maximum on Dec. 28. The coincidence between the occurrence of aurora, magnetic disturbance, and sunspots is noted, but a connexion between these solar and terrestrial phenomena is not necessarily implied in this instance.

Research Items.

AN ANCESTRAL FIGURE FROM NEW IRELAND.—In *Man* for December, Mr. H. J. Braunholtz illustrates a carved wooden figure from New Ireland recently acquired by the British Museum, which belongs to a class of object sufficiently familiar from museum specimens, but of which the meaning and use are still to some extent obscure. The interest of the present specimen lies in the fact that between its legs is an object which clearly represents a friction gong, the *livika* peculiar to New Ireland. This makes the figure unique, although other representations of musicians are known, *e.g.* one playing the pan pipes in the British Museum, and two playing the conch shell and the pan pipes respectively illustrated by Kramer, who describes them as rain-makers. These funerary carvings are only found in the central and northern districts of New Ireland, their region of highest artistic development being the Hamba district, where they have been classified as 'historical' and mythical, the former representing actually known ancestors. One example quoted is that of a famous shark catcher, who was represented with his shark-catching implements. It would therefore be reasonable to regard the present figure as that of a famous *livika* player, though since the *livika* represents a hornbill, it might here represent a totem or might even be a moon-god, of which the hornbill is a symbol. The *livika*, which is manufactured only in a few inland villages, is played at ancestral ceremonies, its sound representing the voice of the spirits. Like the bullroarer, it is then intended to frighten away the women.

CEREMONIAL RUNNERS OF THE FOX INDIANS.—"Contributions to Fox Ethnology," by Mr. Truman Michelson (*Bull. 85*, Bureau of American Ethnology), contains, among other matters, a native text with translation which gives an account of the ceremonial runners of the Fox Indians. The ceremonial runners who, according to this account, ceased to exist about sixty years ago, were three in number, one being drawn from each of three of the four important Fox gentes, the Bear, the War Chiefs, and the Eagle Gens. The member of the Bear Gens was the leader. These runners were blessed by the spirits,—the wind, the deer, and the humming bird. Their functions were carrying messages, especially the news of deaths, and summoning councils; but in addition they exercised a kind of supervision at ceremonial dances, in the councils in case of a division of opinion they gave the decision, and they were rain-makers, or weather controllers. In case of excessive cold they rolled in the snow. To become a ceremonial runner necessitated a severe fast, at the end of which the entrant was blessed by the spirits mentioned above. A detailed account of the instruction given by each of the three spirits is given, in which it is enjoined upon the runner that he shall do his duty cheerfully, shall keep his body clean by frequent bathing, and shall speak no ill of anyone, or mock women. While performing his duty he was to eat no meat but that of the turtle-dove and quail (though at other times ordinary food might be taken), and carry nothing red when sent on an errand to announce a death. His moccasins were to be of buffalo hide, and his offerings to the spirits of tobacco only. Each runner had to make a wooden bowl and spoon, he had to live on the south side of the camp or settlement, and had for his rug the hide of a spotted deer, which it was one of his first duties to obtain for himself by killing the deer. The runners did not marry, and might not be seen by women after childbirth or when otherwise ceremonially unclean, as, for example, during menstruation.

TOXIC EFFECTS OF ROAD TAR EXTRACTS ON TROUT.—In a recent paper, Mr. A. C. Gardiner deals with "The Effect of Aqueous Extracts of Tar on Developing Trout Ova and on Alevins" (*Fishery Investigations*, Series 1, vol. 3, No. 2, 1927. London: H.M. Stationery Office, 1927). The extracts used contained 1·6 parts per 100,000 of 'acid' substances (phenols, etc.), and 0·25 to 1 part of basic substances (pyridine, etc.). It was found in general that susceptibility rapidly increased with age. The fertilisation reaction was unaffected in the tar extracts; and an hour's immersion in these extracts had little or no effect on the subsequent development of freshly fertilised eggs or on embryos 30 days old. Alevins 2 to 3 days after hatching likewise were not harmed by 20 hours' immersion in tar extracts, though they were restless and apparently irritated by the solution. However, from this stage onwards the fry became more and more sensitive, until when 84 days old, none was able to withstand 2 hours' immersion; yearling trout losing equilibrium in 3½ minutes. There is thus a remarkable increase in sensitivity to tar products as the adult stage is approached, the fertilisation process and the young larvæ being unaffected. These conclusions accord with previous work, and it is pointed out that the lethal action of the phenols on the adult trout is probably due to its action on the gills in preventing normal respiration. No explanation is at present suggested for the relative immunity of the alevins. One might perhaps suggest that the critical factor was the ratio of the amount of respiration through the gills to that through the skin. If the gills were unable to function, the adult would be unable to maintain its normal respiration, and death would occur from suffocation. On the other hand, in the larva, derangement of the gills would probably still allow sufficient respiration to occur through the skin; the large ratio of surface to volume of tissue allowing considerable gaseous exchange. The probability of this explanation is enhanced by the fact that sensitivity to tar extracts increases with great rapidity after about the eightieth day. This would be about the time of scale formation, a process which would rapidly reduce the permeability of the skin to dissolved gases.

TOBACCO AMBLYOPIA.—In the recently published issue of the *Annals of Eugenics*, Miss Elderton has made an elaborate statistical investigation of the data collected by Mr. Usher relating to the incidence of tobacco amblyopia, and has arrived at the interesting conclusion, comforting to many laboratory workers, that excessive smoking in itself cannot be proved to cause tobacco amblyopia. The evidence suggests that if there be a tendency to the development of this visual defect, heavier smoking may hasten the time of onset.

NORTH AMERICAN TERRESTRIAL ISOPODS.—H. Lomander (*Proc. U.S. Nat. Mus.*, vol. 72, art. 17, 1927) has examined the North American Trichoniscidæ in the collections of the U.S. National Museum. He finds three species which are also more or less widespread in Europe—*Trichoniscus pusillus*, *T. pygmæus*, and *Haplophthalmus danicus*, and two non-European species—*T. papillicornis* and *Brackenridgia cavernarum*. It is reasonably certain that *T. pygmæus* and *H. danicus*, which in Europe are generally found in hot-houses and gardens, have been transported to North America from Europe with garden produce, etc. *T. pusillus*, which occurs over the whole of

central and northern Europe and is the most common of the terrestrial isopods in the Scandinavian countries, may also be indigenous in the eastern parts of North America. *T. papillicornis*, hitherto found only in the extreme northern portion of the Pacific—Bering Island and Cook Inlet—has, on close examination, been found not to be a Trichoniscus. It belongs to the family Scyphacidæ and is nearly allied to certain species of terrestrial isopods which have been hitherto found only in the Antarctic. This species is made the type of a new genus, Detonella.

AIR BLADDER OF FISHES.—Miss F. M. Ballantyne *Trans. R. Soc. Edin.*, vol. 55, pp. 371-394; 1927), in an important paper, reviews the present state of knowledge of the evolutionary history of the air bladder of fishes, and extends it by observations on this organ in a number of the more primitive types of living fishes such as Amia, Lepidosteus, Acipenser, Gymnarchus, Ceratodus, and Callichthys. As a result of her work, the author supports the view of Sagemehl, as extended and supplemented by Graham Kerr, that the air bladder of the modern fish is derived from bilaterally symmetrical ventrally placed paired lungs. The author traces the following series of evolutionary stages. First there is the gradual reduction of the left and the enlargement of the right lung, as seen in the young of Polypterus and the adult of Ceratodus. The next stage is illustrated by Amia with its pulmonoid air bladder, which has the normal pulmonary nerve and blood supply, but opens dorsally into the alimentary canal. Lepidosteus has a pulmonoid air bladder with pulmonary nerves but blood coming from the aorta. Acipenser shows a condition in which the reduction of the respiratory function is complete and the air bladder is a simple membranous sac with its blood supply from the dorsal aorta. In Salmo the hydrostatic function has developed further and the air bladder has now red-glands in its anterior walls, but it is still a simple sac opening dorsally into the alimentary canal. The stages from the simple air bladder of Salmo to the complex organ present in the Physoclistic fishes have been worked out by Tracy.

FRESHWATER FOSSIL MOLLUSCA FROM THE ARGENTINE.—From the Pehuenchian beds of the Rio Negro, by some considered as of Eocene and by others as of Senonian age, a small collection of fresh-water mollusca is described by M. Doello-Jurado (*Bol. Acad. Nac. Cien. Cordoba*, vol. 30). The present is stated to be a preliminary notice and deals with only nine species belonging to the genera Corbicula, Diplodon, Physa, Viviparus, and Melania. Judging from the photographic figures, which are very clear, the specimens were by no means in a good state of preservation. It should be noted that they were found in association with Dinosaurian remains.

THE AGE OF THE OCEANS.—In an article entitled "The Problem of Geological Time," in *Scientia* for December, Prof. A. Holmes offers some criticisms of the calculation of the age of the oceans based on their sodium content. This argument, depending on statistical measurements in various parts of the world of the sodium in the ocean and the annual increment by rivers, and corrected by taking into account certain other factors, gave about ninety million years. This figure is far below the estimate based on radioactive minerals. Prof. Holmes believes that the discrepancy lies in a false estimate of the annual sodium increment. The above calculation of J. Joly assumes that 1·9 per cent. of all material added annually to the ocean is sodium, which means, since 10 per cent. of that material is derived from the gases of the atmosphere, that 2·1 per cent. of eroded material is sodium. But the sodium percentage of rocks has been calculated to be 2·85 per cent. for igneous and 0·81 per cent. for sedimentary rocks, giving an average of only 1·32 per cent. Prof. Holmes believes that the analyses of river waters for sodium invariably give too high results, and he thinks that this is because much of the salt in rivers comes from sediments and ground waters and is not new sodium added to the oceans by erosion of the rocks. He denies that the sodium method can give any serious contribution to the problem of the age of the oceans.

WATER SUPPLY OF THE NILE.—In continuation of the study of the regime of the Nile, the Egyptian Ministry of Public Works sent an expedition to the Lake Plateau in 1926. Under the title of "The Lake Plateau Basin of the Nile," Dr. H. E. Hurst has published an account of his work on that expedition (Cairo: Government Press, 1927). The discharge of the Victoria Nile was measured with difficulty, but appears to be about 760 cubic metres per second. The only important inflow to Lake Victoria is the Kagera River, which proves to have a considerably lower discharge than was previously supposed. It was thought to vary between 140 and 1500 cubic metres per second, but Dr. Hurst puts the average flow at not more than 250 cubic metres, and reduces the Kagera's contribution to the lake by about twenty-five per cent. Many more measurements are required throughout the year before the contribution of this area to the water supply of the Nile can be stated with certainty, but so far as can be judged at present, it is not large.

THE PETROLOGY OF THE PACIFIC.—A long paper which summarises all existing knowledge of the mineral and chemical constitution of the volcanic islands of the Central Pacific has just been published by Prof. A. Lacroix (*Mém. de l'Acad. des Sciences*, Paris, **59**, 1927). A great many new analyses are presented, and a careful comparison is made with the rocks of the Hawaiian Islands and those of the islands off the South American coast. Throughout the region studied basaltic rocks (including the *andésites* β of Lacroix) with trachytic and ultrabasic differentiates are the dominant types. No granites, crystalline schists, or ancient sediments have been recorded in any form. Three main series are distinguished according to the marked or virtual presence or absence of nepheline and its equivalents. In a few localities dacites and rhyolites are present, but the typical 'andesites' of the circum-Pacific facies (*e.g.* hypersthene-andesites and *andésites* α of Lacroix) are wholly absent. Prof. Lacroix is characteristically cautious in drawing conclusions about the nature and structure of the sub-Pacific crust, and as to the meaning of the regional variations, he remarks: "Il faut reconnaître que les causes du phénomène nous échappent pour l'instant."

GRAVITY SURVEY BY SUBMARINE.—Investigations in gravity observations during the voyage of a Dutch submarine from Holland to Java via the Panama Canal in 1926 were the subject of a paper read by Dr. V. Meinesz on Dec. 12 to the Royal Geographical Society. The apparatus, consisting of three practically isochronous pendulums, was described in detail. It proved satisfactory and the influence of the ship's movements were effectively eliminated. Only provisional figures can be given, but Dr. Meinesz believes that the error arising from the ship's movement is only 0·0008 cm. in *g*. There are, however, other sources of probable error, including a very small error due to the uncertainty of the chronometer rate, and

others which are very difficult to determine, caused by the velocity of the ship and the speed of currents. Only preliminary results are available, until the computation of the observations by the United States Coast and Geodetic Survey are completed. One of the most interesting discoveries is the occurrence of positive anomalies in both Atlantic and Pacific Oceans. After isostatic reduction, the mean of 17 purely oceanic stations in the Atlantic gave an anomaly of +0·025 cm. and the mean of 14 similar stations in the Pacific +0·020 cm. These anomalies do not correspond to a pure longitude term and are greater than those that might be expected because of the deviation between the geoid and the spheroid caused by a corresponding distribution of mass. Several other preliminary results were also discussed in the lecture, which is to be published in the *Geographical Journal* (*v.* also NATURE, Dec. 17, p. 898).

THE HALL EFFECT IN IRON CRYSTALS.—The July issue of the *Proceedings of the Cambridge Philosophical Society* contains a paper by Dr. W. L. Webster on the Hall effect in single crystals of iron. The plates used were cut parallel to one or other of the faces of the crystal, were about 1·3 cm. long, 0·7 cm. broad, and 0·016 cm. thick, and were tested in magnetic fields up to 22,000 gauss. The Hall effect was balanced by means of a potentiometer. Up to 21,000 gauss the effect is proportional to the field and after that remains constant. Its value is identical for the specimens used and for pure iron, and there appears to be no connexion between the effect and the change of resistance of iron crystals in a magnetic field.

HARDNESS AND TEMPERATURE.—The results of Mr. E. G. Herbert's investigation of the effect of temperature on the hardness of metals, were communicated to the Institution of Mechanical Engineers at the meeting on Dec. 2. The hardness is tested by a pendulum hardness tester provided with a spherical faced diamond of 0·5 mm. radius, which rests on a short block of the material to be tested of 13 mm. square section kept at the desired temperature by an electric furnace. Where the specimen is of steel, it is heated to a temperature between 900° and 1300° C., quenched in water or oil, and tested either immediately or after a further heating to 400°-700° C. and slow cooling. High speed steel after the first heating and quenching has a hardness which decreases slowly with rise of the temperature of the test to 600° C. and more rapidly at higher temperatures. The further heat treatment decreases the hardness at low temperatures but raises it at high temperatures, so that it is nearly constant up to 600° C. As the materials cut by the tool steel are hardened by the operation, tests of this hardening have been made and it is found to be closely related to the ductility of the material.

MODIFICATIONS OF CANE SUGAR.—In the *Chemiker-Zeitung* of Nov. 12, Prof. von Lippmann gives a brief account of some investigations which were begun in Japan by Dr. Helderman and are being continued at Utrecht by Prof. Ernst Cohen, on the existence of modifications of cane sugar. In the special number of the *Zeitschrift für phys. Chemie* dedicated to Prof. Cohen, Helderman describes two distinct modifications, precipitated by methyl and ethyl alcohol respectively from aqueous solutions, of which the latter is the more stable at ordinary temperatures. Since the specific gravities and heats of solution show considerable differences, it is obvious that all physical constants of cane sugar will have to be re-investigated.

CONSTITUTION OF COLLOIDAL PLATINUM.—In the *Journal of the Chemical Society* for October, S. W. Pennycuick gives an account of an investigation of the constitution of colloidal platinum. Platinum sols do not require the addition of stabilisers, and so it was possible to prepare sols by sparking pure platinum electrodes in pure conductivity water, great care being taken to exclude all impurities, including carbon dioxide. The conductivity of such a sol at 25° increased over a period of several days, and approaching a limiting value. This equilibrium could be quickly reached by boiling for a few minutes. After any temperature change, however, there was a lag in the equilibrium as indicated by conductivity measurements. Sols with conductivities of more than 40 gemmhos at 25° were prepared. Pennycuick supports Pauli's theory, according to which some of the platinum is oxidised on disintegration, and in contact with water acts as an electrolyte, probably H_4PtO_4. This acid gives rise to the formation of complex anions which are in equilibrium with free hydrogen ions. Experiments on the titration of platinum sols with alkalis confirm the presence of free hydrogen ions, and it suggested that in addition to these, there is a surface layer of hydrogen ions on the complex anion. A change of temperature causes a measurably slow rearrangement of the equilibrium. The titration curves show that the sols are not strictly comparable with either strong or weak acids.

DEVIATION OF WIRELESS WAVES AT A COASTAL BOUNDARY.—Major J. P. G. Worlledge, writing from the United Service Club, Pall Mall, London, S.W.1, refers to the reflection of wireless waves suggested by Dr. A. H. Davis and Dr. R. L. Smith-Rose in a communication by the latter to NATURE of Sept. 19, 1925, p. 498. In the course of some experiments carried out at a direction-finding station during the period January to October 1927, Major Worlledge has obtained evidence of the reflection of wireless waves at a coast line. During the calibration of the direction-finding station it was noted that the bearings on certain stations, using more than one wave-length, showed abnormal variations accompanied by sudden shifts of as much as four or five degrees on wave-lengths in the neighbourhood of 1000 metres. As a result of systematic observation, it was found that the change in bearing was related in a harmonic manner to the frequency of the waves received. The period of this harmonic relation was found to be consistent with the explanation that the change in bearings was due to the reflection of waves from the landward side of the neighbouring coastline. In such circumstances two waves would be received, the direct and reflected waves, and the error in apparent bearing would depend upon the path difference of these waves in terms of the wave-length employed. The maximum deviations of bearings are observed when the wave-length is such that the direct and reflected waves arrive in the same phase, while at intermediate wave-lengths, blurred minima are observed on the direction-finder as a result of the difference in phase of the two waves. In most practical cases the matter is complicated by the fact that reflection may take place from more than one point on the coast-line, and Major Worlledge has arrived at the above explanation only by subjecting a large number of observations to periodogram analysis and comparing the results with accurate maps of the neighbourhood. The theory of the subject has been developed concurrently with the experiments and has given satisfactory agreement.

The Overthrusts of the Trans-Alai and Alai Chains.

By Prof. D. J. MUSHKETOV, Director of the Comité Géologique of the U.S.S.R.

THE great plains which run south-eastward from the Sea of Aral contract to the basin of Ferghana, which lies between the great crescentic curve of the Thian Shan to the north, and a series of chains which abut against the Pamir and the mountainous northern projection of Western India. It was shown by J. V. Mushketov, by surveys between the years 1874 and 1880 (described in his "Turkestan," 1886), that in the Alai Mountains the Palæozoic rocks were overturned in many places, and rocks that are not normally in contact had been brought together over wide areas. These facts were not followed up at that time nor by the systematic survey of Turkestan, which began in 1909. That survey showed that in addition to the Palæozoic rocks being overturned northward the Alai chain is traversed by large fault lines with surfaces sloping southward, and that its Kainozoic and Cretaceous deposits show in many places a paradoxical dip under the Palæozoic, and that exotic cap-shaped masses of the Palæozoic rest on younger rocks.

The geological survey of the Ura-Tuba region, that is, of the northern slope of the Turkestan chain between the valleys of Liaïliak and Zaamin Rivers, which I began in 1925, added much to the information regarding the eastern Ferghana: and the study of the numerous northerly curving Palæozoic band-shaped horsts prove the predominance of pressure from the south during the Kainozoic orogenetic processes. These preliminary observations were verified and completed in 1926 by my collaborator, A. P. Markowski, and later in 1927 by myself from the clear sections along the Liaïliak River.

The fundamental element of the tectonic structure in this area appears to be an inclination towards the north of long band-shaped Palæozoic blocks which trend west and east and are uplifted at the southern end and plunge downward at the northern end.

The formation of some oblong depressions (Rhabat, Bujun, and others) and many morphological peculiarities of the region appear to result from the mechanism which produced this widespread basin structure.

The second series of interesting observations were made during the past summer (1927) in the second part of my journey across the intersection of the Trans-Alai chain, along the Altyn-Dara River, and along the northern slope of the chain from the summit Khtai-Saz to Mt. Kaufmann, 26,000 ft. high.

The western part of the Trans-Alai chain is more complicated and interesting than the eastern part, and fully confirms the already known discordance between the structure of the eastern, or rather the middle part—the Kyzylart, and that of the Peter the Great Mountains.

These observations lead me to the following conception of the structure of the northern slope of this part of the Trans-Alai chain. It is a large isosyncline (about 3 km. wide) which is highly overturned to the north, and is lying almost horizontal; it consists largely of Lower Mesozoic red flaggy sandstones, which rest discordantly upon a base that consists of Upper Silurian limestones and that rises slightly above the floor of the valley. The core of this syncline is highly crumpled and includes 16 to 20 steep fan-shaped folds of Upper Cretaceous and Eocene marls and clays; they are raised by this folding to a height of 18,000 ft. in Mt. Khtai-Saz and other peaks. The southern limb of the syncline is truncated by the overriding from the south of the Lower Cretaceous red series, which, in their turn, are overridden by the Palæozoic beds containing effusive rocks that form the southern slope of the Trans-Alai chain.

Probably, moreover, the whole mass of the Trans-Alai chain, together with its Palæozoic base, was overthrust on to the Alai chain, thus occasioning the southward slope of the Alai chain while a large longitudinal displacement began the formation of the Alai valley. The morphological evidence of this fact, announced in 1903 by the American geologist Pumpelly, is now supported by direct geological proof, by the inclination and disappearance under the Alai valley of the Cretaceous and Kainozoic series of its northern bank (Daraut, Gaz, Sake-Yar). There, of special interest, is the sharp turn of the syncline from an east to west into a meridional strike, accompanied by an overturn to the north; for this change in direction is a supplementary proof of the influence of the southern or Pamir (Alpine) pressure. This change in direction takes place east of the meridian of Mt. Kaufmann, in accordance with the beginning of the curvature of the whole Alai chain into the 'Ferghana flexure.'

Observations on the southern limb of the flexure, between the Alai valley—along the Taldyk River, the southern Yagatch-art and the valleys of Katta-Karakol, Ak-bosagha and Archat—prove the occurrence (along an extent of about 100 km., from the mouth of the Kara-Kavak River, and extending up the southern slope of the Alai to its crest, and farther, beyond Yagatch-art, down the northern slope of the chain) of a large overthrust sheet of the massive Lower and Middle Devonian limestones. This sheet has been followed from south to north, and these limestones are in an absolutely abnormal position, as they lie above the Kainozoic and Cretaceous series and are in apparent accordance with them.

The width of the overriding and the thickness of the masses intersected by it diminish from west to east, in such a manner that on the west the younger series are generally squeezed out and are absent; and then gradually along the overridden band appear younger and younger series, first Cretaceous and finally Tertiary. Thus, to the east of Ak-bosagha, the Devonian deposits lie beneath red sandstones and conglomerates that are very high in the Kainozoic. The surface of the overriding sheet dips distinctly 35° S.E.

The observations of the past season complete the previous data and entirely confirm the conclusions which I have expressed at different times, particularly as to the 'Pamir orogenesis,' and also my preliminary diagrammatic section from the Pamirs through the Alai up to Ferghana (Izvestia Comité Géologique, 1926, No. 1).

The important observations of the recent Pamir expedition of the Comité Géologique of the U.S.S.R. under the leadership of Prof. D. V. Nalivkin are entirely in agreement with those previously mentioned. Prof. Nalivkin has conclusively proved the arch-shaped bending to the north of all the tectonic elements of the Pamir described by myself in 1917, and that the structure consists exclusively of Mesozoic and Tertiary series with Palæozoic rocks overriding them to the west of Kyzylarchat; he has discovered marine Jurassic deposits at the base of a Mesozoic complex along the Markansu valley, and has shown the analogy of the Jurassic formations of the Pamir with those of Western Bukhara; he has also proved the presence of Mesozoic rocks in the region of Mus-Kol; and, finally, he has confirmed the general overriding of the whole Pamir system northward.

Water Powers of Canada.[1]

UNDER the above heading, the Canadian Department of the Interior has just issued a brochure of 94 pages replete with up-to-date information respecting what is perhaps the most striking of all the natural resources of the great northern Dominion. In a foreword, the Deputy Minister, Mr. W. W. Cory, says: "In the vast domain of Canada, the countless rivers and streams, flowing with never failing replenishment from upland to sea, provide to the people of the Dominion an extraordinarily valuable and widely distributed asset in water-power resources which, already, has contributed in great measure to industrial progress, and which assures a supply of low-cost energy sufficient to meet expanding requirements for many years to come." To this may be added from the report itself: "It is not too much to say that, apart from the human factor, water-power is the most vital force behind Canadian industrial development."

As the subject of water-power development in Canada was dealt with by Dr. Brysson Cunningham in two articles which appeared in NATURE on Aug. 27 and Sept. 3 last, it is not necessary to recapitulate such information as is therein contained, but, the present report being of later date, there are several supplementary details of interest to which attention may be directed. The total turbine installation has now (Nov. 1, 1927) been increased to 4,883,266 horse-power, of which 4,012,428 horse-power is in connexion with central electric stations and 526,731 horse-power in connexion with pulp and paper mills, leaving a residue of 344,107 horse-power distributed over a miscellaneous group of industries, ranging from electro-chemical plants of considerable size to the lowly grinding mill serving local needs with a 5-horse-power wheel. The average of 513 horse-power per thousand of the population places Canada second to Norway in *per capita* development, while in aggregate installation she ranks second to the United States. The capital invested in the water-power industry in Canada is estimated at nine hundred million dollars, or more than that invested in any other single manufacturing industry. The corresponding figure in 1910 was 121,000,000 dollars, so that the increase in seventeen years has been more than six hundred per cent.

The outstanding significance of the location of the Canadian water powers is their favourable distribution for development purposes. Eighty-two per cent. of the developed water-power and roughly sixty per cent. of the total resources are situated in the coal-less provinces of Ontario and Quebec, where more than eighty per cent. of the manufacturing industry of the Dominion is carried on. It is this propitious circumstance which has not only enabled Canada to compete successfully with mass production in other countries, but has rendered her industrial structure largely independent of foreign fuel. Moreover, it is attracting to the Dominion important industries from abroad. Already 1400 branches of United States factories are stated to have been established in Canada. In certain specialised products the raw material from other countries is being imported for treatment by low-cost water-power. The bearing of this economic factor on the future welfare and progress of the Dominion can scarcely, as yet, be adequately estimated, but it is bound to be of great importance.

The brochure not only contains a wealth of figures and statistics, detailing the development in each of the provinces of the Dominion, but also it is illustrated by maps, diagrams, and a number of interesting photographs.

[1] Department of the Interior, Canada: Dominion Water Power and Reclamation Service. Water Resources Paper No. 60: Water Powers of Canada. Pp. 94. (Ottawa: F. A. Acland, 1927.)

The Relation between Rainfall and Flow-off.

IN Great Britain, knowledge of rainfall distribution is relatively detailed and exact. Moreover, most of the rainfall measurements which have been made are available to all who desire to consult them. On the other hand, the information which has been published regarding the flow-off of rivers is, by comparison, very slight in amount and most incomplete. A fair amount of data regarding flow-off has been spasmodically collected by various parties who are interested in the yield of certain rivers from the point of view of water-supply, but for reasons which are not connected with the increase of scientific knowledge, such data generally remain unpublished and inaccessible to the general student of the economy of rivers.

In some other countries the case is quite otherwise. Thus, the data published about the run-off of the more important rivers of the United States of America is very considerable, and would easily bear comparison with the corresponding rainfall data available for that country.

As a result of the conditions prevailing in Great Britain, there has grown up a devious method of obtaining an estimate of the average annual flow-off of a river. This method starts with an average annual rainfall map of the area drained by the river, and proceeds to make allowances for losses by evaporation, percolation into other river-basins, etc., and so arrives at an estimate of the average annual yield of the stream. As a rule, next to nothing is known about the magnitude of the losses, and in practice a quantity equivalent to from 10 to 14 inches of rainfall over the area is assumed to represent them. It needs but little consideration to appreciate the fact that measurements of evaporation from water-tanks and of percolation, as usually made, are carried out under conditions which bear but little resemblance to the corresponding conditions in the drainage area, and that they, therefore, find no direct application to the problem.

When a local authority produces a scheme for the appropriation of the water of a stream for purposes of water supply, it is of course incumbent on the authority to obtain parliamentary sanction for the adoption of the scheme. It is interesting to note that, in the records of the proceedings of the parliamentary committees which are appointed to hear evidence for and against such schemes, it is common to find considerable argument developed around the value to be assigned to the average annual rainfall over the catchment area, even if the various estimates of the value do not markedly differ among themselves; whereas the empirical figures which are deducted on account of losses by evaporation, etc., are often accepted without question. No doubt the reason for this unscientific procedure is that rainfall data are numerous and there is ample scope for argument in reference to the method of applying them to the problem in hand, whereas trustworthy data for evaporation from the area are entirely wanting, so that in the absence of run-off data, no opportunity for argument occurs in respect of the allowance to be made for losses.

The present investigation by Capt. W. N. McClean

of the rainfall over the area drained by the River Garry in Inverness-shire and of the run-off of the stream [1] is of considerable interest from this point of view, for it provides the means of comparing the two quantities and so forming an estimate of the losses due to evaporation and percolation in that area. The River Garry is situated in one of the wettest regions of the British Isles, the average annual rainfall being in excess of 90 inches. The investigation is the first of its kind to be made in Great Britain in respect of a stream in an abnormally wet region.

A map of the average annual distribution of rainfall over the area is the basis of the rainfall side of the work. A method is then developed whereby the total quantity of rain which falls over the area in any day can be estimated from measurements made at a few gauges in the valley. It is very difficult to assess the accuracy of these estimates. No doubt the error may be considerable on an individual day, but over a period of about a month the aggregate error should be much less.

The estimates of run-off of the stream were made by means of a continuous record of water level, combined with measurements of velocity at various points in the cross-section of the stream, and on various occasions. A calibration table is thus drawn up which enables values of water-level to be immediately converted into values representing the discharge of the stream.

[1] "Rainfall and Flow-off, River Garry, Inverness-shire." By Capt. W. N. McClean. Institution of Water Engineers, Dec. 9, 1927

In comparing rainfall with run-off due allowance is made for the storage in the river basin.

A balance-sheet of rainfall and flow-off is prepared by dividing the observation period of the three years 1913 to 1915 into parts each about a month in length, beginning and ending at times when rainfall was slight and the water in transit had fallen to a minimum. The net loss of each period is thus determined. These losses are presumed to be accounted for by evaporation, percolation, and (in winter) by storage in the form of snow. In spring, and sometimes in winter, the balance-sheet may show net gains: these are ascribed to the effects of melted snow which had previously been stored. The average loss is about $8\frac{1}{2}$ inches (of rain) per annum. The figure is a low one in comparison with the values usually accepted. It could readily be increased by supposing that the rainfall has been underestimated, and for such a supposition there is some ground.

The three years included the year 1915, which had an abnormally dry summer in the North of Scotland. From this circumstance the author is able to compile a valuable table of estimated lowest possible flow-off. This table depends only on the measurement of flow-off. The table in turn provides the necessary data for the computation of the maximum storage required to provide a continuous rate of draw-off.

The paper is a valuable contribution to our knowledge of the economy of a river situated in a region where the rainfall is very large.

R. CORLESS.

Anthropometric Measurements and School Progress.

A PAPER entitled "Body Measurements, Respiratory Tests and School Progress," which has an important bearing upon the methods and uses of anthropometric measurements of school children, was read before the Royal Anthropological Institute on Dec. 20, by Dr. A. A. Mumford, Medical Officer of the Manchester Grammar School. Body measurements have been taken annually at the Manchester Grammar School by the inspector of physical training on a uniform system since 1881. These measurements have been used to test growth and stimulate the use of the gymnasium by individuals below normal. Since 1909 the School Medical Officer has used these measurements to assist him in forming judgments about the satisfactoriness or otherwise of the boys' growth. With the co-operation of form masters it has been possible to correlate them with the boys' school work and conduct, and the records of each individual have been kept on cards which show the whole of the boys' school career at a glance.

By adapting a method suggested in a paper published in NATURE by Mr. Cecil Hawkins, height, weight, and chest girth were arranged and graded in half-yearly age groups in 5 per cent. percentiles. These groups made it possible to distinguish tall and small, thin and stout, narrow- and broad-chested, and also indicated in which one boy surpassed or was behind another.

It became apparent that it was desirable to carry out tests of functional as well as structural peculiarities, and respiratory tests were added. The tables were then graded on a time increment basis, which showed advances on the average in units of six months. The metric system of measurements was adopted, making it possible to use measurements of height and chest girth for calculations of volume, the true specific gravity being obtained in the swimming bath. Measurements were also made of particular parts of the chest. It was thus possible to advise parents and masters as to the kind of activity which would appeal most strongly to the boy or of which he stood in most need.

The observations showed that there was no single or uniform ideal boy, but that there were natural and essential differences which had to be found out, studied, and if possible measured. In seeking for a guiding principle to body build and shape in relation to physical activity, much help was obtained from the study of ancient brasses and from scientific tailoring, as well as from the measurements of records for the American Army, from which it was realised that there are special forms of body build which stand in relation to special forms of bodily exercise, and that each form of exercise makes special demands on body form and requires special methods of respiratory action. Hence the School Medical Officer needs to appreciate how wide are the differences in physical equipment between different individuals in relation to subsequent as well as school life. The basis of these differences is anthropological and must be studied in terms of functioning of the whole body. Sir Arthur Keith in his work on the mechanism of respiration in man, on the posture of man, its evolution and its disorders, and on the evolution of human races in the light of the hormone theory, has contributed greatly to the needs of the School Medical Officer.

Inquiry shows that body measurements and respiratory tests are also related to mental activity, and of the capacity to withstand and to recover from the mental strain in school life. The measurements of the School Medical Officer should be compared with the reports of the boys' progress furnished by the masters. Without such periodic reviews it is impossible to judge the effect of mental concentration on the boy's present growth or future fitness. Observation has shown that although undue absorption in either mental or physical activity involves

damage, proper exercise of physical powers is probably very beneficial to the cultivation of mental powers. An inspection of figures relating to boys who have gained entrance scholarships to Oxford or Cambridge during the past twenty years points in a similar direction. It was evident that boys winning scholarships at Oxford and Cambridge tended to display a somewhat accelerated physical growth when compared with the average boy. They also possessed a slightly better physical frame. This was most marked in boys winning first-class honours, and indicated that these boys maintained their position with less strain owing to a combination of higher mental ability and a superior bodily physique. In the boys of the next two grades the acceleration was less marked, indicating the strain of a lesser mental and physical ability. On the whole, the honours group excels in sports as well as brain.

The study of the adaptability of the human frame to meet the demands of energy involved by the various forms of mental and bodily work required in modern civilisation should be one of the principal objects of the modern School Medical Officer.

University and Educational Intelligence.

CAMBRIDGE.—Mr. H. L. H. H. Green, Sidney Sussex College, has been appointed demonstrator in anatomy.

AN election to three Beit Fellowships for scientific research will take place on or about July 16. Candidates must be of European descent and graduates of a university of the British Empire or of equivalent standing. The fellowships are of the annual value of £250 and are tenable at the Imperial College of Science and Technology. Forms of applications and all information may be obtained, by letter only, from the Rector, Imperial College, South Kensington, London, S.W. Applications must be received on or before April 20.

TWO Theresa Seessel research fellowships, each of the value of £300, are being offered by Yale University 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 fitness to carry on successfully original research of a high order. The holder must reside in New Haven during the college year, October to June. Applications, accompanied by reprints of scientific publications, 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., U.S.A., before Mar. 1 next.

WE have mentioned before in these columns "Poverty Problem" lectures of the University of Calcutta. The lecturer, Captain J. W. Petavel, has epitomised them in a volume entitled "The Plan of the Educational Colonies Associations." These associations have been formed, one in India and the other in England (Hon. Sec., J. B. Pennington, 3 Victoria St., Westminster, S.W.), to encourage pioneer efforts to put the plan into operation. Teachers in the proposed colonies are to be paid only on a half-time basis, as most of their time will be spent in running their own small farms or workshops with the help of groups of pupils. The scheme has received influential support in Calcutta. In the June number of *School Life*, the organ of the United States Bureau of Education, there appeared an account of the Educational farm colony of Rabun Gap, Georgia. This colony is based, in the main, on the principles on which Captain Petavel relies; that is to say, each family resides on its farm, the labour of the children is largely utilised, under skilled direction, in conducting the necessary farm operations, the produce furnishes nearly everything that is eaten in the colony, and a market is thus created for the farmers. The whole plant is utilised for educational purposes, and especially to make better farmers and citizens.

A DISTINGUISHING feature of the Rabun Gap colony is its system of 'rotating farm homes.' Each of the 20 families accommodated on the colony's 1500 acres is admitted for a period of five years only, and this is liable to be curtailed if the family does not 'make good.' At the end of its tenure it is expected to have attained to high standards of farm practice and of living, and to carry these with it elsewhere; its children meanwhile having had a good grounding in the ordinary school subjects and a training that should enable them eventually to become successful owners or managers. The scheme has been in successful operation on a self-supporting basis for twenty years. A contributory cause of its success is that the families are chosen from among more or less isolated hill crofters accustomed to a meagre and rough life. Whether it would have succeeded with people of the type of those from among whom Captain Petavel proposes to recruit his colonists is open to doubt. It is now, owing to a disastrous fire, to be re-established as a public utility corporation associated with the local education authorities. Half a million dollars are to be spent on the equipment of the reorganised colony.

WE have received a new and revised edition of "A List of the Serial Publications available for consultation in the Libraries and Scientific Institutions of the Union of South Africa." The List has been compiled for the Research Grant Board of the Department of Mines and Industries by Mr. A. C. G. Lloyd, the librarian of the South African Public Library, Cape Town, who has had the assistance of Mr. Percy Freer and Miss M. Ralling, members of the staff of the library. Notices of previous issues of this list appeared in NATURE in 1912, 1917, and 1921. It is remarkable that the number of serial publications catalogued in the list has more than doubled since 1921, having increased from 1350 to 3117. We must suppose that the greater part of this increase must be ascribed to the energy shown by Mr. Lloyd in collecting the necessary information from the various libraries and institutions scattered throughout South Africa, and we congratulate him on the successful accomplishment of a very difficult piece of work. Some forty-four libraries have been consulted, and these include the fine mathematical library of Sir Thomas Muir, which is destined to form part of the South African Public Library. After the title of each publication an indication is given as to the libraries in which it may be found. In every case all gaps in the sets are carefully noted, so that an opportunity is given for bringing pressure to bear upon librarians who should take steps to complete their sets. English and American serials are entered in their alphabetical order, but foreign publications are entered under their place of publication. We prefer the alphabetical arrangement of all journals as carried out in the "World List of Scientific Periodicals." However, the South African list has an alphabetical index containing the names of most of the foreign periodicals, with references to their position in the body of the work.

Calendar of Customs and Festivals.

January 9.

PLOUGH MONDAY, the first Monday after Epiphany, an ancient popular festival which marks the close of the Christmas and New Year celebrations. It has been explained as the day on which agricultural work is resumed after Christmas, and it is compared with St. Distaff or Rock Day, Jan. 7, the day after Epiphany, when the women are supposed to return to their work. On St. Distaff's Day a contest between men and women took place, the men burning the women's flax and the women drenching the men with water. A similar contest sometimes took place on Plough Monday. If the ploughman could rise sufficiently early in the morning to place his whip, ploughstaff, or other field implement by the fire before the maid put the kettle on it, the maid lost her shrove-tide cock, and vice versa.

Although Plough Monday is said to mark the return to work, the observances recorded have also been described as a festivity of the workers similar to that enjoyed by their masters during the holidays. Superficially they have that appearance rather than of a resumption of labour. Before the Reformation, candles were burnt before some of the images in the church, and a collection was made for the cost of the 'Plough lights'; but this part of the custom did not survive the change, although the levy of money continued to be made.

The essential feature of the custom was that a band of young men, sometimes with their shirts worn over their coats, sometimes in their shirt sleeves, and bedecked with ribbons, drew a plough, also dressed in ribbons, and sometimes called the 'fool plough,' to the principal houses in the neighbourhood, where they expected to be regaled with bread and cheese and ale, or to receive gifts of money. If there were no immediate response, and a tremendous din of shouting and blowing of horns produced no result, the ground in front of the door was ploughed up. The day ended with a merrymaking on the proceeds. The men who drew the plough were known as 'plough bullocks'—in Huntingdonshire as 'plough witchers.' In Lincolnshire the procession included thrashers carrying their flails, reapers with sickles, and all who were in any way connected with the work of the field, even to the smith who sharpened the plough, and the miller. As usual in folk mummings, important personages were 'the Fool' and 'Bessy,' a man dressed in woman's clothes. The latter carried the money box; the former had an inflated bladder, and was dressed in the skin of a calf, or in one case of a fox with dangling tail. Bessy sometimes had an ox-tail dangling beneath his skirts. It is significant that chasing and belabouring with sticks a man dressed in a calf skin was a Hogmanay custom in Scotland.

When brought into relation with customs found elsewhere, the object of the Plough Monday celebration becomes clearer. Certain Rumanian observances will serve. In the ceremony of 'the great plough' (*Plugul Cel Mare*), which takes place on the morning of Jan. 1, a number of young men go around to the houses of the wealthier people. Eight are harnessed to a real plough, one is equipped as a sower who precedes the plough and sows corn in its path, while another carries a friction drum made of wood, goat's skin, and horsehair, with which the lowing of oxen is imitated. On arriving at their objective, two of the party recite a long poem, which describes all the stages of Trajan's harvest from the sowing of the corn and its fertilisation by the rain, to the reaping and carting of the crops, and how Dochia (the daughter of the last king of Dacia conquered by Trajan) makes and bakes cakes for the workers. The verses close by wishing equal good fortune to the inmates of the house.

From these two customs, then, it would appear that the object of drawing the plough about on Plough Monday, a practice which had degenerated into little more than a noisy piece of horseplay with the object of raising contributions towards a merrymaking, at an earlier stage had been to wish or, more properly, to secure good luck and prosperity to those to whom visits were paid. Like other festivals of the kind, it must originally have been communal in character. The circulation among neighbouring houses at first was probably inclusive, a communal rite intended to secure the well-being of the whole society, as is usually the case. Among the Gilyaks, for example, at the slaying of the sacred bear, the animal was taken round to every house in the village.

Such a communal purpose may suggest an explanation of the even more primitive features. The Fool and Bessy, the two characters who appear constantly in folk dances, may usually be taken to represent the male and female principles in Nature, and their presence in the ceremony the promotion of fertility: the Fool in wearing the skin of the calf is identified with the animal itself, which is further indicated by the appellation of 'plough bullocks' given to those who draw the plough.

As a parallel may be cited the wolf dance of the Sioux, in which the dancers identify themselves with the wolf by wearing wolf skins and gather round the one who represents the buffalo to pull him down, thus magically securing the supply of buffalo meat; and the buffalo dance of the Mandans, as recorded by Catlin, in which they wear buffalo skins. The Fool and those who draw the plough may therefore actually be regarded as a survival of the belief in their identity with the oxen, the beating of the cow skin in Scotland possibly being a representation of the killing of the sacrificial animal to promote the strength of the deity which it represents. Sir James Frazer has shown that the corn-spirit is often represented by a bull or other animal which is sacrificed. The high leaps of Bessy, which showed her stockings and breeches, may be compared to the leaping of the dancers of many parts of Europe, by which women in a mimetic dance promote the springing of the corn.

HANSEL MONDAY.—The first Monday in the New Year, or more commonly Old Hansel Monday, on the first Monday after Jan. 12 (*i.e.* Jan. 1, O.S.) in Scotland was celebrated by gifts similar to our Christmas boxes. A liberal entertainment at breakfast was given to the farm-hands, and the rest of the day was a holiday. Servants were also engaged for the year. It was the principal day for making trial and forecasts of the future. In Skye a form of weather divination was practised at this time. It is a common and widespread custom to regard the weather of each of the next twelve months as being foretold by that prevailing on each of the twelve days between Christmas and Epiphany.

In Scotland the twelve days were sometimes reckoned in this period, then known as "the twelve days of Christmas"; by some from New Year's day; but in Skye, the period began with Hansel Monday. In the Balkans "a dry Epiphany and a dripping Eastertide" foretell plenty, and may be compared with "a green Yule makes a fat churchyard." Apart from the weather, the period between Christmas and Epiphany was peculiarly favourable for all forms of popular prognostication.

Societies and Academies.

LONDON.

Optical Society.—Dec. 8.—**T. Y. Baker**: The design of reflecting prisms. In the majority of reflecting prisms used in optical systems, reflections most frequently take place at angles of 45° ; and the planes of successive reflections are either the same or perpendicular to one another. The reason seems to be that these systems are easily portrayed on a drawing board. Any angles of incidence and any alterations in the plane of reflexion can be dealt with by the construction of a spherical diagram, either by measurement of an accurately drawn diagram on a sphere, or by computation by spherical trigonometry. From the data derived from the diagram, a wire model of the axial ray in its passage through the prism can be constructed. Next a wooden model of the full beam of light is constructed, and finally a model of the complete prism. Among the systems examined is that used in the prism binocular. Apparently a systematic examination of the possible prisms has never been made, but if it were done a skew prism of compact form and without re-entrant angles which could be made in a single block of glass might be found.

Geological Society, Dec. 14.—**Edward Greenly**: The Lower Carboniferous rocks of the Menaian region of Carnarvonshire: their petrology, succession, and physiography ; with palæontological notes by **Stanley Smith**. The term Arvon is a convenient designation for the region. The Lower Carboniferous rocks of Arvon consist in the main of a limestone series with many beds of sandstone and shale. This is underlain by a singular formation, composed of yellow and red loams and breccias, which are studded with pisolites of göthite and kaolinite. The blocks in the breccias are angular, and the loams are unstratified. The loams are of alien, the blocks of local, derivation. The limestones are rich in corals and branchiopoda, and are all in the zone of Dibunophyllum. The structure is that of an asymmetrical synclinal infold, truncated by a large boundary-fault. The series rests with complete unconformity upon the Mona complex and the Ordovician rocks ; and there is rapid overlap in a west-north-westerly direction. From the direction of the overlap, and from the contents of the conglomerates, it is inferred that the region which is now Snowdonia was completely submerged in Lower Carboniferous times. At first, the climate seems to have been arid, with a large diurnal range of temperature ; but, as the subsidence advanced, moist and genial conditions began to set in, persisting throughout the remainder of the period represented by the limestone series.

Linnean Society, Dec. 15.—**K. Münster Störm**: Recent advances in limnology. The object of limnology as a synthetic science is to investigate the reciprocal action of biotopes and biocenoses, and the cycle of organic substances within the microcosms represented primarily by the lakes. Recent researches confirm that the three biological lake types, *eutroph*, *oligotroph*, and *dystroph*, recognised by Naumann and Thienemann, must be regarded as natural, and should form the basis of attempts to establish more detailed classification schemes. A scheme embracing all lake types known at present is put forward which is based upon the (N+P), Ca, and humus 'spectra' proposed by Naumann for expressing the position of an individual lake with regard to those essential factors.—**T. A. Stephenson**: On species among the Cœlenterata. Cœlenterate species are difficult to define. The characteristics of the nematocysts have been suggested as useful criteria, for they are characteristic and their variations appear to be arbitrary. The species of British Actiniaria are sharply marked off from one another by their methods of reproduction. The structure of the nematocysts is a useful generic and family character, and their size sometimes distinguishes species ; but in critical cases they give no assistance, and differences of habits are the decisive factors.

EDINBURGH.

Royal Society, Dec. 5.—**E. T. Whittaker**: The influence of gravitation on electric phenomena. The address described the attempt of Faraday to find experimentally a connexion between gravitation and electricity, and the discovery by Einstein of the true principle of the connexion. The author has recently completed work on electric phenomena in the field of a single gravitating mass and in a uniform gravitational field.—**C. G. Darwin**: The new outlook on the mechanics of the atom. The address gave an account of the recent developments in the wave theory of matter, with especial reference to the description of motions, as opposed to stationary states.—**N. B. Eales**: The anatomy of a fœtal African elephant, Part 2. The muscles of the trunk and limbs. The dorsal muscles and ligamentum nuchæ are strengthened to carry the weighty head, which is heavier than in and other terrestrial mammal. Occipital muscles are fixey so far back as the thoracic vertebræ, and some of the cervical and thoracic muscles are firmly fixed to the pelvis and sacrum. Both limbs have enhanced extensor and weak flexor muscles. The five digits are prevented from spreading by strong lateral ligaments. In its musculature the elephant shows no close affinity with the Ungulata.—**H. W. Turnbull**: The invariant theory of the quaternary quadratic complex, Part 1. The reduced system. By a reduced system is meant a set of symbolic factors in terms of which any concomitant of the given ground form and of all possible types of quaternary variables, can be expressed. It differs from the ordinary set of factors given by the fundamental theorem for symbolic methods by being easier to handle. The investigation throws light on the properties of the Riemann-Christoffel curvature tensor.

PARIS.

Academy of Sciences, Dec. 5.—**Paul Appell**: The application of the theorem of virtual work to movement with friction.—**Maurice Hamy**: A particular case of diffraction of the solar images at the focus of a telescope.—**de Sparre**: The danger that may arise from cavitation in the case of a sudden stoppage of pumps feeding a main.—**G. Friedel**: The forms assumed by myeline in contact with water. Reply to a criticism by M. Nageotte.—**E. Mathias, C. A. Crommelin, and H. Garfit Watts**: The rectilinear diameter of ethylene. Ethylene obeys the law of the rectilinear diameter. The deviations from the straight line are larger than those for hydrogen and neon, and are of the order of 1 per cent.—**E. Bataillon**: The mitoses of simple activation in crossings of batrachians.—**Ragnar Frisch**: The theorem of determinants of Hadamard.—**Hadamard**: Remarks on the preceding communication.—**Pierre Vernotte**: A property of the method of least squares.—**Mandelbrojt**: Suites of holomorph functions.—**Julius Wolff**: The series $\Sigma A_k/(z-a_k)$.—**Henri Cartan**: Some theorems of R. Nevanlinna.—**J. Villey and Et. Hochard**: A strabometric manograph with deformable electric condenser. An elastic metallic mem-

brane receives on one face the cyclic pressure to be studied, and on the other face a permanent known pressure. The membrane forms one plate of a condenser, and is balanced against a known condenser through an electrometer. The sensibility of this instrument is limited only by the error of reading an ordinary static manometer used to control the readings.—**Henri Bénard**: Vortices in bands and Rayleigh's theory. Description of experiments confirming the theoretical predictions.—**Emile Belot**: The seismicity of the sun and the periodicity of magnetic storms. The lines traced by magnetographs on the earth are regarded as the electromagnetic translation of the curves which would be recorded by seismographs placed at the surface of the sun.—**A. Schidlof**: A construction furnishing the mass of the charged material point in the universe of five dimensions.—**L. Décombe**: Electrified spherical pellicles and spectral series.—**C. Raveau**: The reversible triangular cycle. Demonstration of several classes of thermodynamic relations.—**Mlle. O. Jasse**: A new interferential method of measuring the refractive indices of liquids.—**Georges Simon**: The use of the spectroscope in the regulation of superposition fringes.—**Georges Vaudet**: The spark spectrum of chlorine and bromine in the Schumann region. The lines given extend from wave-length 2252 A. to 1302 A.—**J. Rossignol**: Spectroscopy of the spark of mercury produced in an oscillating high-frequency circuit in permanent regime.—**Salomon Rosenblum**: The powers of slowing down by the atom relative to the α-rays.—**Mlle. C. Chamié**: The phenomenon of grouping of atoms of radioelements. Additional experiments are described showing that the atoms of radioelements can be associated in groups in various media and under varying conditions.—**A. Seyewetz** and **D. Mounier**: The action of light upon nitrated colouring matters. Phenols or amines containing the nitro group turn brown when exposed to sunlight or ultra-violet light. It is probable that a reducing action has taken place, but the presence of the amino group could not be proved.—**Ch. Quillard**: A method of distinguishing aluminium alloys based on the use of *p*H indicators.—**Charles Prévost**: The allyl transposition and the mechanism of esterification.—**Urion**: The preparation of 1, 5-heptadiine and 2, 6-octadiine. These hydrocarbons are produced by the interaction of the dimagnesium derivative of dipropargyl and methyl sulphate.—**Paul Fallot**: The mountainous region between Priego and Cabra (Andalusia).—**L. Gaurier**: A particular form of filling up in some high mountain lakes.—**Adolphe Lepape**: The origin of the radioactivity of the springs of Bagnères-de-Luchon. There is a relation between the radioactivity and the amount of sulphur present in the waters.—**William Herbert Hobbs**: The expeditions to Greenland of the University of Michigan. An account of the work done during the summers of 1926 and 1927. The object of the expeditions was to extend our knowledge of the glacial anticyclone.—**Lucien Daniel**: The variations of the secretory apparatus in various grafted plants.—**R. Dostal**: Morphogenic observations on *Caulerpa prolifera* of the bay of Villefranche-sur-mer.—**J. Dumont** and **B. Ganossis**: The deflocculation and the plasmolysis of the earthy coatings.—**Emile Saillard**: The coefficients of diastatic inversion.—**Louis Bounoure**: The chondriome of the primary gonocytes in *Rana temporaria* and the search for the genital elements in the early stages of development.—**Paul Chabanaud**: The nasal organ of *Solea vulgaris*.—**F. X. Lesbre** and **R. Tagand**: A triple monster of the ovine species. A description of a lamb, born dead, which had one head and neck, was double in the middle and triple below.—**Denis Bach**: The nitrogenous nutrition of the Mucorineæ. The assimilation of uric nitrogen.—**Angel Establier y Costa** and **Charles Kayser**: The effects of puncture of the fourth ventricle: hyperallanturia and troubles of thermal regulation.—**J. E. Abelous** and **H. Lassalle**: The influence of the section of a nerve on the general excitability of the nervous system.—**Michel Polonovski** and **René Hazard**: The action of *N*-methylgranatoline on the circulation, the pneumogastric and the heart.—**Perret-Maisonneuve**: The secretion and utilisation of the wax in the bee (*Apis mellifica*). Bees will utilise any suitable material for making their cells, and the conclusion is drawn from the experiments detailed that the secretion of wax under the normal conditions of existence of the bee is an economical necessity and not a biological function.—**Maurice Pietrre** and **André Chrétien**: The influence of some electrolytes on the phenomena of agglutination. Researches on the agglutination of bacilli of the paratyphoid group by specific immunosera. The age of the organism does not appear to be an essential condition, the most important factor being the chemical state of the bacillus.—**A. Blanchetière**: The hydrolysis of ovalbumen by pepsin in its relations with the formation of the diacipiperazines.—**Jean Delphy**: The constitution of the nuclear apparatus in the Infusoria: the Anoplophryimorphs.—**G. Lavier**: Particulars of the nucleus in the trypanosomes of the Brucei group, of recent isolation.—**Raymond Poisson**: A new eccrinid, *Tæniellopsis orchestiæ*, a protophyte parasite of the rectum of *Orchestia bottæ*. Its evolutive cycle.—**Jules Amar**: The laws of pathogenic action.

CAPE TOWN.

Royal Society of South Africa, Oct. 19.—**J. F. V. Phillips**: *Olea laurifolia* Lam. (ironwood): an introduction to its ecology. This is a highly important tree ecologically, sylviculturally, and economically. Despite its slowness of growth and the various disabilities to which it is subject, the species is fully capable of holding its ground in the Knysna forests and even of increasing its frequency if not kept in check. There is a steady demand for the timber.—**H. G. Fourcade**: (1) A new method of aerial surveying: second paper. The adjustment of an aerial traverse to terminal conditions is developed. An instrumental method of transferring, without computations, the vertical point from plate to plate is described, and a simple procedure for determining the directions of successive air bases is worked out. The ground control may be limited to single points at the end of traverses, instead of the clusters of 3 formerly thought necessary for fixing the positions of the terminal pairs of plates. (2) The principal point and principal distance in photogrammetry. The principal distance gives the angular scale of photographs and, in consequence, is a fundamental constant of the photogrammetric camera. The principal point, being the origin from which plate measures must proceed, is equally important. Former methods for determining these constants lacked precision because they depended on linear measurements of a central projection made upon a commercial plate, which usually is by no means plane, and either ignored distortion or treated it as an accidental error.—**P. R. v. d. R. Copeman**: Studies in the growth of grapes (Part 6). The acid-sugar ratio. An expression of the form $y = b/x - c/x^2 - a$ may be used to express the acid y in terms of the sugar x. The constants are affected to a greater extent by changes in locality than by seasonal changes. If r be the ratio acid–sugar, then $rx = b/x - c/x^2 - a$, and therefore the ratio may be calculated from the sugar content of the juice.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 13, No. 10, October).—**J. S. Nicholas**: The application of experimental methods to the study of developing Fundulus embryos. From the time when the embryo of this marine fish has attained a definite form, it can be safely removed from the egg-shell; the technique is described. The embryos so obtained develop in sea water, fresh or distilled water, and were used for experiments. These show that determination of tissues occurs at an early stage.—**J. H. Bodine**: The action of Na, K, and Ca chlorides on the egg of Fundulus. The embryo dissected from the egg is resistant to sodium chloride solution although the larva is killed. Both the other chlorides kill the embryo quicker than the egg, and the larvæ are very sensitive. Mixtures of sodium and calcium chlorides are not toxic for eggs, but very toxic for embryos.—**T. P. Abello**: Absorption of ultra-sonic waves by hydrogen and carbon dioxide. Waves of a frequency of 612,000 per second from a piezo-electric crystal were passed through a tube 5 cm. long and the intensity of the emergent beam was measured by a torsion vane. Plotting percentage volume of carbon dioxide or hydrogen in the air in the tube against the intensity gives points which follow a logarithmic curve.—**W. H. McCurdy**: On the fine structure of some mercury lines.—**Leonard B. Loeb**: On the duration of the existence of doubly charged positive ions in gases, and their detection. A critical discussion of recent results leads to the conclusion that while doubly charged positive ions are undoubtedly generated by the ionising agent in certain cases, they are few in number, and it is doubtful if they exist in the gas as multiply charged ions for sufficient time to be studied as such in ordinary ionic experiments.—**G. A. Miller**: Groups generated by two operators of order three, the cube of whose invariant is invariant.—**R. L. Moore**: Some separation theorems.—**John Belling**: A working hypothesis for segmental interchange between homologous chromosomes. Assuming that a break in the chain of genes of a chromosome takes place when the chain is at maximum extension (leptotene stage), then when two homologous chromosome conjugate, the breaks may or may not coincide. In the former event, should the four ends not be even or a twist have occurred, there is opportunity for interchange as the genes link up again.—**Robert E. Burk**: The heterogeneous thermal decomposition of ammonia in strong electric fields. One method by which a contact catalyst may function is by weakening appropriate bonds in the adsorbed molecules by atomic disturbances, *i.e.* distortion of the electronic orbits by the surface fields of the catalyst. With molybdenum wire 0·005 cm. diameter and fields of 44,000 volts per cm. at the surface, and platinum wire 0·0005 cm. diameter and fields of 150,000 volts per cm. at the surface, no change in rate of decomposition was observed.—**Bernard Lewis**: The photochemical decomposition of hydrogen-iodide; the mode of optical dissociation (see NATURE, April 2, 1927, p. 493).—**Jacob Papish** and **L. E. Hoag**: The detection of uranium by a photoluminescence test. A bead of fused sodium or potassium fluoride, when 'activated' by a trace of uranium, gives a brilliant and distinctive luminescence if illuminated by ultra-violet light or by a condensed iron spark. Columbic acid gives a similar luminescence with sodium but not with potassium fluoride, but the latter is not so sensitive as a reagent.—**Herbert L. Lombard** and **Carl R. Doering**: Cancer studies in Massachusetts. (1) The relationship between cancer and density of population in Massachusetts. The earlier finding of increased cancer death-rate with density of population among natives born of native parents is negatived on making adjustments for age and sex distribution. The statistics for foreigners are insufficient to give significant results, although the cancer death-rate appears to be higher than among natives. Part of the density phenomenon may be due to better facilities for diagnosis.

Official Publications Received.

BRITISH.

Nigeria. Proceedings of the First West African Agricultural Conference, held at Ibadan, Nigeria, March 1927. Pp. 196. (Lagos: Government Printer.)

British Museum (Natural History). Picture Postcards. Set M3: Oceanic Angler-Fishes, Series No. 1. 5 cards in monochrome. 6*d*. Set M4: Oceanic Angler-Fishes, Series No. 2. 5 cards in monochrome. 6*d*. (London: British Museum (Natural History).)

The Marine Biological Station at Port Erin (Isle of Man): being the Forty-first 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. 32. (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd.) 1*s*. 6*d*. net.

Proceedings of the Royal Physical Society for the Promotion of Zoology and other Branches of Natural History, Session 1926–27. Vol. 21, Part 3. Pp. 109-158. (Edinburgh: Oliver and Boyd.) 6*s*.

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 1926. By Joseph Baxendell. Pp. 28. (Southport: Fernley Observatory; London: Meteorological Office.)

Torquay Natural History Society. Transactions and Proceedings for the year 1926–7. Vol. 5, Part 1. Pp. 81+4 plates. (Torquay.)

FOREIGN.

Sveriges Geologiska Undersökning. Ser. Aa, No. 160: Beskrivning till Kartbladet Klintehamn. Av Henr. Munthe, J. Ernhold Hede och G. Lundquist. Pp. 109+1 tavla. 4.00 kr. Ser. Aa, No. 164. Beskrivning till Kartbladet Hemse. Av Henr. Munthe, J. Ernhold Hede och Lennart von Post. Pp. 155+1 tavla. 4.00 kr. Ser. Aa, No. 166: Beskrivning till Kartbladet Lurö. Av R. Sandegren. Pp. 43+1 tavla. 4.00 kr. (Stockholm.)

United States Department of Agriculture. Technical Bulletin No. 24: The Magpie in relation to Agriculture. By E. R. Kalmbach. Pp. 30. (Washington, D.C.: Government Printing Office.) 10 cents.

Museums of the Brooklyn Institute of Arts and Sciences. Report upon the Condition and Progress of the Museums for the Year ending December 31, 1926. By William Henry Fox. Pp. 71+3 plates. (Brooklyn, N.Y.)

Cornell University Agricultural Experiment Station. Memoir 107: Experimental Studies of Cultivation of certain Vegetable Crops. By H. C. Thompson. Pp. 73. Memoir 108: Studies of the Influence of Menhaden-Fish Meal on Calcification in Growing Animals. By L. A. Maynard and R. C. Miller. Pp. 23. (Ithaca, N.Y.)

Smithsonian Institution: Bureau of American Ethnology. Bulletin 85: Contributions to Fox Ethnology. By Truman Michelson. Pp. vii+168. (Washington, D.C.: Government Printing Office). 75 cents.

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, 1926. (Publication 2879.) Pp. xii+551+125 plates. (Washington, D.C.: Government Printing Office.) 1.75 dollars.

Department of Commerce: U.S. Coast and Geodetic Survey. Terrestrial Magnetism. Serial No. 393: Results of Magnetic Observations made by the United States Coast and Geodetic Survey in 1926. By Daniel L. Hazard. Pp. 18. (Washington, D.C.: Government Printing Office.) 5 cents.

CATALOGUES, ETC.

Catalogue de livres anciens et modernes rares ou curieux relatifs à l'Orient. (No. 5.) Pp. 117-180. (Paris: Libr. Adrien-Maisonneuve.)

Sotheran's Price Current of Literature: Catalogue of Science and Technology, No. 3. Annotated and Classified List of Rare and Standard Works on Exact and Applied Science. Part 8: including 12, Mining and Metallurgy. (No. 806.) Pp. 841-928. (London: Henry Sotheran and Co.)

Old and Modern Books: English and Foreign Literature, Modern First editions, Voyages and Travels, Americana. (No. 18.) Pp. 72. (Newcastle-on-Tyne: William H. Robinson.)

A Rough List of Recent Purchases of Valuable Books on Zoology, Botany, the Physical and Mathematical Sciences, Sport, etc. First Portion. (New Series, No. 20.) Pp. 60. (London: Wheldon and Wesley, Ltd.)

Diary of Societies.

SATURDAY, JANUARY 7.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. E. N. da C. Andrade: Engines: Putting the Furnace in the Cylinder (Juvenile Christmas Lectures) (V.).

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch) (College of Technology, Manchester), at 4.—H. S. Primrose: Electric Melting of Non-Ferrous Metals.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemical Section) (at 36 George Street, Manchester), at 7.

WESTERN JUNIOR GAS ASSOCIATION (at Works of Bath Gaslight and Coke Co.).—W. L. Ashman: Some Notes on Water Softeners and Water Softening.—H. C. Feltham: Future of the Gas Engine.

MONDAY, JANUARY 9.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Dr. J. Horne: Obituary Notice of Laurence Pullar.—Prof. J. Lorrain Smith: Obituary Notice of Prof. Henry Harvey Littlejohn.—Penelope M. Jenkin: Note on the Sympathetic Nervous System of *Lepidosiren paradoxa*.—Prof. D. Noël Paton: Reflex Postural Adjustments of Balance in the Duck.—Dr. E. A. Baker: The Photographic Latent Image as a Phenomenon of Luminescence (third paper).—Edith Philip Smith: A Comparative Study of the Stem Structure of the Genus Clematis, with special reference to Anatomical Changes induced by Vegetative Propagation.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—Capt. P. P. Eckersley: Technical Principles of Broadcasting (Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—A. E. Loe and others: Discussion on Portable Power Appliances.

INSTITUTE OF METALS (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30.—Open Discussion.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Award of Prizes and Studentships; Criticism by L. Sylvester Sullivan on Work Submitted.

SURVEYORS' INSTITUTION, at 8.—C. H. Bailey: The Reports of the Royal Commission on Mining Subsidence.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Dr. T. G. Longstaff: The Nanda Devi Problem.

INSTITUTE OF CHEMISTRY (Manchester and District Section) (at Manchester).—Prof. H. S. Raper: Some Inter-relations of Chemistry and Physiology.

TUESDAY, JANUARY 10.

INSTITUTION OF MINING ENGINEERS (Annual General Meeting) (at Geological Society), at 11 A.M.—Prof. H. Louis: Presidential Address.—Prof. H. Briggs and Prof. H. Louis: The Rhéolaveur Coal-washer in Belgium.—Dr. J. S. Haldane and Dr. R. V. Wheeler: The Use of a Lamp-room Photometer.—T. A. Southern: Life-saving in Colliery Explosions and Fires.—J. P. Rees: The Measurement of Low Air-velocities in Mines.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. E. N. da C. Andrade: Engines: Heat Engines which produce Cold (Juvenile Christmas Lectures) (VI.).

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—Dr. L. Dudley Stamp: The Connexion between Commercial Oil Deposits and Major Structural Features, with Special Reference to Asiatic Fields.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Sir Dugald Clerk: Standards of Thermal Efficiency for Internal-Combustion Motors.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—T. R. Thomas: The Effect of Type and Disposition of Machinery on the Strength of Ships.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—A. C. Banfield: Bridges, Pictorial and Otherwise.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.15.—H. T. Harrison: The Problems of Public Lighting by Electricity.

INSTITUTE OF METALS (North-East Coast Local Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.30.—G. Mortimer: Permanent Mould Casting in Aluminium Alloys.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—C. C. Swatman: Cleaning Mud Gatherings for Diatoms.—M. Burton: Deep Sea Sponges and the Beauty of their Structure.

SHEFFIELD METALLURGICAL ASSOCIATION (Annual General Meeting), at 7.30.

PHARMACEUTICAL SOCIETY OF GREAT BRITAIN, at 8.—Sir William J. Pope: Colour Photography (Lecture).

ROYAL SOCIETY OF MEDICINE (Psychiatry Section), at 8.30.—Dr. W. Brown: Theories of Suggestion.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Centre) (at Broadgate Café, Coventry).—M. Platt: The View-point of the Owner Driver.

INSTITUTION OF THE RUBBER INDUSTRY (Liverpool Section) (at Common Hall, Hackins Hey, Dale Street, Liverpool).

WEDNESDAY, JANUARY 11.

ROYAL SOCIETY OF ARTS, at 3.—Prof. A. Smithells: Flame (Dr. Mann Juvenile Lectures) (II.).

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—G. M. Lees: The Geology of South-Eastern Arabia.

OVERHEAD LINES ASSOCIATION (at Institution of Electrical Engineers), at 5.30.—Major T. Rich: French Regulations.

INSTITUTION OF CIVIL ENGINEERS (Informal Meeting), at 6.—Roger T. Smith: The Effect of Acceleration and Deceleration on the Wear of Railway Track.

GLASGOW UNIVERSITY ALCHEMISTS' CLUB (jointly with E.U. Chemical Society), at 7.30.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch, Graduate Section) (at Middlesbrough), at 7.30.—G. Booth: Colliers.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Institute of Chemistry), at 8.—J. R. Nicholls: The Determination of Small Quantities of Benzoic and Cinnamic Acids, with some Notes on the Colorimetric Determination of Salicylic Acid.—The Preservatives Determination Committee of the Chemists of the Manufacturing Confectioners' Alliance, Food Manufacturers' Federation: A Rapid Method of Determining Sulphur Dioxide, and Four Additional Papers.

ROYAL SOCIETY OF MEDICINE (Laryngology, Medicine, and Odontology Sections), at 8.15.—Special Discussion on The Influence of Naso-oral Sepsis on the Lungs and Gastro-Intestinal Tract. Openers: E. D. D. Davis and C. A. S. Ridout (for Section of Laryngology); Dr. R. A. Young and Dr. T. I. Bennett (for Section of Medicine); J. G. Turner and A. Bulleid (for Section of Odontology).

CERAMIC SOCIETY (at North Staffordshire Technical College, Stoke-on-Trent).—Prof. E. L. Collie: Dust Inhalation with special reference to Silicosis.

SOCIETY OF CHEMICAL INDUSTRY (Nottingham Section).—S. R. and E. R. Trotman and J. Brown: Action of Acids on Wool.

THURSDAY, JANUARY 12.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Prof. W. E. H. Berwick: Soluble Sextic Equations.—J. Wishart: A Problem in Combinatorial Analysis giving the Distribution of Certain Moment Statistics.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Colour Group), at 7.—Informal Meeting.—E. A. Bierman: Colour Plate Technique, with Display of Autochromes through the Lantern.

INSTITUTE OF METALS (London Local Section) (at 83 Pall Mall), at 7.30.—Dr. G. D. Bengough: Corrosion, with Special Reference to Standard Tests (Lecture).

ROYAL SOCIETY OF MEDICINE (Neurology Section) (at National Hospital, Queen Square, W.C.), at 8.—Clinical Meeting.

INSTITUTION OF MECHANICAL ENGINEERS (Glasgow Branch) (at Glasgow).—E. G. Herbert: Cutting Temperatures: Their Effect on Tools and on Materials.

INSTITUTION OF MECHANICAL ENGINEERS (Leeds Branch) (at Leeds).—L. H. Fry: Some Experimental Results from a Three-cylinder Compound Locomotive.

INSTITUTION OF MECHANICAL ENGINEERS (Cardiff Branch) (at Cardiff).—Prof. C. J. Hawkes: The Marine Oil-Engine (Thomas Lowe Gray Lecture).

OIL AND COLOUR CHEMISTS' ASSOCIATION (at 8 St. Martin's Place, W.C.).—R. G. Daniels: Some Points in the Manufacture of Zinc Oxide.

INSTITUTION OF THE RUBBER INDUSTRY (Birmingham and District Section) (at Grand Hotel, Birmingham).—F. W. Lanchester: India-rubber as an Auxiliary to Suspension.

FRIDAY, JANUARY 13.

ROYAL ASTRONOMICAL SOCIETY, at 5.—E. A. Kreiken: Some Remarks on the Orbits of Spectroscopic Binaries.—A. T. Doodson: Application of Numerical Methods of Integration to Tidal Dynamics.—Nizamiah Observatory, Hyderabad, Occultations of Stars by the Moon, 1926 January–1927 September.—Hong Kong Observatory, Transit of Mercury observed at Hong Kong, 1927, Nov. 10.—S. Rosseland: On the Time of Relaxation of Closed Stellar Systems.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Newcastle-upon-Tyne), at 6.—J. Calderwood: Diesel-Engine Drive for Generators and other Auxiliary Machinery on Board Ship.

PHILOLOGICAL SOCIETY (at University College), at 8.—Dr. W. Perrett: Greek Music.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.—W. S. Duke-Elder: Factors controlling Intra-ocular Pressure.—M. L. Hine: Report on a Case of Neuro-fibromatosis of the Eyelid and of an Artificial Eye which burst in the Socket.—E. Wolff: A Bend in the Sixth Cranial Nerve and its Clinical Significance (Anatomical Specimen).

JUNIOR INSTITUTION OF ENGINEERS.—N. E. Jackson: Air Conditioning: A General Survey of its Uses and Application.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (at Chemical Society).—H. R. S. Clotworthy: The Manufacture of Artificial Silk: with special reference to Viscose.

SATURDAY, JANUARY 14.

INSTITUTION OF MECHANICAL ENGINEERS (Bristol Branch) (at Bristol).—Prof. C. J. Hawkes: The Marine Oil-Engine (Thomas Lowe Gray Lecture).

EXHIBITION.

JANUARY 10 TO 12.

ANNUAL EXHIBITION OF THE PHYSICAL SOCIETY AND THE OPTICAL SOCIETY (at Imperial College of Science and Technology), from 3 to 6 and from 7 to 10.—Discourses at 8:—

Jan. 10.—A. Whitaker: Progress in the Recording and Reproduction of Sound.

Jan. 11.—V. E. A. Pullin: Recent Application of X-Rays.

Jan. 12.—Dr. J. W. T. Walsh: Artificial Daylight.

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