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Science at the Post Office.

AFFAIRS relating to the technical services under the Post Office have in the past few years been greatly in prominence; indeed, this has been the case since a Select Committee of the House of Commons began in 1912 to investigate the original contract in connection with the Post Office scheme for an Imperial Wireless Chain. The manner and method adopted by the Post Office in handling this scheme have in many ways proved most unfortunate for the State.

More recently, the serious and widespread complaints of the public concerning the quality of the Post Office telephone service led, in the early part of last year, to the appointment of a Select Committee to inquire generally into the situation; the Committee met forthwith and took much evidence from the officials of the Department and also from witnesses representing various public bodies. This evidence was reported to the House of Commons in June last (Report from the Select Committee on the Telephone Service. H.C. 191 of Session 1921): within the past few days the Committee has submitted its recommendations to Parliament, wherein a radical reorganisation of the Post Office is proposed (Report from the Select Committee on the Telephone Service, 1922 [No. 54]).

Since the Select Committee (of 1921) was appointed, particularly by reason of the allegations made by telephone users regarding the inefficiency of the service provided for them—a matter obviously closely connected with the question of the technical qualifications of the engineering staff employed thereon—it follows that those portions of the evidence given before the Select Committee, which deal with the methods adopted by the Post Office in recruiting its staff, are of considerable importance from the point of view of the reforms which should be taken in hand. Among the witnesses appearing before the Committee who dealt with this subject were the present engineer-in-chief and a former engineer-in-chief to the Post Office. The present engineer-in-chief in his evidence indicated the policy the Department is now adopting in the matter of recruiting its engineers, whilst the former engineer-in-chief, who gave evidence on behalf of the London Chamber of Commerce, contrasted the standard in the qualifications accepted by the Post Office from its engineers with that demanded in similar circumstances by the telegraph and telephone authorities in America and in Europe: the comparison tells greatly to the disadvantage of the authorities at St. Martin's-le-Grand. It was pointed out by the latter witness that whereas, from early times, telegraph and telephone administrations in foreign countries have exercised great care in appointing to the engineering grades leading to the superior positions in the technical branch of their undertakings candidates who have a high standard of technical qualifications, on the other hand, in the British Post Office, subordinate officials, who were not properly qualified, have, in many cases, been promoted into responsible positions.

The condition of affairs in relation to the engineering staff of the Post Office, to which allusion was made by the former engineer-in-chief in his evidence, was in no way in the nature of the giving away of official secrets: the unsatisfactory state of affairs prevailing on the staff side of the engineering department of the Post Office has already been brought to public notice by the Select Committee appointed in April 1912, to inquire into the wages and employment of Post Office Servants. This Committee, in dealing with the Engineering Department, reported:

"That it is proposed to recruit the class of Assistant Engineers by competitive examination, one half of the vacancies being offered to Post Office Servants up to the age of 40 in the case of those who have engineering experience, including junior engineers, and 32 in the case of those who have not, and the other half to outside candidates of not more than 24 years of age who have had two years' training in a technical college or in works. . . .

"That the work has become more technical, more complicated and more difficult, and that the age limit of 32 ought rather to be lowered than abolished.

"That there is no justification for reserving a proportion of the vacancies in the Assistant Engineers' Class for clerks in the Engineer-in-Chief's Office.

"That it is undesirable to limit the field of recruitment for the class of Assistant Engineers to those within the Department, and that it is important that 50 per cent. of the vacancies should be filled by young men of wider education and higher engineering attainments than are usual among Post Office Servants." (Report from the Select Committee on Post Office

Servants (Wages and Employment). No. 268. 1913. See para. 776.)

Although, as the above extract from the Select Committee's Report shows, it was tacitly admitted by the officials who gave evidence that the need existed for recruiting for the Post Office service men of wider education than those already serving, nevertheless a scheme, introduced in 1907, for recruiting twenty-five per cent. of engineers by open competition has been allowed to remain in abeyance from 1911 until the present time. Now that engineering vacancies are again to be filled by open competition from among candidates who have received an adequate education, twenty per cent. only of the engineers required for the telegraph and telephone services are apparently to be recruited in this way, whilst the remaining eighty per cent. of these positions are to be reserved for the subordinate grades serving in the Department, in order to fill these as heretofore by internal promotion.

In the matter of recruiting their engineering staff, the attitude of the British Post Office has been widely different from that of the telegraph and telephone administrations in other parts of the world. In the early days of telegraphy, when the specialised technical education needed by the telegraph engineer was not provided in the then existing schools, the telegraph administration itself, in many cases, arranged for appropriate courses to be given under its own auspices, as for example the courses at the East Indian Engineering College, Cooper's Hill; at the École Supérieure des Télégraphes, Paris; at the Istituto superiore, Rome; at the State Telegraph School, Stockholm; at the Versuchsamt, Berlin; etc. Now that instruction of a suitable kind is available in the technical high schools and universities abroad, foreign telegraph and telephone administrations, in practically every part of the world, recruit their engineers from amongst men who hold a diploma in civil or mining engineering as well as some recognised certificate in electrical engineering, or a diploma in electrical engineering; and, in some cases, where suitable courses are provided at universities, as in Belgium, Bavaria, Germany, etc., candidates for the higher career on the technical side are required to possess either a suitable degree or to hold a recognised diploma of equivalent standard.

Quite apart from the fact that the telegraph and telephone services cannot be carried on satisfactorily in this country by engineers possessing a lower standard of qualifications than that demanded from men occupying similar positions in foreign countries, it is exceedingly important on other grounds that the recruitment of engineers for the Post Office engineering department shall, now that a complete re-organisation of the Department is recommended by a Select Committee, be placed upon a sound basis. How important the other grounds are will readily be apparent if the estimates presented to Parliament last year be scanned through, for it will be found that the "establishment" of Post Office engineers is in this document shown to be above 570.

A further matter which, in view of the complicated nature of the engineering work undertaken by the Post Office and of the responsibilities of those in high positions, requires early attention is the status and method of selection of the chief of the Post Office engineering department and his immediate assistants. From every point of view, it is imperative that the officials holding these positions should be men of eminence in the engineering profession. Strong reasons exist at the present time for throwing open these appointments to the engineering profession generally. The adoption of such a course would present no difficulties, nor would it be exceptional: the appointment of the head of a department has at all times been recognised as being one which may be filled by a candidate from outside the Department. Many precedents exist in the Civil Service for the bringing in of a person from the outside to fill vacancies in high positions: for example, in the Post Office itself, during the past twenty-five years, four of the five men who have held the chief administrative position, that of secretary, and one of the engineers-in-chief have been persons who began their careers and spent many years outside the Department. It cannot be questioned that the chief technical adviser in an undertaking of the magnitude and complexity of the Post Office telegraph and telephone department requires to be a man of professional attainments of as high an order as is the administrative chief whose colleague he is to be.

No difficulty need be experienced by the Postmaster General in making a suitable selection of a technical adviser from an open field of candidates, if he will but call in the assistance of an *ad hoc* committee or board to advise him as to the merits of the several candidates; such a committee or board might, for his purposes, consist of the presidents of the Royal Society, the Institution of Civil Engineers and the Institution of Electrical Engineers. It has for some time been widely felt that such a method of filling the chief positions in government departments has become generally necessary in order to meet the present-day conditions. So far as the Post Office is concerned, in view of the announcements which have appeared that the present engineer-in-chief will be vacating his position in May next, the matter has become pressing. The adoption of the procedure indicated by the Postmaster General, when filling this vacancy, would meet with very general approval and give considerable satisfaction in the country.

The Imperial Institute.

IT is astonishing that, at a time when the Imperial Institute is looking forward to further developments in its work, a proposal should be put forward involving the dismantling of more than half of the recently extended and improved collections in the Public Exhibition Galleries of the Institute—without question the finest illustration of economic geography in the world—in order to make room for the war relics known as the Imperial War Museum at present housed in the Crystal Palace. The *Times* of March 7 contains leading and special articles on the subject in which a clear case is made for the abandonment of the proposal. Attention is directed to the resolution of protest recently passed by the Executive Council of the Institute. While appreciating the desire for economy in housing the War Museum, the council considers that this object should be achieved by some other method than by a plan which would be seriously detrimental to the development of the educational and commercial work for which the Imperial Institute was erected and endowed. Resolutions of protest have also been received by the council from a number of important bodies, including the Association of British Chambers of Commerce; the Chambers of Commerce of Liverpool, Manchester, Glasgow, and Bristol; the Royal Institute of British Architects; the Timber Trade Federation; the Institute of Builders; and the Silk Association.

For a quarter of a century the Imperial Institute with very slender means has been carrying on work of great service to the Empire, a fact far too little known and appreciated. The reward of such endeavour should be the provision of better facilities for development, and it is precisely in this respect that the proposals now put forward on behalf of the War Museum would be so detrimental in their effects. The Imperial Institute is becoming the recognised headquarters of organised effort in this country for the development of knowledge of the natural resources of the overseas countries of the Empire, and it is to be hoped that the Government will see that nothing of the character of the proposals justly condemned by the *Times* shall prevent the achievement of so desirable a purpose.

A Treatise on Petroleum.

Petroleum. By Sir Boverton Redwood. Fourth edition, reset throughout. In three Volumes: Vol. 1, pp. xxx+364+pl. 16. Vol. 2, pp. iv+365-740+pl. 17–31. Vol. 3, pp. iv+741-1353. (London: C. Griffin & Co., Ltd., 1922.) £5, 5*s.* net.

IN a review of the first edition of this work, published in NATURE in December 1896 (vol. 55, p. 169), it was asserted that "to write, or to compile a comprehensive text-book on petroleum, demands an acquaintance with dissimilar subjects and varying walks of life, very rarely centred in one individual. The present work is and will ever remain remarkable as the production of a man whose scientific attainments, and whose relation to the petroleum industries, were such that he, probably better than any other living man, was fitted to undertake the task."

During the quarter of a century that has since elapsed the "dissimilar" sciences that form the foundation of petroleum technology have both widened and deepened; chemical research has extended our knowledge of the constitution of the hydrocarbons that form mineral oil; the newly developed branch of colloidal chemistry, in its bearing on the properties of argillaceous substances, has affected the methods of refining and thrown new light on the problems of crude-oil migration underground; the discovery of new occurrences and, especially, the compilation of data obtained from established fields have put a new complexion on the questions of oil geology; improvements in mechanical engineering have modified the methods of exploitation and transport; whilst the remarkable development in the use of internal combustion engines, inspired by stern necessity during the war, has been accompanied by an extension of the theoretical and practical aspects of oil as a source of power. In complexity and volume each of these phases of the natural history of oil and the technique of its uses is to-day comparable to the whole range of petroleum technology as it was when Sir Boverton Redwood first attempted the task of summarising the disconnected and apparently unrelated data of the petroleum industry.

To keep in touch with these developments was perhaps possible to the author if to no one else; to keep abreast of them he frankly recognised as impossible, and thus we find in this new edition of a work which "is and will ever remain remarkable" the results of the friendly co-operation of more than two dozen specialists. The contributory work of these friends is evidence of their belief in the value of this treatise as a work of reference, and is at the same time a sign of the magnetic personality of the author and the affectionate respect with which he was regarded among all classes of workers in the oil world. But the thorough revision of some parts in this way serves to bring into relief others which remain as they were issued with the third edition in 1913. The book in this respect bears the marks of the war, during which the author's unremitting devotion to honorary public service left him insufficient time for his accustomed methodical compilation of new facts and for the judicial examination of new theories. To specialists in the accessory sciences and to local workers in distant fields, who will necessarily subject appropriate chapters to microscopic analysis, the deficiencies thus left will be obvious; to those who knew the author personally, and were thus able to estimate the heavy burdens which were laid on him during the anxious years 1914–18, these blemishes will be regarded as veritable war wounds.

Thus, this fourth edition of a recognised standard work, even with its blemishes, will be to workers in the oil world an appropriate memorial to its author. In most chapters there are the results of his characteristically painstaking assembly of data; the constant sense of relativity shown in their summary; the judicial instinct with which conflicting theories are balanced; the conscientious recognition of the work of others; the cautious estimates of "prospects" likely to affect commercial interests; the record of observations privately obtained from innumerable friends; and, finally, the signs of war weariness which probably brought about the fatal illness to which he succumbed only two days after passing for press the complicated section on shale oil and allied industries.

The publication of this edition marks a definite stage in the history of petroleum technology; in complexity its ramifications have now passed beyond the comprehension of any one individual; no single person can hope to prepare the fifth edition of Redwood's "Treatise." Its author has passed away, but his spirit remains incarnated in the Institution of Petroleum Technologists which he founded just before the war, and that body might well regard as its chief mission the maintenance up to date of this its bible as a standard work of reference. The Institution has already in the press a volume summarising recent developments in special branches of the petroleum industry, and this work, supplemented by Mr. Dalton's revised and extended bibliography, will bridge many of the gaps left in the Treatise by Sir Boverton Redwood's unexpectedly sudden death.

T. H. Holland.

Entropy as a Tangible Conception.

Entropy as a Tangible Conception: An Elementary Treatise on the Physical Aspects of Heat, Entropy, and Thermal Inertia for Designers, Students, and Engineers, and particularly for Users of Steam and Steam Charts. By Eng. Lt.-Commr. S. G. Wheeler. Pp. 76. (London: Crosby Lockwood and Son, 1921.) 8*s.* 6*d.* net.

OPINIONS will differ as to the merits of the title which Lt.-Commr. Wheeler has chosen for this volume. The extreme relativist, who regards the notion of force derived from our muscular sensations as a relic of animism, will no doubt condemn it. "To-day we have dispossessed the demons, but the *ghost of a muscular pull* still holds the planets in place."[1] On the other hand, the student of either physics or engineering will welcome any suggestion which assists him in understanding the nature of the "ghostly quantity," entropy. "The more shadowy the conception to be visualised, the greater the need of a definite material analogy." The quotation is from the instructive presidential address to the Physical Society of London delivered by Prof. Callendar in 1911. Here it is pointed out that the caloric theory is perfectly consistent with Carnot's principle and with the mechanical theory for all reversible processes. The quantity measured in an ordinary calorimetric experiment is the motive power or energy of the caloric, and not the caloric itself. Prof. Callendar identifies caloric with the "thermodynamic function" of Rankine, or the "entropy" of Clausius.

With this address and with the important paper by Sir J. Larmor "On the Nature of Heat" (Proc. Roy. Soc. vol. 94, p. 326, 1918) we imagine Lt.-Commr. Wheeler is not acquainted. He sets out to give a more tangible interpretation of entropy than that afforded by Boltzmann's statement that it is "the logarithm of the probability of a complexion." This he endeavours to do, and in our opinion with considerable success, by means of mechanical analogies. There is, needless to say, nothing novel in such an attempt. Poynting and Thomson, in their text-book on "Heat," direct attention to quantities which are analogous to entropy; indeed, we may, according to Prof. Callendar, go back to "the old picturesque phraseology of the material fluid, implied in Carnot's waterfall." Just as gravitational energy may be regarded as the product of mass and the height of the mass above zero level, so heat energy may be regarded as the product of "thermal inertia" and temperature. Thus entropy, being, as Swinburne called it, "the measure of the incurred waste," may be interpreted as "incurred thermal inertia." But in this book a distinct point, which we had not previously met with in print, is made by considering, not linear, but rotational, motion, so that thermal inertia corresponds to the moment of inertia, mk^2, of a rotating system. Here we have a case where the rotational inertia is capable of variation through changes in the value of k, the radius of gyration.

This may be illustrated by suspending a flat, circular disc from a point in its circumference by a thin wire by means of which it can be spun round around a vertical axis (Fig. 1). At first the disc will rotate about its original vertical diameter, but on the attainment of a certain speed the disc will start to

[1] Dr. Mott-Smith, in J. M. Bird's "Relativity and Gravitation." (Methuen, 1921.)

rise, the wire now making an angle with the vertical whilst the disc rotates about an axis through its centre and perpendicular to its plane, the centre remaining vertically below the fixed point of suspension. At a still higher speed the disc will begin to whirl about the point of suspension with the wire and its own plane both practically horizontal. "The changes in inertia of the rotating disc occur at definite speeds as it receives energy, and it is not so improbable as at first sight it may seem, therefore, that the changes in form which occur at perfectly definite temperatures (as, for instance, when heat is added to ice to turn it to water, and to water to turn it to steam) may really take place in a similar manner by some corresponding change in disposition in the particular internal or ionic movement which we imagine to constitute heat; in other words, that this motion may enjoy some form of increased freedom which may be regarded as an increase of thermal inertia."

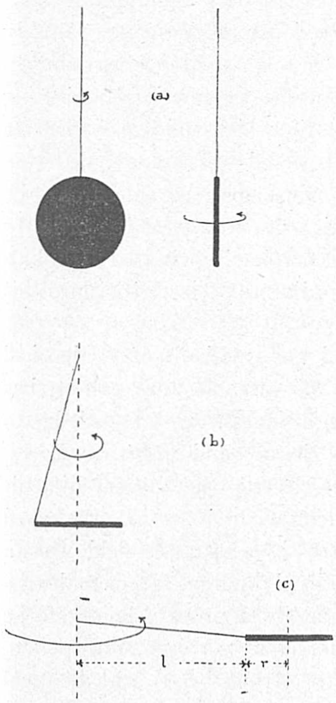


FIG. 1.—An instance of change in rotational inertia.

The conception of entropy as incurred thermal inertia is worked out in detail in the later chapters, and an interesting mechanism is described which affords a parallel to the behaviour of the working substance in an engine (Fig. 2). In this model the actual working substance is represented by an arrangement consisting of a short shaft carrying a pair of heavy "governor" balls mounted on bell-crank levers controlled by varying tension springs. Changes in the rotational inertia of the revolving masses represent changes in the thermal inertia of the working substance. With the apparatus illustrated in the book it is possible to go through a cycle of operations, such as the usual steam-engine cycle (Rankine's cycle) or Carnot's cycle, and examine the analogies between thermal and mechanical processes in detail.

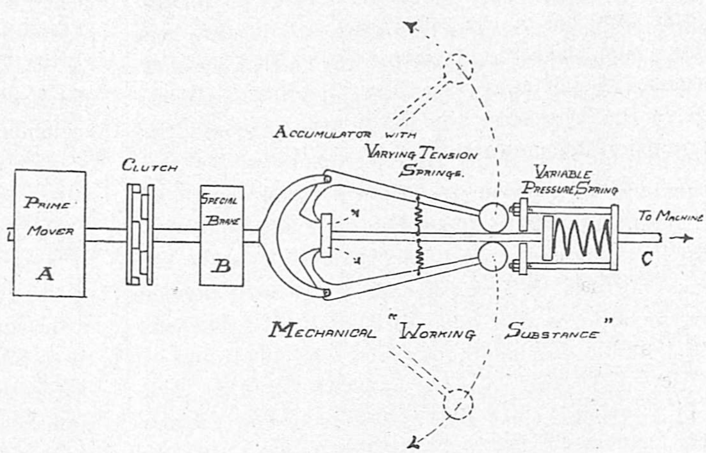


FIG. 2.—Mechanism illustrating the behaviour of the working substance in an engine.

Teachers and students of thermodynamics would be well advised to study this volume.

In connection with such mechanical analogies our attention has been directed to an address delivered before the Institution of Civil Engineers in 1883 by Prof. Osborne Reynolds. The lecturer referred to the work of Rankine, who assumed the thermal motion to be rotatory, and, when compelled to abandon the theory of "molecular vortices," called on all those who taught the subject of thermodynamics to try to find some popular means of illustrating the second law. "The call was made twenty years ago; but I believe up to the present no such illustration has been forthcoming." "The communication of heat to matter means the communication of internal agitation—mob agitation. If, then, we are to make a machine to act the part of hot matter, we must make a machine to perform its work in virtue of internal promiscuous motion amongst its parts." As an illustration, Osborne Reynolds instances the possibility of raising a bucket by violently shaking the upper end of a heavy rope or chain. A modification of the illustration is afforded by a kind of chain composed of a series of parallel horizontal bars of wood connected and suspended by two strings. "By giving a circular oscillation to the upper bar, the whole apparatus is set into a twisting motion (agitation); the strings are continually bent, and the vertical length of the whole system is shortened." Osborne Reynolds refers also to the governor of a steam-engine, which acts by kinetic elasticity depending on the speed. "The motion of the governor is not of the form of promiscuous agitation, but, though systematic, all the motion is at right angles to the direction of operation, so that the principle of its action is the same." Here we have the germ of the model discussed in the book under review. We may venture the opinion that the development of this model owes not a little to the late Prof. A. M.

Worthington, whose name, however, is nowhere mentioned. "These kinetic examples of the action of heat must not be expected to simplify the theory, except in so far as they give the mind something definite to grasp; what they do is to substitute something we can see for what we can barely conceive."

The Mass Formula of Cathode-ray Corpuscles.

Vérification expérimentale de la formule de Lorentz-Einstein. Par Prof. Ch.-Eug. Guye, en collaboration successive avec S. Ratnowsky et Ch. Lavanchy. (Mémoires de la Société de Physique et d'Histoire naturelle de Genève, vol. 39, fasc. 6.) Pp. 273–364 + plates 4–6. (Genève: Muséum d'Histoire naturelle, 1921.) 20 francs.

THIS memoir gives a detailed account of experiments made by MM. Guye and Ratnowsky in 1907–9, and by MM. Guye and Lavanchy in 1911–13, with the object of testing the mass-formulæ of Abraham and of Lorentz for the cathode-ray corpuscles. Preliminary notices of these researches have appeared from time to time, but now they are published in their final form, preceded by a theoretical and historical introduction of twenty pages, whilst twenty pages are devoted to the experiments of Guye and Ratnowsky, and forty pages to those of Guye and Lavanchy; the whole concludes with a small collection of tables and plates. There are records of twenty-seven experiments by Guye and Ratnowsky for the range from $\beta=0{\cdot}21$ to $\beta=0{\cdot}59$, and of 151 experiments by Guye and Lavanchy from $\beta=0{\cdot}25$ to $\beta=0{\cdot}49$. The first series of experiments gives for the excess of the observed mass of the electron above the Lorentz mass a mean value of five thousandths, and for that above the Abraham mass a mean value of nineteen thousandths, with a probable error of about three thousandths; the second gives for the same quantities two ten-thousandths, eleven thousandths, and one two-thousandth respectively. Thus the evidence of these investigations is strongly in favour of the Lorentz mass formula, in complete agreement with previous researches of similar rank, such as those of Bucherer, Wolz, and Neumann on β-rays, and of Hupka on accelerated photo-electrons.

Like Hupka, Guye and his associates used a relative method; the electric or magnetic force, as the case happened to be, which was required in order to produce a prescribed deflection of a given fast cathode-ray pencil, was compared with that needed to produce an equal deflection of a slow cathode-ray pencil selected as a standard. But whilst Hupka used only the magnetic deflection and relied for the determination of the speed of his photo-electrons on the measurement of the vacuum tube potential employed in accelerating them, Guye and his associates used both the electrostatic and magnetic deflections, not simultaneously, as had been the usual previous practice, but separately and alternately. Thus they eliminated errors due to variations in the state of the vacuum tube, rejecting *ab initio* all experiments in which sudden changes in its condition were suspected. They avoided the large errors which are almost inseparable from the measurement of very high potentials (of the order of 80,000 volts), which completely vitiated Hupka's results, at any rate according to Heil's criticism of his experiments.

The relative method, or method of "identical trajectories," as Guye and his associates call it, has the advantage of not requiring an exact knowledge of the distribution of the electric and magnetic forces, which, especially for the electric field, is very difficult to determine with sufficient accuracy. Since the speed of an electron is not altered by a magnetic field, we can for two cathode-ray pencils of different speeds make the terminal deflections equal by a proper choice of the ratio of the magnetic forces at corresponding points, and so ensure that the trajectories are identical throughout; then the electro-magnetic momenta (transverse mass × speed) will be in the ratio of the magnetic forces—*i.e.* of the electric currents generating the field. But for the electric field the equality of the terminal deflections of two cathode-ray pencils of widely different speeds does not guarantee the identity of their trajectories, if only because the electric field generally alters the speed. In the experiments of Guye and his associates the changes of speed produced amounted to only a few thousandths of the whole, so that the trajectories were very nearly identical, and the error arising from this cause was negligible. Consequently for two cathode-ray pencils of widely different speeds undergoing equal electrostatic deflections the products of their transverse masses into the squares of their speeds could be taken to be in the ratio of the deflecting electric forces—*i.e.* of the differences of the potential between the plates of the condenser used to produce the deflection. Thus the ratios of the speeds and of the transverse masses of the two cathode-ray pencils could be expressed in terms of the measured ratios of the currents in the magnetising coils and the potential differences of the condenser. In this way the speeds and masses of a number of cathode-ray pencils of various high speeds were compared with those of a pencil of a standard low speed, without the need of finding the distribution of the electric or magnetic fields or the discharge potentials for the high-speed pencils.

In order to test the mass formulæ the speed and mass of the slow-speed pencil were found by measuring the discharge potential directly with an electrometer, which could be effected with sufficient accuracy, because in this case the difference of potential was only about 14,000 volts. The speed ($\beta = 0 \cdot 228$) was calculated by successive approximation, the appropriate mass formula being employed to estimate the necessary correction to the zero mass, which for this low speed amounted to only 3 per cent. The result, together with the measured electrostatic deflection, supplied the data needed for the evaluation of the electric field integral, which was used in the comparison with the high-speed cathode-ray pencils. In the earlier experiments this field integral was also evaluated by graphic calculation from the constants of the condenser, but the experimental method of determination was adopted finally as more accurate, the difference between the two methods being about 5 per cent. In the later experiments curved condenser plates were used, in order to render the trajectories more nearly equipotential; in this case graphic calculation was impossible. No data are given for the magnetic field integral, perhaps because it was always eliminated; nevertheless, its evaluation from the constants of the apparatus might have been useful as a check, and would have made the direct calculation of the magnetic deflection possible, with a view to meeting beforehand Heil's objection to Hupka's use of the relative method, viz. that the observed magnetic deflections differed widely from those calculated from the measured currents and the constants of the apparatus.

Apart from the absence of this check, every precaution seems to have been taken to ensure accuracy; the earth's magnetic field was compensated, electrostatic influences were guarded against, special arrangements were used to secure regular working of the vacuum tube, and the number of observations was amply sufficient to eliminate practically all accidental errors. The authors are to be congratulated on producing a most valuable contribution to our knowledge of the dynamics of the electron.

British University Problems.

Second Congress of the Universities of the Empire, 1921: Report of Proceedings. Edited by Dr. Alex. Hill. Pp. liv+452. (London: Published for the Universities Bureau of the British Empire by G. Bell and Sons, Ltd., 1921.) 21*s*. net.

THE Report of the Proceedings of the Second Congress of the Universities of the Empire held at Oxford on July 5–8, 1921, has just been published as a volume of more than five hundred pages. It will be recalled that the first of these Congresses was held in 1912, and, but for the intervention of the war, would have been followed by the second in 1917. Fifty-nine universities—six more than in 1912—sent upwards of three hundred delegates and representatives to it. The main topics under discussion were the balance of studies; the teaching of civics, politics, and social economics; secondary education; adult education; technological education; the training for commerce, industry, and administration; the training of school teachers; finance; research; and the interchange of teachers and students—all, of course, with reference to the universities. Such a varied and comprehensive programme required some skill in arranging and handling, and Dr. Hill is to be congratulated on the way he has edited the Report.

Thirty-five papers were presented to the Congress. These have been printed *in extenso*, together with verbatim records of the discussions which followed. Though lack of space prevents it, a mere list of the names of the various speakers would be interesting in itself, as giving a list of distinguished scholars drawn from all quarters of the British Empire. For such particulars, reference must be made to the Report itself. The opening address was given by Lord Curzon, the Chancellor of the University of Oxford, who welcomed the Congress to Oxford, and expressed his opinion of the value of such Congresses as having it in their "power to play a very important part in developing the organisation and drawing closer the bonds of the British Empire." This was followed by an able paper on "The Present and the Future of Hellenism." Unfortunately, the discussion was limited, no doubt, by the fact that it was followed by four other papers in immediate succession. Sir A. J. Balfour, the Chancellor of the Universities of Cambridge and Edinburgh, who presided at the discussion on "The Universities and the Teaching of Civics, Politics, and Social Economics," in his opening speech raised the question of innate differences of races among human beings, but decided, very wisely, not "to wander into a topic so tremendous." In the general discussion, the point that "only a few boys in any school can go to the university" was raised, and, curiously enough, was emphasised in a paper which followed dealing with the question of the university and secondary education. The same point came up in another form, when Lord Haldane, in a notable address on adult education, referred to the extent to which the universities were dependent on the taxes and rates. "Democracy," he said, "is beginning to ask why it is that, while they pay the rates and taxes, only a limited section of society gets the benefit." A most interesting discussion followed the six papers dealing with various aspects of this subject.

On the subject of technological education, four papers were contributed. Lord Crewe deprecated "the intellectual vulgarity that sets the scholar in a different class from the workers, either for laudation or contempt." In the discussion, reference was made to the "great misfortune" of segregating students of technology in separate "technological universities," and so preventing them from mixing with the students of other faculties, to their mutual loss. In the debate on "The Universities and the Training of School Teachers" a similar note was struck, several speakers emphasising the necessity of a university atmosphere for such training.

Sir Robert Stout, Chancellor of the University of New Zealand, in opening the meeting on "University Finance," gave an interesting account of educational finance in New Zealand. The discussion, *inter alia*, brought into relief the different attitudes of the over-seas universities and the home universities to the question of State aid and university autonomy. One of the most important, and certainly one of the most interesting, discussions took place on the subject of "Research." Lord Robert Cecil, in summing up the debate, made it quite clear that at present research in the universities is mainly obstructed by "want of money and want of leisure." In this we may well agree. In the last session, the case for the institution of a Sabbatical year for the professoriate was well argued, but obviously "want of money" is the rock upon which such a scheme will founder. Sympathetic references which were made to the death of Lord Balfour of Burleigh, who should have presided at the discussion on "The Training for Commerce, Industry, and Administration," are duly recorded.

The Report gives a full account of a most instructive congress, and the papers and discussions bristle with points which in recent years have been giving rise to much thinking in university circles. Any one interested in higher education cannot fail to profit by reading it.

India as a Centre of Anthropological Inquiry.

Principles and Methods of Physical Anthropology. By Rai Bahadur Sarat Chandra Roy. (Patna University Readership Lectures, 1920.) Pp. xiii + 181. (Patna: Government Printing Office, 1920.) 5 rupees.

THERE is not an anthropologist in Europe who will not extend a welcome to this work by Rai Bahadur Sarat Chandra Roy, reader in anthropology at Patna University, not only for what it is, but also for what its appearance signifies. Anthropology, hitherto a plant of exotic growth in India, has at length taken root in the native mind. A single readership in a single university is a somewhat slender root for a plant which has to cover more than 300 millions of people, but those who have noted the series of excellent researches and monographs which have been published in recent years by Mr. Roy and by his colleagues and disciples will have no fear of the result if a fostering hand be extended by the Government of India. Our knowledge of the peoples of India has been laid by those great-minded Civil Servants who realised that good government must be based on accurate, intimate, and sympathetic records of the mentality, customs, and traditions of the governed. It was at the feet of one of these great Indian servants, Sir Edward Gait, now chancellor of Patna University, that Mr. Roy was introduced to the methods and aims of modern anthropology.

The book under review, "Principles and Methods of Physical Anthropology," is based on the first course of lectures given by Mr. Roy as reader in anthropology in Patna University. The lectures now published, six in number, form one of the best introductions to the study of anthropology in the English language. It is true that many minor statements require emendation or qualification, but we are surprised that one who has made his reputation as a cultural anthropologist should have grasped so accurately the methods, aims, and theories of those who study the evolution of the human body and brain, as well as the rise and spread of modern races of mankind.

A mere enumeration of the titles given to the six lectures or sections into which this book is divided will show the scope of the author's work. The first is devoted to the evidence relating to man's place in the zoological scale; the second to the evidence relating to man's antiquity; the third to the theory of evolution; the fourth to the theory of evolution applied to man's body, brain, and culture; the fifth to man's first home and early migrations; the sixth to the evolution of human races and their classification. Thereafter follow appendices giving the chief schemes for classification of human races, bibliographies, etc.

Hitherto the problems of anthropology have been viewed solely through European eyes; it is well that they should be seen also from the point of view of those who live on the banks of the Ganges. Certain it is that India is nearer the hub of the anthropological universe than Western Europe. Many anthropologists in looking round the world for the most likely place to serve as a cradle land of mankind have selected India or some neighbouring region—a belief in which Mr.

Roy has faith. But whether this be so or not there can be no doubt that India lies on the great racial divide of modern mankind. Within its population taper off the three great divisions into which human races are grouped—the white, yellow, and black. Here, too, three great linguistic families come into juxtaposition. It is a vast treasure-house of ancient ιites, beliefs, and customs.

It is a great task to which the author of this work has set his hand. He is bold enough to hope that his school will do for the 300 millions of India what the anthropological schools of Cambridge and Oxford have done for the 36 millions of England. The English pioneers had an uphill fight, and it is the memory of this experience which will make them extend a willing and helping hand to Rai Bahadur Sarat Chandra Roy, reader in anthropology in Patna University, in the difficulties and apathy which now confront him and his school.

ARTHUR KEITH.

Our Bookshelf.

University of London. Galton Laboratory for National Eugenics: Eugenics Laboratory Memoirs, VII. On the Relationship of Condition of the Teeth in Children to Factors of Health and Home Environment. By E. C. Rhodes. Pp. viii+80. (London: Cambridge University Press, 1921.) 9*s*. net.

MR. RHODES has analysed the records of five School Medical inspectors charged with the examination of the school children of an administrative county, with a view of discovering whether relationship could be traced between condition of teeth and factors of health and home environment. The bulk of the paper is devoted to an investigation of methods of standardisation, *i.e.* to the solution of a problem of the following kind: given that two observers having different standards of classification examine and group into classes random samples of the same population, required, the corrections of the several distributions needed to render the results comparable. Two methods of solution, involving different assumptions, are employed. It is shown that the individual variations of standard are very large and that, for purposes of correlation, it is necessary to deal separately with each inspector's data. Actually very little correlation was found between the state of caries in the teeth of children aged 12-14 and either general health or home environment.

Both the author and Prof. Karl Pearson, in an introductory note, emphasise the need of standardisation. The results of this inquiry justify the following remark of Prof. Pearson: "There are many urgent practical problems which could be adequately solved by a study of the child population of this country, but they can only be solved by the leisurely laboratory method of observation, by standardised judgments and an efficient training in modern statistical methods. At present the observations are too rapid to be oι great scientific value, the judgments are personal opinions rather than real measures of fact, and the statistical methods of school officers' reports rarely indicate a knowledge extending beyond the elementary rules of arithmetic. These results are not due to any fault of the medical officers themselves, but to the inadequate system under which they are trained for their work, and to the speed under which they are compelled to form their record."

Mr. Rhodes' paper, despite the necessarily negative character of his main conclusions, is a valuable piece of work and enforces lessons which the public, not excluding medical officers, are slow to learn.

Hellenism and Christianity. By Edwyn Bevan. Pp. 275. (London: George Allen and Unwin, Ltd., 1921.) 12*s*. 6*d*. net.

WITH the exception of two essays on "Bacchylides" and on "The Greek Anthology," all the essays in this volume deal with some aspect or other of the relationship of Christianity to the world, ancient or modern. Touching the ancient world, there are two essays on the earliest contacts of Christianity and Paganism, and two especially delightful ones on St. Augustine. The essays on the modern world all revolve around the conflict between our "rationalistic" civilisation and religious experience as focussed by the life and teaching of Christ. The author's limpid style makes it a pure pleasure to read his arguments, and his complete candour should secure for them respectful consideration even from those who stand intellectually aloof from theology. A good example of his method, on a non-controversial topic, is the short essay on "Dirt," in which he works out in a most interesting way the polarity of our feelings towards objects, like our bodies and sex, which we treat as at once sacred and unclean. Of miracles he holds that their possibility cannot be scientifically disproved, but at the same time he regards them as altogether "peripheral" in Christian belief, and he finds the evidence both for the Virgin Birth and for the Bodily Resurrection of Christ too uncertain to build the edifice of faith upon them.

The intellectual difficulties of the Christian faith arise no longer from any supposed conflict with natural science—evolution is accepted by "educated Christian opinion" and the Book of Genesis is mythology—but with anthropology, comparative psychology, and philosophy. At most, however, these can show only, not that the Christian hypothesis is *impossible*, but that it is *unnecessary*. Mr. Bevan's answer is that the case for Christianity rests, not on argument, but on the quality of the Christian life. "If the Church Christian wants to convince the world of the supreme value of its ideal of love, it can only do so by steadily confronting the world with the actual thing." True, but this only means that among all the millions of nominal Christians, Christianity has rarely been seriously tried. Will it ever be widely tried? That is the question.

R. F. A. H.

Hermann v. Helmholtz' Schriften zur Erkenntnistheorie. Herausgegeben und erläutert von P. Hertz und M. Schlick. Pp. x+175. (Berlin: Julius Springer, 1921.) 90 m.

THE centenary of Helmholtz's birth is the occasion of the publication of these little known writings. They are chosen for their special importance in regard to present-day problems and in particular to the recent developments of mathematical theory.

The Historical Geography of the Wealden Iron Industry. By M. C. Delany. (Historico-Geographical Monographs.) Pp. 62 + 3 maps. (London: Benn Brothers, Ltd., 1921.) 4*s.* 6*d.* net.

This is the first of a series of "historico-geographical" monographs published under the editorship of Prof. H. J. Fleure, which are to be essentially research monographs. It would greatly enhance the value of the series if in future numbers the matter were indexed or at least paragraphed with suitable headings. A single chapter of forty pages does not facilitate reference. As regards its matter, however, this short monograph is well done, although it is difficult to follow the distribution of the Wealden forest at different ages on the sketch maps provided. The author traces the iron industry in this part of England from its beginning, in Roman days or earlier, to its decline in the eighteenth century, when, as is well known, it could no longer compete with the more favourably located industry on the coal-fields. There appears to be a gap in the history of the industry for seven or eight centuries after Roman times; at any rate, the author has been unable to find evidence of its existence in that period. Some interesting details are given of the methods employed and the kind of iron work produced.

Letters to the Editor.

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

Precursors of Wireless Telegraphy.

A tradition is growing (cf. Nature, March 9, p. 316), and requires scrutiny, that it was owing to discouragement by Sir George Stokes that D. E. Hughes abandoned his experiments in 1879, anticipatory of the methods and apparatus of modern wireless telegraphy. This is in contrast to all that is known of Stokes' extreme caution in advancing opinions, for which in fact he has usually been blamed, for example by Kelvin and Rayleigh in connection with spectrum analysis. From the modest letter of Hughes published in the *Electrician* in 1899, and in Fahie's "History of Wireless Telegraphy," Appendix D, which describes his very remarkable investigations, such an inference could scarcely be fairly drawn: "The experiments shown were most successful, and at first they (Spottiswoode, Huxley, and Stokes) seemed astonished at the results; but towards the close of three hours' experiments Prof. Stokes said that all the results could be explained by known electro-magnetic induction effects, and therefore he could not accept my view of actual aëreal electric waves, unknown up to that time, but thought I had quite enough original matter to form a paper on the subject to be read at the Royal Society." Hughes continues that he was so dismayed at being unable to convince them that he actually refused to write a paper on the subject until he was better prepared to demonstrate the existence of these waves, and with this end in view he continued his experiments for some years (Fahie, *loc. cit.* p. 310).

The key to the matter has, I believe, been supplied by the extracts from Hughes' original notebooks, now in the British Museum, which Mr. Campbell Swinton read at the Jubilee Meeting of the Institution of Electrical Engineers, and which he has kindly shown to me in manuscript. They show that Hughes held that in some way "the effects were due to electric conduction through the air" (Nature, *loc. cit.* p. 316). Those who knew Stokes would expect that he would demur stoutly to such a doctrine as misleading, and would insist that "they could be explained by known electro-magnetic induction effects." For it was not unknown even before Maxwell's theory (1860–64) that the inertia of such induction could propagate waves along wires, which, if of very high frequency, would travel, as Kirchhoff showed in 1857, with the speed of light. The transcendent advance of Maxwell's definite theory, confirmed as fact by Hertz in 1886–1888, was that in favourable conditions such waves could release themselves from the matter and travel free across space; and, more fundamental still, that it is just by such free transmission that all electric and optical effects become established.

It seems clear to my mind that the affair was a misunderstanding, such as can readily be imagined, between the tenacity of the practical inventor and the insight of the theorist who was conscientiously determined not to give countenance to a misapprehension of the nature of the phenomena. But if Maxwell had been present (he had recently died), or Kelvin, who were more closely interested in the problem of the nature of the transmission of electric influence than Stokes, they would perhaps have used further efforts not to allow the subject to drop; though it would at that time have required all the resources of theory to make progress along the lines of these experiments.

The episode is so interesting from the point of view of the philosophy of history of scientific discovery, not to mention the practical application of the microphone operating by loose contacts by Hughes himself, in the manner developed much later by Branly and Lodge and Marconi, that a full statement from all aspects should be on record.

Joseph Larmor.

Cambridge, March 18.

Stonehenge: Concerning the Four Stations.

Just within the surrounding earthwork of Stonehenge there are two stones symmetrically placed with reference to each other on opposite sides of the centre. There are also two mounds in corresponding complementary (or reversed) positions. The arrangement is shown on the accompanying plan (Fig. 1), the dimensions for which have been taken from Flinders Petrie's very careful measurements as published in his work, "Stonehenge—Plans, Description and Theories" (1880).

For the purpose of this paper the arrangement is referred to as "The Four Stations." The two stones are numbered respectively (on Petrie's system) 91 and 93, and the two mounds 92 and 94.

Concerning this pair of stones and pair of mounds Colt Hoare remarks:—

> "There are two small stones within the *vallum*, and adjoining it, whose uses have never been satisfactorily defined. The one on the south-east side is near nine feet high, and has fallen from its base backwards on the *vallum*; the other, on the north-west side, is not quite four feet high; both rude and unhewn. There are also two small *tumuli* ditched round, so as to resemble excavations, adjoining the *agger*; they are very slightly elevated above the surface, and deserve particular notice, as they may give rise to some curious and not improbable conjectures" ("Ancient Wilts," i. p. 144).

Colt Hoare opened the northern mound (No. 94), and in it found "a simple interment of burned bones." He also opened the southern mound (No. 92), "but found nothing in it" ("Ancient Wilts, i. pp. 144 and 145).

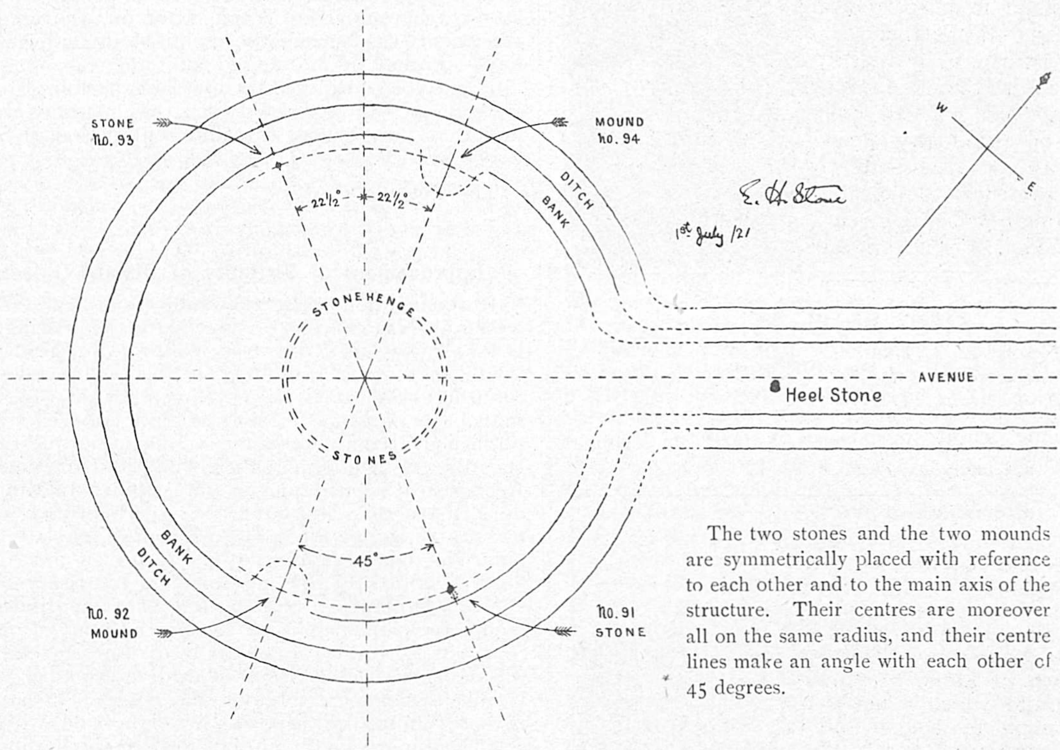
From the fact that a cremated interment has been found in mound No. 94 it has been assumed that both the mounds are barrows, and that they are moreover of the same period as the Round Barrows in the neighbourhood. On this assumption it is concluded that Stonehenge was constructed during the Bronze Age period or perhaps later. The arguments for this conclusion may be briefly summarised as follows :—

(*a*) In mound No. 94 was found a cremated interment.

"The stones were certainly not standing when Round Barrows were first erected on Salisbury Plain ; for one is contained within the *vallum*, which, moreover, encroaches on another" ("Ancient Britain," p. 476).

It will be observed that the whole of this argument is based on the assumption that mound No. 94 is really a Bronze Age Barrow. The mere fact that in it was found a cremated interment is, however, inconclusive, as we know that the Round Barrow people had a cuckoo-like habit of depositing a cremation in an existing hole or position originally intended for some other purpose. Col. Hawley's recent discoveries in connection with the "Aubrey Holes" furnish examples of this practice.

On Colt Hoare's plan the positions of the two stones and of the two mounds are not correctly



The two stones and the two mounds are symmetrically placed with reference to each other and to the main axis of the structure. Their centres are moreover all on the same radius, and their centre lines make an angle with each other of 45 degrees.

FIG. 1.—Plan of Stonehenge. Scale—120 feet to 1 inch.

The two mounds are therefore barrows, and are of Bronze Age date.

(*b*) As barrows they would originally have been isolated constructions of circular bowl-shaped form. This [supposed] original form has been partly infringed upon by the bank of the main surrounding earthwork.

The circular earthwork surrounding Stonehenge is therefore of later date than the mounds, and is therefore also of later date than the neighbouring Round Barrows.

(*c*) The Stonehenge stone structure was erected after the surrounding earthwork.

Stonehenge is therefore of later date than the neighbouring Round Barrows, and was probably constructed near the end of the Bronze Age or perhaps later.

By some archæologists this argument is considered absolutely conclusive. Rice Holmes, for example, remarks :

shown, and from that plan it would not appear that they had any particular relation to each other or to the general scheme of Stonehenge.

But if the carefully made measurements by Flinders Petrie be correctly plotted to a large scale some very significant facts concerning these Four Stations at once become apparent, *e.g.* :—

(*a*) The four positions (Nos. 91, 93, 92, 94) are absolutely symmetrical in reference to each other and to the general plan of Stonehenge.

(*b*) They are all four on the same circle, *i.e.* their centres are all at the same distance from the centre of the structure.

(*c*) If a line be drawn through the centres of the two stones (91 and 93), and another line be drawn through the centres of the two mounds (92 and 94), these lines will intersect at the centre of Stonehenge.

(*d*) The two lines drawn as specified under (*c*) are at an angle of 45° (or an eighth of a circle) with each other. They moreover make equal angles of $22\frac{1}{2}°$ (or a sixteenth of a circle) with the cross centre line of Stonehenge.

This symmetry is very striking, and is so complete

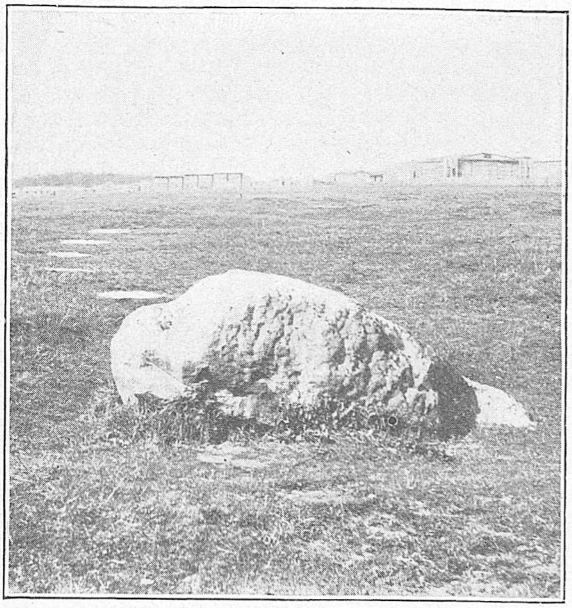


Fig. 2.—Stone No. 91. To south-east.

that it cannot be accounted for as a mere coincidence. It obviously points to the conclusion that the Four Stations, Nos. 91 to 94, were all specially located in relation to one another as parts of one scheme to serve some definite purpose in the general design of Stonehenge.

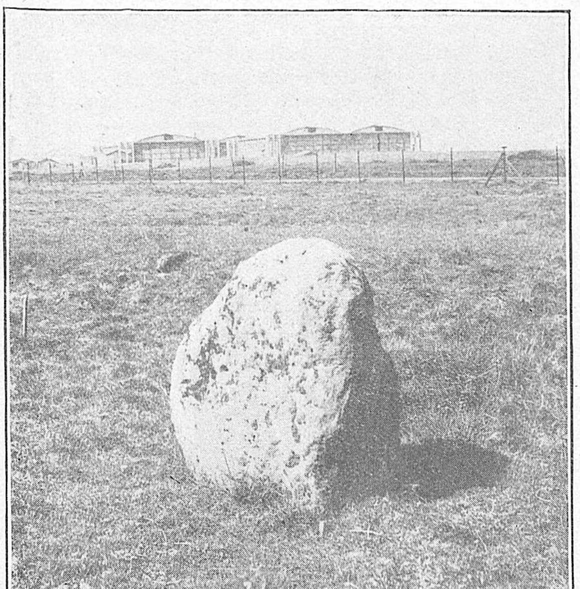


Fig. 3.—Stone No. 93. To north-west.

On this Flinders Petrie remarks :—

"On examining the stones and mounds 91 to 94 on the earth bank it will be seen that they are exactly opposite, stone to stone, and mound to mound. This strongly shows that they are contemporaneous ; as is also shown by the fact that the diameters joining their centres cross each other at . . . just half a right angle ; and further the diameters are complementary to each other, being symmetrical about the axis of the structure" ("Stonehenge," p. 21).

We cannot doubt that at one time there was a stone in each of the positions now indicated by the two mounds ; and that, whatever the purpose of the arrangement may have been, it had nothing to do with the neighbouring Round Barrows.

The two stones (Nos. 91 and 93), now in place, are shown in the accompanying photographs (Figs. 2 and 3). It will be observed that the ground is level around the base of each stone.

The two mounds (Nos. 92 and 94) are of very slight elevation, and are scarcely noticeable on the ground. Assuming that each of these two sites had at one time been occupied by a stone, we may suppose that the small amount of earth forming the present mound was thrown out of the excavation made when the stone was removed. When, later on, the cremated interment was buried, the incipient mound was perhaps trimmed up and added to.

It may be considered certain that the Four Stations were in no way connected with the "Aubrey Holes," and that they belong to a different period of Stonehenge history.

E. Herbert Stone.

The Retreat, Devizes.

Improvement of Visibility of Distant Objects.

In connection with the subject of some recent letters in Nature on "A Method of Improving Visibility of Distant Objects" by Prof. C. V. Raman (October 20, 1921) and by Mr. A. G. Lowndes and Sir David Wilson-Barker (November 10, 1921), it may be of interest to mention that two years ago I published a complete essay on the same question in the French Bulletin Officiel de la Direction des Recherches Scientifiques et industrielles du Ministère de l'Instruction Publique, No. 4, February, 1920, pp. 229-48, under the title "Sur l'utilité de la lumière polarisée dans les observations faites en mer ou au bord de la mer, et sur une jumelle à polariseurs."

Every advantage of polarised light mentioned by your correspondents, such as improvement of optical contrasts, visibility of colours in distant objects, etc., was considered and discussed in detail in that paper. I must mention that I took the research in hand in 1916 for military purposes, in connection with the French Ministry of Invention and Research and with the French Admiralty. The results and my former reports were communicated to the English Board of Invention and Research (1917). A little later, Prof. W. F. Durand, of Leland Stanford University, then the Scientific Attaché to the American Embassy in Paris, having been kind enough to order the translation of my reports into English, that English version was given likewise to the official agent of the British Ministry of Munitions Optical Department, Mr. F. C. Dannatt, now representative of the British Scientific Apparatus Manufacturers, Ltd., in Paris. At the end of the war the French Navy had a small number of binoculars equipped with spar polarisers of the Glazebrook-Ahrens type cemented with a special oil, as described in my paper. The constructor, M. A. Jobin, member of the French Bureau des Longitudes, supplied a few of those binoculars, at the request of the British Government, through Mr. Dannatt.

I do not wish to take up the space available in Nature with a translation of my paper, but a short summary of a few of my conclusions may be of interest.

Contrary to Mr. Lowndes's opinion, I objected very strongly to the tourmaline plates (except for some special purposes dealing with naval artillery) on account of the high colouring they give, either green or pink, which, unfortunately, results in an inaccurate rendering of the natural tints of objects and makes ineffective one of the most striking advantages of polarised light, the wonderful and delightful disclosure of true colours in far-distant objects.

Although the choice and careful making of the Bénard-Jobin spar prisms cemented by a special poppy-oil prepared by M. Duffieux (then my assistant) to equip the Jules Huet prism-binoculars of the French Navy gave unqualified satisfaction, I must confess—and I did so in the introduction of my paper—that I feel very much inclined to consider a very thin plate of *herapathite* (sulphatoperiodide of quinine) of a few square millimetres, having its crystallographic directions quite uniform in the whole area covering the ocular-ring, as the best of all polarising equipments, I cannot say it is the most practical one, because beautiful transparent and uniform herapathite plates are not easily obtained. However, I sincerely hope that my conclusion will please W. B. Herapath's fellow-countrymen, particularly as quinine salts are more easily obtained than Iceland spar.

Nevertheless, I mentioned at the end of p. 230 of my paper the old use of tourmaline spectacles to discover the fishes in deep water, and so on. *Nihil sub sole novum.* The optical constructor to whose talents I referred in my paper, without mentioning his name, as having, when he was a young man in the 'eighties, played a hoax on his fellow-anglers along the River Marne with tourmaline spectacles forty years ago, is now living in Grenoble. His name is M. Ivan Werlein, formerly well known and appreciated for his skilfulness by French physicists and crystallographers when he was working in Paris.

HENRI BÉNARD.

University of Bordeaux, February 8.

Statistical Studies of Evolution.

SINCE Dr. Willis and Mr. Udny Yule in their reply to my letter in NATURE (March 2) have asked me to explain the case of the New Zealand flora, I feel that I should attempt to do so.

The time taken for almost all animals and probably many plants to spread to the boundaries of a continuous area of habitable environment is short compared with geological time: witness the progress of *Elodea* in this country since its introduction only some sixty years ago. Surely, therefore, the majority of species at any particular time have already reached the boundaries of that area of habitable environment to which they are isolated (*e.g.* the Marsupials of the isolated Australian region).

Now the Indo-Malayan flora of New Zealand has arrived recently, geologically speaking, and has not yet reached a state of equilibrium; it is still spreading, unlike the majority of species. As Dr. Willis and Mr. Udny Yule showed clearly in their original article, the distribution of a fauna or flora that is still spreading will conform to the "Size and Area" curve. I believe that not only a spreading fauna or flora but also one which has reached the boundaries of its habitable environment will conform to the "Size and Area" curve.

The oldest endemic families of New Zealand must have reached this state of equilibrium and, on my theory, should conform to the "Size and Area" curve. Perhaps Dr. Willis could tell me if they do so in this or in a parallel case.

C. A. F. PANTIN.

Christ's College, Cambridge, March 13.

MR. PANTIN has not replied to our query as to why neither the northern nor the southern group of plants in New Zealand shows any increase of local species when it reaches the region where the other group shows its maximum of such forms. Why is one group represented by its most widely ranging endemics at the place where the other shows chiefly its endemics of least range?

If the Indo-Malayan invasion is so young in New Zealand, why do its members, though mostly trees, show a rather greater average range than those of the herbaceous southern invasion of plants of northern-hemisphere type? Though it is a long time since Britain was cut off from the Continent, why have 227 of its 1548 species not yet reached a distribution of more than 5 vice-counties out of 112, and why have only another 229 reached one exceeding 100?

All observation goes to show that dispersal of introductions is rarely rapid, unless, as in Ceylon or New Zealand, St. Helena or North America, man has completely altered the conditions, and destroyed or interfered with the societies that already existed. A few cases like *Elodea*, chiefly water plants, are known, and it is probable that the plant entered a society that was very incomplete. No other introduction has spread rapidly in England for centuries, though when the Romans came here, and cut down the forest, thus altering the conditions, many introductions were rapidly dispersed about the country.

To suppose that species have mostly reached their possible limit of dispersal is to return to a position like that taken up by the advocates of special creation, invoking incomprehensibility. Why should *Coleus barbatus* be found through tropical Asia and Africa, including the summit of Ritigala mountain in Ceylon, while *C. elongatus*, differing only in the form of the calyx and inflorescence, and a few minor points, is confined to that summit? Why should a species of the New Zealand flora that reaches the outlying islands range much further *in New Zealand* than a species that does not? Why should one that reaches the Chathams range much further than one that reaches the Aucklands or the Kermadecs? Nothing but Age and Area can even suggest an explanation of such facts.

No theory based upon natural selection will enable one to make predictions about distribution, whereas Age and Area has already been used successfully in this way nearly a hundred times, and has increased our knowledge of the subject. If we suppose that dispersal is already completed there is little left to investigate, and to explain the distribution of species about the world (as opposed to purely local dispersal) becomes a task that has been abandoned as hopeless by leading authorities upon distribution. The fact that Age and Area can be used for successful prediction shows that it is probably correct, and it offers an explanation incomparably simpler than does the natural selection theory, and explains with ease facts utterly incomprehensible to the latter, such as that the Auckland Is. contain 45 per cent. of Monocotyledons in their flora, the Chathams 31 per cent., and the Kermadecs only 21 per cent. How can natural selection explain the remarkable maps in *Ann. Bot.* 32, 1918, pp. 343 *seq.*, and the curves on pp. 357, 360? Mr. Pantin's theory seems to us to lend itself neither to explanation nor to prediction. We feel compelled again to emphasise that his supposition as to random combinations of environmental limitations does not appear to us to bear any relation to facts. Nor, if it did accord with facts, can we agree that his conclusions would follow.

J. C. WILLIS.
G. UDNY YULE.

Radiology and Physics.[1]

By DR. G. W. C. KAYE.

THE appreciation of the physicist by the medical worker in this country is of recent growth, but radiologists, while fully alive to the enormous part that radiology will play in medicine in the future, are only awakening to the fact that, if radiology is to advance as it should, they will have to correlate it continuously with physics. They may not find such correlation very easy. Not that physicists would look askance at the idea; the difficulty is that there are so few of them who are interested. The physicist has never been taught to look upon radiology as offering a possible career. Even had he been prepared to risk it, he would not have found educational facilities to put him on his way. There are probably not half a dozen physicists employed in radiology in this country. The Germans discovered, long before the war, that the secret of progress in radiology was to bring the medical man and physicist continually together and let them work side by side. They went further and introduced them both to the manufacturer—but that is another story! Is the British radiologist in a position to submit techniques, backed up with a wealth of physical and scientific data such as the German has recently given to the world? It is to be hoped so, but the British radiologist is sadly handicapped by not being able to look to the physicist for the discharge of duties which he has neither time nor, possibly, inclination to see to himself.

Radiology needs men who have a sound knowledge of the physics of radiology and are, furthermore, well grounded in electrical engineering, especially on the high-tension side of the subject. If we could ensure a steady supply of qualified physicists and electro-technicians who knew that in their future work they need not fear that they will not enjoy, both professionally and socially, the full status of their medical colleagues, we could look forward to a desirable all-round improvement in the science and art of British radiology.

Within the last decade we have learnt that X-rays are identical with light rays in almost every particular, the main difference being that the wave-lengths of the X-rays are much shorter. Until recently, a gap of about 4 octaves existed between the shortest known ultra-violet ray and the longest X-ray, but within the last few months it has been discovered that the continuity is complete and that the X-rays follow on and, indeed, overlap the ultra-violet end of the spectrum. The study of this missing group of octaves had invited attention for some time. The grating method proved unavailing for the purpose, the wave-lengths being too small for our artificially ruled gratings and too big for crystal gratings. Further, at either end of the gap the vacuum spectrometer had proved necessary owing to the extremely absorbable nature of the rays. The problem has finally been attacked with success in this country and America by Millikan, Richardson, Hughes, and Kurth who, using indirect photoelectric methods, have traced X-ray spectrum lines of various elements right across the gap and into the already explored ultra-violet. Fig. 1 shows the positions of some of these lines.

The following are the wave-lengths in Angström units, *i.e.* 10^{-8} cm. of the regions of the spectra we have been discussing:—

Visible light	7200 to 4000
Ultra-violet light	4000 to 200
X-rays	500 to 0·06
γ-rays	1·4 to 0·01

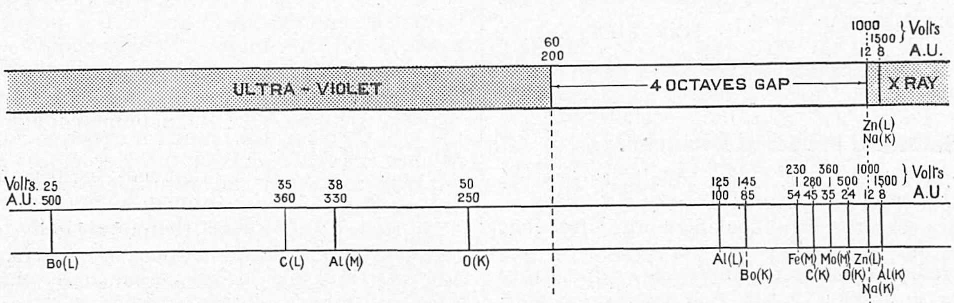


FIG. 1.

It thus appears that we can now claim a knowledge of the existence of over 13 octaves of X-rays or, including radium γ-rays, nearly 16 octaves. As yet the radiologist has only turned about 3 octaves of these to account.

As is now well known, the parallelism between light rays and X-rays is maintained by the presence of spectrum lines in the X-ray spectra. Just as the spectrum of a hot body normally consists of a continuous spectrum of white light, together with certain spectrum lines the wave-lengths of which are characteristic of the radiating material, so an element emitting X-rays not only gives out "white" radiation, but superposes its characteristic lines on the general spectrum. The characteristic X-ray spectra are found to be much less complicated than light spectra and are more readily sorted out into groups or series of associated lines. These several series, each of which includes a number of lines, are designated—J, K, L, M—and are broadly differentiated by a progressive increase in the average

[1] Abridged from the Mackenzie-Davidson Memorial Lecture delivered on February 17 at the Royal Society of Medicine.

wave-length of each group as we pass from one to another, series J having the shortest wave-length and requiring the highest voltage to excite it. It should be added that all the constituent lines of a group are excited simultaneously at a critical minimum voltage.

The work on X-ray spectra has thrown great light on the structure of the atom, and, in passing, it may be recalled that present-day theory regards all atoms, of whatever kind, as built up of two kinds of "bricks," and two only—(*a*) negatively charged electrons, and (*b*) hydrogen "nuclei," each more than 1800 times as heavy as an electron and carrying a charge equal to that on the electron, but positive in sign. Rutherford's nucleus theory of the atom, now universally accepted, regards an atom as built up of a minute positive nucleus (to which practically the whole mass of the atom is attributed) surrounded by a cluster of electrons grouped in rings. The total number of electrons in these rings is equal to the atomic number (N) of the atom in question. The nucleus of the atom is regarded as built up of hydrogen nuclei held together by electrons, the former being in excess to just such an extent that the nucleus as a whole contains N positive charges. This serves to counterbalance the N negative charges of the electron rings, the result being an electrically neutral atom. For example, platinum has an atomic number of 78. Its atomic weight determined chemically is 195. Thus, if platinum is a simple element, the platinum atom has a nucleus composed of 195 hydrogen nuclei and 117 electrons, the difference (78) serving to counterbalance the 78 electrons in the rings. The various elements differ only one from another in that they have different nuclear charges, the nucleus determining the mass and radioactive properties, while the number and grouping of the cluster of electrons in the rings control the chemical and spectroscopic properties. For example, the K radiation is supposed to arise from the displacement of an electron in the innermost ring, the L radiation from the next ring, and so on.

Within the last few years it has been established experimentally that there is a definite boundary to every spectrum of general X-rays on its short wave side. The position of this boundary (or quantum limit) is not affected by the nature of the element emitting the X-rays, but is dependent solely on the maximum voltage applied to the tube. The relationship is given by the well-known quantum equation of Planck. Substituting the accepted values of the constants, it follows that

$$\text{max. voltage} = \frac{12{,}400}{\text{shortest wave-length in A.U.}}$$

This very simple relation provides us with a scale of quality which, if not perfect, is more exact than any which the radiologist has been in the habit of using. Spectral curves of X-ray intensity are not symmetrical, the shortest waves are the dominating ones. The mean effective wave-length (or "centre of gravity") of a spectrum of rays approximates to the wave-length of the peak of the curve, *i.e.* the wave-length of maximum intensity. Now there is some evidence that this wave-length of the peak (λ_m) is proportional to the limiting or quantum wave-length (λ_o); in many cases λ_m proves to be approximately 4/3 times λ_o. But in practice it is much easier to measure λ_o than λ_m, and this fact gives an added importance to the measurement of the quantum limit and enables us to identify very fairly the quality of a mixed bundle of X-rays. No doubt something depends on the wave-form of the exciting potential, but the effect of this is probably less important as the voltage is raised. The precision of the method would be enhanced if steps were taken to standardise apparatus and technique, so that all work could be done by the use of, at most, three or four spectra the distinctive features of which, including energy distribution, could be determined and specified.

But how is the radiologist going to measure wave-lengths in his operating room? At present, the easiest plan appears to be by measuring the maximum voltage and using Planck's relation. The voltage can be obtained by use of a reliable type of electrostatic voltmeter, or, failing that, by measuring the alternative gap by means of some approved type of spark gap such as the sphere gap. Another and a better plan is to measure the quantum limit by means of a portable direct-reading spectrograph of the type designed in Germany by Seemann (Fig. 2). Incidentally, these direct-reading spectrographs act as very convenient

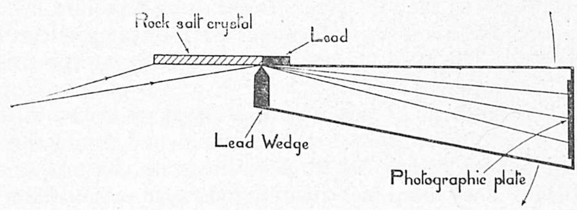


FIG. 2.

and accurate high-tension voltmeters, which afford a measure of the true maximum voltage effectively operating a tube.

There are two things that may happen to a beam of X-rays when passing through a material. Part of it may be absorbed, and is therefore wholly transformed into characteristic radiations of the material, the process always being accompanied by the liberation of electrons. The rest of the beam is scattered or dispersed which, in effect, is equivalent to stating that while the rays are unaltered in quality a considerable proportion of them have their direction altered. Scattering, which finds a close parallel in the dispersion of light by a fog, is more noticeable with light atoms than with heavy.

We explain these two effects—absorption and scattering—by supposing that absorption is caused by the flicking off by the X-ray of an electron in one of the ring systems in the atom. The outcome is the vibration of the ring systems in question with characteristic periods and the expulsion of an electron from the atom at high speed. If, on the other hand, it happens that the X-ray is incapable of definitely ejecting an encountered electron but merely jars it, so to speak, then the electron, having absorbed the energy of the X-ray, vibrates not with its own free period but with a forced period which is prescribed by the X-ray and it re-emits its new-found energy in all directions, though chiefly round and about the original direction. With a medium weight or heavy atom the proportion of scattered to absorbed radiation depends upon the wave-length and may be small. With a light atom the amount of scattered radiation is almost always large.

The problems of scattering have come to the fore recently in radiology in connection with deep therapy. The human body is made up chiefly of carbon, hydrogen, and oxygen—all light atoms—and its ability to scatter X-rays in the adjacent air has long been familiar to radiologists, especially in screening work. But the extent of the scattering within the body itself is just as marked, and this is the case whether the rays are of medium or high penetration. It has been established by Dessauer and others, from measurements made on specified areas at various depths within the tissue, that from 60 to 80 per cent. of the effectiveness of highly penetrating rays is due to scattered rays which originally were not directed at the area in question.

The subject of protection has recently excited a great deal of attention by reason of a series of casualties to prominent radiologists. The various radiological societies and institutions in London co-operated in 1921 in the formation of a representative Committee, which was asked to go into the whole question and draw up recommendations for the guidance of all concerned. It was agreed that the question of the protection of the operator was the sole issue; the existing measures had proved to be adequate so far as the patient was concerned. The word "protection" was to be interpreted in a wide sense.

The Protection Committee was fortunate in securing Sir Humphry Rolleston as Chairman and, under his eminent leadership, has already drawn up two memoranda. They need not be referred to in detail here, but they have already been widely acted upon, and there is little doubt that presently the bogey of X-ray dangers will have been laid. In years to come this country will be entitled to congratulate itself on having given a lead to the world in this matter.

The Committee has laid down certain standards of protection against X- and γ-rays, which are expressed very simply in terms of the equivalent thickness of sheet lead. These thicknesses were based on available experimental data; for example, the X-rays from a tube excited by about 180,000 volts are cut down over 10,000 times by 3 mm. of lead, and over 1 million times by 10 mm. of lead. The choice of the actual protective material may, of course, be determined by insulating, electrostatic, or other considerations, but its thickness should be such as to provide protection equivalent to the amount of lead specified.

The Committee sought and secured the co-operation of the National Physical Laboratory, both in investigatory work and in the question of the inspection of existing X-ray departments in hospitals and other institutions. The N.P.L. has already inspected a number of X-ray departments throughout the country, and it may be said at once that, if the conditions which obtained there may be regarded as typical, the Protection Committee needs no justification in its labours. The Committee has adopted the common-sense principle that, wherever possible, the tube box or enclosure should form a complete shield in all directions, allowing only the minimum aperture for the work in hand. Few installations subscribe to this very reasonable demand. In some cases the scattered radiation in different parts of the X-ray rooms proved to be so excessive as to prohibit examination by electroscope, and observations had to be confined to noting the comparative ease with which the bones of the hand could be seen on a screen as it was carried round the room.

It is established that ventilation is of prime importance but, unfortunately, the radiological departments are generally situated in the basement. Ventilation difficulties are multiplied tenfold in consequence and, further, the rooms are largely shut off from the beneficent effects of sunshine. In the majority of cases the high-tension system consists of stretched over-head small gauge wires, connected by spring tapes, or spirally wound fine wires to the various apparatus. The resulting brush discharge produces ozone in abundance, and, as extractor fans are rarely fitted, the unfortunate operator gets the full benefit. The Protection Committee has recommended the use of smooth tubes or rods or heavily insulated wires with the object of abolishing the evils of brush discharge. It suggests the employment of commodious rooms with ample head room, especially in the case of deep therapy outfits where the exciting voltages are in the region of 200,000. Another danger is here indicated; more than one fatality has been occasioned by accidental discharge to an operator working in a small room with slack or looped high-tension wires.

Generous recognition should be paid to the X-ray manufacturers of this country for the way they are beginning to co-operate with the Committee. The British X-ray manufacturers, divided as they are, are mostly carrying on under great difficulties at the present time. Yet, despite their difficulties, almost all of them have taken steps to obtain from the National Physical Laboratory test figures for the various protective materials which they are incorporating into existing and new installations. Such measurements are rapidly and inexpensively carried out by the Laboratory, and no radiologist need deny himself the security which the N.P.L. certificate affords. The Laboratory experience amply confirms the necessity for such tests. For example, lead glass has been tested—of which only 5 mm. were required to give the protection of 1 mm. of lead. For other samples of glass as much as 10 mm. were required. The corresponding figures for lead rubber show variations between 1·7 mm. and 4 mm. as the equivalent of 1 mm. of lead. Thus, with either protective material a manufacturer can easily be 100 per cent. out in his reckoning if he employs uncertified material. He owes it to himself and his customers to take no such risks.

Two noteworthy steps, pregnant with promise for the future of radiology, were taken in the establishment of the Diploma in Radiology and the formation of the Society of Radiographers. Here again this country has taken the lead. And when some day we get an Institute of Radiology, with which Mackenzie-Davidson's name should be associated in some way, a further great step will have been taken to assist radiology in this country to take the proud position among the sciences to which its important and beneficent activities entitle it.

Forests in Relation to Stream-flow and Erosion.

ONE of the common marvels to the ordinary person is that so little is really known about such an everyday phenomenon as rainfall. It is a satisfaction to remember that, thanks to the British Rainfall Organization, more is known of the rainfall of Britain than of any other country, but our complacency may be a little disturbed when we reflect that for investigations as to what happens to the rain after it falls we have to turn to other lands. Water-engineers, indeed, have data from which much might be learned; but water engineers are secretive folk, and the records of investigations on the run-off of the Severn, Exe, and Medway remain the only records generally accessible. The results of these investigations, though extremely valuable, are not, however, very definite, as the areas are so large and the problems correspondingly complicated. More definite results are to be expected from the experiment being carried out by the United States Department of Agriculture in Colorado.[1] The areas dealt with are small and the problem more defined, though even in the small areas there studied conditions are by no means so simple as might be desired.

The intention of the experiment planned in 1909 was to make a complete study of the effects of forest cover on stream-flow and erosion. The main idea of the method employed is simple enough. It was, to select two small forest-covered valleys, contiguous, of the same size, similar and similarly situated, to find the rainfall and run-off from each, then cut down the forest from one of the areas and repeat observations. It appears almost a laboratory experiment. The first trouble was the trouble of the cook who desires to cook a hare, or perhaps it would be better to say, a brace of grouse, and it must be confessed at once that though two somewhat similar birds were caught they were not of the same kind, and as investigation proceeded unexpected anatomical differences presented themselves, extremely interesting in their own way, but not making for uniform cooking; it appears also that even if they had been both of a kind they were particularly difficult birds to cook. The valleys chosen lie about the 10,000 feet level in a region with precipitation about 20 inches a year, about half of which falls as snow and a goodly proportion of the rain in thunderstorms, both phenomena introducing difficulties.

The publication before us is a preliminary report giving an account of the first part of the experiment from 1911 to 1919, and discusses the data obtained while both valleys, A and B, were forest covered. Both valleys are small, B of 200 acres and A a little larger, varying in elevation from just over 9000 feet to just under 11,000 in the case of B, and somewhat over in the case of A. The geological structure is identical, namely, augite-quartz-latite, little porous to water, covered with a few feet of soil and decomposed rock, porous and sandy in texture, forming a permeable and well-drained top layer. The forest cover, conifers of various kinds, is almost identical. The valleys are not, however, of quite the same shape—A is long and narrow, B is much more like a bowl; the exposure is rather different, the centre line of A being south of east, while that of B is north of east. This is important in view of the fact that the winter snowfall runs off as it is melted by the summer sun, and indeed both the time and degree of response of the two streams to any factor influencing the *régime* are somewhat dissimilar. For example, after rainfall A rises more rapidly and reaches its maximum flow earlier than B, B may then be higher than A for a time, while at the end of the flood A may be higher than B. As a result, it has been necessary to construct tables and diagrams to show the relation of B/A for a great variety of conditions, and some 16 "rules" have been formulated for comparing the discharge of B when the discharge of A and the rainfall is known.

The readings for the run-off may probably be accepted. Very great care has been taken to construct suitable dams, gauges, and basins. The construction of the measuring apparatus is described in great detail, and the readings appear in general to have been exceedingly accurate and trustworthy. But it is a little difficult to place implicit confidence in either the precipitation statistics or the use that is made of them. Though details are, perhaps significantly, lacking, it is evident that the exposure of the gauges for rain and snow is not up to the standard required in this country, while their distribution also leaves something to be desired. Only five were set up in the two valleys; two are close together in the lower part of each basin and one at almost the highest point of A, while a sixth was just outside the lower portion of both basins.

The number would, of course, be abundant for ordinary rainfall work, but in a scientific experiment which is otherwise marked by accuracy, British experience would suggest that the number was inadequate, and we should imagine that over a vertical height of 2000 feet there would be considerable differences in rainfall, especially when a good proportion of the rain falls in thunderstorms. It is possible that conditions are different in Colorado, but we should have been more satisfied if evidence had been adduced to show that this was so. Nor is our confidence increased when we learn that in the second part of the experiment, when the forest is removed from B, only the gauges in the A valley are to be read. It is scarcely sufficient to say that "the use of the single record cannot be seriously objected to when it is considered that at the lower end of A there is the *choice of the better catch* of two gauges, and this value *is averaged* with the catch of the third gauge at the head of the valley." The italics are ours. It is only fair to say that much more care has been taken with another and equally important side of the problem, the melting of the snow. Observations of the depth of the snow at the time of thaw are taken at a considerable number of points.

It will be interesting to see in ten years' time the results of removing the forest. No doubt valuable results will be obtained which will be of use in dealing with the Forest Reservations of the Rockies, but even so, light will be thrown on only a small portion of the small problem. We shall know what is the effect of removing forest cover only under somewhat special conditions. There will be plenty room for further investigation.

[1] "Stream-flow Experiment at Wagon Wheel Gap, Colorado," Monthly Weather Bureau Supplement, No. 17. Government Printing Office, Washington, 1922.

Disintegration of Elements.

By Sir Ernest Rutherford, F.R.S.

I HAVE been asked to say a few words about a telegram in the *Times* of March 14 giving an account of a paper communicated to the American Chemical Society at Chicago by Dr. G. Wendt and Mr. C. E. Iron. It reported that, when a powerful condenser discharge at 100,000 volts was sent through a very fine tungsten wire, the filament exploded with a "deafening report," producing a flash estimated to correspond to a temperature of at least 50,000° F. The telegram states: "After the flash he (Dr. Wendt) found atoms of tungsten decomposed into simpler atoms and the result was the change of metallic tungsten into gaseous helium." The experiments were made to investigate whether any atomic disintegration can be effected by such high temperature discharges, and apparently the authors believe that they have obtained positive results.

We must await a much fuller account of the experiments before any definite judgment can be formed; but it may be of interest to direct attention to one or two general points. During the last ten years many experiments have been recorded in which small traces of helium have been liberated in vacuum tubes in intense electric discharges, and it has been generally assumed that this helium has been in some way occluded in the bombarded material. On modern views, we should anticipate that the disintegration of a heavy atom into lighter atoms, *e.g.* into atoms of helium, would be accompanied by a large evolution of energy. Indeed, it is to be anticipated that the additional heating effect due to this liberated energy would be a much more definite and more delicate test of disintegration of heavy atoms into helium than the spectroscope.

Our common experience of the large effect of temperature in ordinary chemical reactions tends to make us take a rather exaggerated view of the probable effects of high temperatures on the stability of atoms. While it seems quite probable that momentary temperatures of 50,000° F. can be obtained under suitable conditions in condenser discharges, it should be borne in mind that the average energy of the electrons in temperature equilibrium with the atoms at this temperature corresponds to a fall of potential of only 6 volts. In many physical experiments we habitually employ streams of electrons of much higher energy and yet no certain trace of disintegration has been noted. In particular, in Coolidge tubes an intense stream of electrons of energy about 100,000 volts is constantly employed to bombard a tungsten target for long intervals, but no evolution of helium has so far been observed.

Obituary.

Prof. A. D. Waller, F.R.S.

BY the death of Prof. Augustus Désiré Waller, on March 11, in his sixty-sixth year, the scientific world has lost an unique personality—a physiologist of international eminence and of exceptional calibre.

Waller studied in the Universities of Aberdeen and of Edinburgh, graduated in the former, and commenced his experimental work in Ludwig's laboratory in the year 1878. From here he proceeded to University College, London, whence he was appointed to the lectureship in physiology in the London School of Medicine for Women. He subsequently held the corresponding post in the Medical School of St. Mary's Hospital. In 1902 Waller became Director of the Physiological Laboratory of the University of London, of which, aided by the generosity of his brothers-in-law, and enabled by the wisdom and liberality of the Senate, he had been largely instrumental in securing the foundation. This post he held, amid difficulties, with conspicuous success, until his death.

Whilst at St. Mary's, Waller had felt the need of and had found the time and energy to establish and equip a library and laboratory, in his home, and it was there that most of his earlier researches were carried out. From there also he supplemented the resources of the University by the unstinted loan both of books and of valuable apparatus. He was closely associated with the Institut Marey from its inception, latterly as vice-president, and took an active part in the direction of its affairs.

Nearly 200 publications, covering a very wide field, stand to Waller's credit. Early papers on the circulatory system led to a study of the electromotive phenomena of the heart beat and to the discovery that an electrocardiogram could be recorded on the human subject. His earliest records with the capillary electrometer, though accurate, were not what he expected them to be. Influenced by this, and misled by an insensitive instrument, he subsequently published and afterwards withdrew an inaccurate picture of the electrical events in the cardiac cycle. In consequence of this mischance the credit of Waller's discovery has been wrongly attributed to others. Some years later, with the aid of a more perfect instrument—Einthoven's string galvanometer—he returned to this work, which had been meanwhile developed and extended by Prof. Einthoven in Leiden. Thanks to Waller, the string galvanometer became now, for the first time, available for clinical diagnosis in London. Its employment spread from his laboratory in all directions, notably to University College Hospital and to the National Hospital for Diseases of the Heart, in the latter of which he was appointed consulting physician.

This, though perhaps the most notable piece of Waller's electro-physiological work, was a small fraction of its total. He was the pioneer of galvanography in physiology and was the first to record, photographically, the negative variation and the electrotonic currents of nerve, both of which he studied exhaustively. Of especial interest, in this connexion, are (1) his discovery that protracted excitation of a nerve produced the same effect on subsequent negative variations as did the administration of carbon dioxide, and (2) his inference that this similarity implied liberation of carbon dioxide by the nerve. He investigated also, in full detail, the "Nach-strom" of earlier German writers. He called this the "blaze-current," found it to be one of the earliest and last signs of life, and applied it successfully as a test of vitality in seeds.

Waller devoted much time and energy to anæsthetics, studying their effects on surviving tissues and organs as well as on the intact organism. He also devised methods for estimating the concentration of anæsthetic vapours in air and apparatus for controlling their dosage.

During the last few years Waller concerned himself chiefly with the psycho-galvanic reflex and with the physiological cost of muscular work. In the first case he elaborated and improved pre-existing technique and made valuable observations—*e.g.* on the distribution of the emotive response. The second problem he tackled with all his energy and enthusiasm. Realising the importance of testing the workman, with the least possible disturbance, in the course of his normal job, he pushed simplification of apparatus and technique to the utmost. By this he made it possible to estimate expired carbon dioxide anywhere, at short notice, and from large numbers of subjects. He did not think that his results yielded information so precise as that obtainable from more detailed analyses and more complicated and cumbrous apparatus. He urged, however, that with his simplified technique he was able to accumulate data which could not be obtained, during a normal job, by the more complicated procedures, and claimed that these data furnished a good first approximation to the physiological cost of various kinds of labour.

Lack of space prevents detailed analysis of Waller's remaining work. He made valuable contributions on the laws of excitation and of sensation, on the sense of effort, on the relation between stimulation and response, on retinal and cutaneous currents, on the kneejerk and other neuromuscular phenomena in man. He worked also with plants—on photo-electric responses, and on growth, as well as on the testing of seeds already mentioned.

In addition to his papers Waller wrote an exceptionally original "Introduction to Human Physiology." This was followed by volumes of lectures—on animal electricity—the signs of life—physiology the servant of medicine—the electrical action of the human heart, and by a very suggestive essay on the psychology of logic.

Of his public services in the foundation and direction of his laboratory it is difficult to speak too warmly. On the opening of the laboratory Waller instituted short courses of research lectures, without fee, the first of which was delivered by himself. This was followed by similar courses by physiologists from other laboratories, not merely of London but also of Oxford, Cambridge, the Colonies, Europe, and the United States. The value of such lectures proved to be so great that they were promptly adopted by most of the colleges and schools of the University, not only in physiology but also in other branches of experimental science.

Not merely problems of academic science but problems of applied physiology, in the broadest conception of the term, were undertaken by the many who utilised the laboratory for research. Some such problems have already been mentioned, and to these may be added, *e.g.*, the chemistry of metabolic processes and products; the distribution of anæsthetics in the blood; snake poison; memory, mental fatigue; surgical shock, tetanus; the testing, assaying, and standardisation of drugs; the poison gases of the war; dietetics—studied by men of such varied interests as Sir Leonard Rogers, Sir Sidney Russell Wells, Sir William Willcox, Sir Frederic Hewitt, Sir Thomas Lewis, Prof. Gamgee, Prof. Buckmaster, Prof. M. C. Potter, Prof. F. W. Hobday, Dr. F. W. Pavy, Dr. George Oliver, Dr. F. S. Locke, in addition to the laboratory staff and a whole host of younger workers. The laboratory itself and its earlier work have been dealt with more fully in a special article in NATURE of March 9, 1905, p. 441.

Waller was elected a fellow of the Royal Society in 1892. The Academies of Science of Paris and of Bologna also recognised his work, the former awarding him a Prix Montyon, the latter the Premio Aldini sul Galvanismo.

We spoke of Waller as an unique personality. He was extraordinarily energetic and able, combining boyish impetuosity and rashness with great acumen and exceptional intellectual power. He made unusually warm friends, unusually bitter enemies, and was only appreciated adequately by the greater among his scientific contemporaries and by the more intimate of his personal friends.

W. L. S.

NEWS has been received of the death, on February 3, of Professor Vladimir Ivanovitch Palladin, who for many years had been Professor of Plant Anatomy and Physiology in the University of Petrograd. Professor Palladin's contributions to botanical science consist of numerous publications, from 1886 onwards, recording his researches in vegetable physiology. These are chiefly of a biochemical nature, and many of them are concerned with the respiration of plants, some of Palladin's investigations on this subject having led him to formulate his theory regarding "respiration-pigments" and oxidases. The decomposition of proteids in plants, the formation of chlorophyll, and alcoholic fermentation are among the other subjects which he studied. An English edition of Palladin's text-book on plant physiology was published in Philadelphia in 1918, having been previously translated into both German and French.

WE see with much regret the announcement of the death on March 24, at fifty-eight years of age, of Prof. W. B. Bottomley, Professor of Botany at King's College, London, from 1893 to 1921.

WE much regret to record the death on March 21, in his eighty-second year, of Dr. J. T. Merz, author of *The History of European Thought in the Nineteenth Century*, and other notable works.

THE *Chemiker Zeitung* announces the death, at the age of 54, of Prof. Emil Heyn, director of the Kaiser Wilhelm Institut für Metallforschung, Berlin-Dahlem. Prof. Heyn was well known to metallurgists for his researches on alloys.

Current Topics and Events.

The thirteenth Kelvin Lecture of the Institution of Electrical Engineers by Sir Ernest Rutherford on "Electricity and Matter" will be delivered at 6 o'clock on May 18, and not on May 11 as previously announced.

Dr. Ernest Barker, Principal of King's College, London; Dr. A. E. Cowley, Oxford, Bodley's Librarian; and Dr. G. C. Simpson, Director of the Meteorological Office, have been elected members of the Athenæum Club under the provisions of the rule of the club which empowers the annual election by the committee of a certain number of persons "of distinguished eminence in science, literature, the arts, or for public service."

The library of the Rothamsted Experimental Station, Harpenden, one of the best agricultural libraries in the Empire, has recently been enriched by a rare volume (believed to be the first printed book on agriculture in France) given by Lady Ludlow, who has on several previous occasions made important gifts to this institution. The volume is entitled "Le livrė des prouffitz champestres et ruraulx," and was printed by Pierre de Sainte Lucie at Lyons in 1539. It is of special interest in view of the influence exerted by the French agricultural authors of a somewhat later period on the Elizabethan agricultural writers in this country, whose influence in turn lasted almost to Victorian times.

Captain Amundsen's plans for his new Arctic Expedition for drifting across the polar basin in the *Maud* are now complete. The *Times* announces that Capt. Amundsen has left Norway to rejoin his ship at Seattle, where it has been refitted for the voyage. Sailing on June 1, Capt. Amundsen expects to enter the ice near Wrangell Island at the end of July, and hopes to reach Greenland or Spitsbergen in four or perhaps five years' time. The crew will consist of ten all told, including one Eskimo. An aeroplane for reconnaissance work is to be carried. The ship's wireless equipment has been much strengthened and now has a radius of 2000 miles. It is expected that the high-power station at Stavanger will be able to reach the *Maud* throughout its voyage. Capt. Amundsen proposes to send daily weather messages via Washington.

The summer meeting of the Institution of Electrical Engineers at the Scottish centre will be held at Glasgow on May 30-June 2 next. A paper will be read on May 31 at the University of Glasgow by Prof. Magnus Maclean on the hydro-electric resources of the Scottish Highlands, and the remainder of the meeting will be spent in visiting works and electrical installations. Arrangements have been made for tours of inspection of a number of power stations and works in the neighbourhood of Glasgow, and a two-day excursion will be made to Oban and Kinlochleven, where the British Aluminium Company's hydro-electric installation will be visited.

A summary of temperature, rainfall, and sunshine for the several districts of the United Kingdom for the winter season comprised by the 13 weeks from November 27, 1921, to February 25, 1922, was given in the *Weekly Weather Report* ending February 25. The mean temperature for the period was in excess of the average in all districts, the greatest excesses being 2°·8 F. in the north and south of Ireland, and 2°·2 F. in the English Channel district. In the south-east of England the excess was 1°·4 F. The least excess in any district was 0°·7 F. in the east of Scotland and the north-east of England. The rainfall was in excess of the average for the winter in all districts except in the south-east and south-west of England and in the English Channel. The deficiency in the south-east of England was only 0·16 in., but in the other two districts it amounted to 1·4 in. In the west of Scotland the excess was 3·70 in., the rainfall measurement being 17·98 in. The duration of bright sunshine was generally in fair agreement with the normal.

The exhibition of travel films, now being held at the Philharmonic Hall, London, under the direction of Brig.-General Sir Percy Sykes, is due to the enterprise and enthusiasm of a number of soldiers and explorers. The idea which inspired the undertaking is an excellent one and it is being admirably carried out. Each series of pictures is being produced by men who possess special qualifications for the task, and the journey is to be described either by the leader of the expedition or by a traveller well acquainted with the country. The exhibition, therefore, is of great educational value, and in many respects it differs entirely from the ordinary picture show. In the case of Burma, the pictures (by the Solar Films Co.) have been carefully selected in order to give a vivid conception of the various aspects of the people and the country. The wonderful Schwe Dagon Pagoda near Rangoon is first shown, and then scenes on the river Irrawaddy and in the hill country round Bhamo, followed by a thrilling railway journey through the tropical forest and across the Gokteik Bridge. On the way back to Rangoon the Royal Palace and shrines at Mandalay are shown. In the course of the journey the natives are seen weaving silk, climbing trees to get orchids, rowing boats with their legs instead of their arms, and directing elephants engaged in moving teak logs. The pictures, assisted by Maj.-Gen. Dunsterville's interesting explanations, leave a clear impression on the mind alike of the country, the people, and the conditions under which the Burmese live. This exhibition is to be followed by travel films of Morocco, Andalusia, Timbuctu, the Land of the Incas, and Persia.

Sir Robert Robertson gave an instructive survey of the work and scope of a scientific society in his presidential address to the West Kent Scientific Society on February 27. During the last four years forty-six papers have been read before the society, and of these nearly one-third have dealt with subjects belonging to physics and applied physics. Next in order of numbers come zoology and chemistry—each making about one-sixth of the total—and then follow astronomy, physiology, geology, sociology, and mathematics. About 60 per cent. of the papers were by members of the society and the remainder were by visitors. In most cases the papers were descriptive accounts of results of recent work and progress in particular fields, presented so as to be intelligible to scientific workers generally rather than to specialists. The West Kent Scientific Society, like most local scientific societies, thus fulfils on a small scale, and for its own area, the functions of the British Association with which it is affiliated. Few local societies can expect to receive many communications containing new results of original investigations; first, because their proceedings, if published, are rarely easily accessible or widely distributed, and next because recognised specialist societies are usually ready to accept and publish such papers. A local scientific society ought, however, to be recognised as the natural body to be consulted upon all local matters in which scientific knowledge or guidance is required, just as the Chamber of Commerce is for commercial questions; and it is in this direction that such societies may exert most valuable social influence. Sir Robert Robertson's address ought to do something towards promoting federation and development with this end in view.

PROF. A. P. LAURIE'S discourse delivered at the Royal Institution on February 17, on Pigments and Mediums of the Old Masters, began with the Egyptian Blue used in Egypt from the IVth Dynasty, which he had identified on the wall paintings in Crete in the Palace of Knossos. This became ultimately the blue used for wall paintings throughout the Roman Empire. Prof. Laurie has shown that it is formed within a limited range of temperature at about 850° C. when sand, copper carbonate, soda, and lime are heated together for a considerable time. The green found on Egyptian paintings is formed when the magma is raised to a higher temperature. Prof. Laurie has traced the use of this blue until about the end of the 2nd century, but it is not found on the earliest Byzantine illuminated manuscripts of the 7th century which are in the possession of the British Museum, being replaced by a badly washed ultramarine from lapis lazuli. Prof. Laurie also referred briefly to the pigments used in classical times as described by Pliny, and found by Sir Humphry Davy and other researchers on Pompeian frescoes, and traced the pigments used from 700 up to 1700 as determined, partly by literary evidence and principally by the actual examination of illuminated manuscripts, pictures, and legal rolls in the possession of the Record Office and Venetian Ducali. The history of pigments brings out interesting points, such as the close agreement between the pigments used on the Lindisfarne Gospels and Scoto-Irish manuscripts with those used in Byzantium, the gradual improvement in the preparation of ultramarine and the use of a green which was apparently verdigris dissolved in Venice turpentine. This is apparently the green found in the Van Eycks and other pictures of the 15th and early 16th centuries. Azurite was used almost universally as a blue from about 1480 to 1640, and was replaced by smalt and by an artificial copper carbonate known as blue bice. Prof. Laurie also described how tiny samples could be taken from a picture without injury, and showed the scheme of analysis for the identification of blue pigments, explaining the value of such inquiries for fixing the dates of pictures and detecting forgeries.

AT the monthly meeting of the Zoological Society of London, held on March 15, the Secretary directed special attention to the acquisition by the Society of two Indian elephants presented by H.H. The Gaekwar of Baroda, a lioness, bred in India, presented by H.H. The Maharajah of Magurbhanj, and an Allamand's Grison from Pernambuco presented by Lieut.-Commander Rutherford Collins. Thirty-two new fellows were elected to the Society and thirty-five candidates proposed for fellowship. During February 126 additions to the Society's menagerie were received, 39 by presentation, 81 deposited, 5 by purchase, and one born in the gardens.

THE National Union of Scientific Workers has received a number of scientific publications from the People's Commissary for Education in Russia among which are the following: "History of the World," by K. N. Malinin; "Man: his Origin, his Structure, his Future," by C. A. Chugunof; "The Foundations of Life," by P. M. Schmidt; "Life," by Sir Edward A. Sharpey Schafer, a translation of his presidential address to the British Association for the Advancement of Science delivered at the Dundee meeting in 1912; "Outline of the History of Geological Knowledge," by A. P. Pavlov; and "Spectrum Analysis and the Structure of the Atom," by D. C. Rojdestvinski. The National Union of Scientific Workers is willing to endeavour to arrange with the Russian Commissary for Education for the exchange of scientific publications between men of science in Great Britain and Russia.

IN issuing their new quarto catalogue of scientific apparatus Messrs. Pye and Co. of Cambridge invite special attention to the reduced prices, which they claim are now in many cases down to pre-war level. A number of new pieces of apparatus are described, including an X-ray spectrometer, a fluxmeter, a reflecting moving coil galvanometer at 3*l.* 10*s.*, a Rayleigh stroboscope and a centrifugal force machine. A large proportion of the apparatus intended for the use of students has been designed by Dr. Searle. The catalogue consists of 150 pages, well printed and illustrated, and is bound in stiff cloth covers. The name of the firm on the front page of the cover is very readable, but there is no name on the back, and when the catalogue is placed on the shelf amongst others there is nothing except the colour of the cover to indicate whose it is. It is curious that our instrument makers should desire to render their catalogues inconspicuous in this way, but there can be no doubt about the fact, as this is the fourth case which has come to our notice in the past few months.

Our Astronomical Column.

Ratios of Planetary Distances.—Mr. F. A. Black, 57 Academy Street, Inverness, sends us a communication in which he points out a fairly close approximation which connects the ratios of the planetary distances. Using the names of the planets to denote their respective mean distances from the sun, then

$$\frac{\text{Mercury}+\text{Earth}}{\text{Venus}+\text{Mars}}=\frac{\text{Jupiter}+\text{Uranus}}{\text{Saturn}+\text{Neptune}}.$$

The logarithms of the ratios are 9·79050 and 9·78935 respectively. The approximation is sufficiently close to be interesting, though it is unlikely that it has any physical basis. It will, of course, be observed that corresponding members of the inner and outer planetary groups occupy corresponding places on the two sides of the equation.

Reid's Comet, 1922 (*a*).—Mr. H. E. Wood has computed revised elements of this comet, from Johannesburg observations on January 23 and 30, and February 5.

$$T = 1921 \text{ October } 26{\cdot}40738 \text{ G.M.T.}$$
$$\left.\begin{aligned}\omega &= 183^\circ\ 31'\ \ 9{\cdot}4''\\ \Omega &= 275^\circ\ \ 6'\ 26{\cdot}8''\\ i &= \ 32^\circ\ 56'\ \ 6{\cdot}1''\end{aligned}\right\}1922{\cdot}0$$
$$\log q = 0{\cdot}2183570$$

The comet was photographed by Prof. Barnard on February 3, when it was of magnitude 10; it is now fading. The comet passed perihelion 86 days before discovery, and was fairly well placed for northern observers last autumn, reaching its maximum brightness (about 9½ mag.) on December 1. The fact that it then escaped observation suggests that many comets may pass their perihelion undetected and also that possibly the search for them is not being carried on quite so assiduously as before the war. As the comet is out of reach of European observers and growing fainter, it is useless to give an ephemeris.

Wireless Time-Signals.—There are four papers on this subject in the January issue of the Mon. Not. R.A.S., from the Greenwich, Pulkovo, Uccle, and Edinburgh observatories. Prof. Sampson, in the last-named paper, brings out the facility which these signals afford for determining the errors of the individual time-determinations, for the mean of them all may be assumed to be a satisfactory datum-line. He gives curves of the errors, which demonstrate the curious fact that each observatory is liable to be in error by as much as 0·2 sec., and that the error frequently persists for some weeks in the same direction. The cause is obscure; lateral refraction, due to dissymmetry in the distribution of atmospheric pressure is examined but is insufficient to explain the whole anomaly. Prof. Sampson infers that the observations throw grave doubts on the exactitude of accepted longitude results, which generally rest on special observations made during limited periods. It seems likely that better results may be obtained by using the whole of the clock comparisons made by wireless over periods of several years. Under the old method of observing, personal equation necessitated interchange of observers, but with the travelling-wire method the difference of observers is reduced to vanishing point. There are two precautions to be observed: first, the time-signals, which are necessarily made with a predicted value of clock-rate, must be corrected by later observations at the sending observatory; secondly, the same system of R.A. of clock stars and mean sun must be employed at both stations; it may be pointed out that the *Connaissance des temps* value of the R.A. of mean sun (used at Paris) differs by 0·06 sec. from the value in the Nautical Almanac; the former uses Le Verrier's solar tables, the latter Newcomb's.

Stars of the β Canis Majoris Type.—The Journal of Royal Astronomical Society of Canada for February contains a study of these stars by F. Henroteau. They were at first supposed to be simply spectroscopic binaries, with periods of 3 to 6 hours; but the author expresses doubt as to whether this is the true explanation of the changes of wavelength, as the amplitudes, shape, and periods of the velocity curves all show variations, as do also the widths and intensities of the spectral lines. A list is given of 24 stars suspected to be of this type: one of them is 12 Lacertæ, which Prof. Guthnick has investigated with the photo-electric photometer at Babelsberg, finding a small light-variation in the same period as the change of radial velocity. The suggestion is made that they may be binaries in course of formation, rotating Jacobian ellipsoids, or binaries disturbed by a third companion. The stars are nearly all of type B, which is the type where Dr. Jeans found that fission is most likely to take place.

Spectroscopic Parallaxes with Objective Prism Spectrograms.—It has been thought that slit spectrograms on a large scale were necessary for the determination of spectroscopic parallaxes, but Dr. Harlow Shapley and Mr. Bertil Lindblad show in Harvard College Observ. Circ. No. 228 that good results can be obtained using the large stock of objective prism spectrograms available at Harvard. The pair of lines most used are 4215 (ionised strontium) and 4326 (iron); use was also made of the cyanogen bands and the lines of hydrogen, calcium, and manganese. The research is at present limited to naked-eye stars of types Ko to K2. A list of fifty parallaxes is given; the largest being λ Sagittarii 0·113″, and δ Leporis 0·091″ (this large value accords with its proper motion of 0·696″). The probable error of a deduced absolute magnitude is of the order of 0·3 mag., which is satisfactorily small.

The Sun's Rotation from Spectroheliograms.—The spectroheliograms used in this investigation[1] were taken at the Yerkes Observatory between 1903 and 1909 by Prof. Philip Fox, Director of the Dearborn Observatory. The conversion into heliographic longitude and latitude was effected graphically, the image being projected by a lantern on to a globe marked with circles and tilted into the requisite position. The following formulæ were deduced for ξ, the mean daily motion:—

Northern hemisphere . $\xi = 11^\circ{\cdot}107 + 3^\circ{\cdot}449 \cos^2 \phi$.
Southern ,, . $\xi = 12^\circ{\cdot}143 + 2^\circ{\cdot}408 \cos^2 \phi$.

The differential motion of flocculi round spots is investigated, and is found to indicate an *anticyclonic* whirl, *i.e.* opposite to the rotation of the sun on its axis, in the case of single spots, while it is *cyclonic* round the leading spots of bipolar groups.

A diagram is given comparing Fox's results with those of other observers. It shows that the angular speeds of the following classes of objects form an ascending series, the increase from first to last being about 1° per day: Reversing layer, Sun-spots, Faculæ, and Flocculi (present work), λ4227 (Adams), Hα (Adams).

[1] Publications of Yerkes Observatory, vol. iii. part 3.

Research Items.

AN AMERICAN PITT-RIVERS MUSEUM.—The famous ethnological collection made by General Pitt-Rivers first became known to students when it was exhibited at the Bethnal Green Museum in 1874–75. In 1883 it was presented to the University of Oxford, and since then, under the direction of Mr. Henry Balfour, its value has greatly increased. The distinguishing feature of this museum is that the exhibits are arranged, not in geographical or racial order, but in series illustrating the evolution of the chief human inventions. A collection of the same kind was made by the authorities of the United States National Museum for the Trans-Mississippi Exhibition held at Omaha in 1898, and since then it has been developed by distinguished anthropologists like Mason, Holmes, and Walter Hough, the author of an interesting pamphlet discussing it, entitled "Synoptic Series of Objects in the United States National Museum illustrating the History of Inventions." This pamphlet describes, with a good series of illustrations, the chief inventions in the order of their development —fire-making, torches and candles, lamps, cooking utensils, knives and forks, and so on. The vast resources of the American collections have produced a fine series of examples. The present pamphlet, adapted to our collections, might well serve as the basis for a popular manual of ethnology.

STONE IMPLEMENTS IN THE PERTH MUSEUM.—It is a matter of great importance that the collections in our provincial museums should be made more readily accessible to students. They often contain exhibits of considerable value, either the result of excavations in some local area with its store of antiquities, or of the benefactions of local collectors or of travellers who have brought material from abroad and are proud to share it with their neighbours. The student, if catalogues are available, will often find stored away in some local collection just the link which he needs in some line of research. Perth in its museum happily possesses exhibits of both these types—some implements locally discovered, and those brought from foreign countries. In the Transactions of the Perthshire Society of Natural Science (vol. vii, part 3) Mr. J. Asher publishes an excellent catalogue of the collection, with full descriptive notes and photographs of the more interesting specimens. He has also given references to works of authority, Proceedings of learned societies, and the like, in which objects of a similar type are described or discussed, and it is satisfactory to learn that copies of all the publications to which reference is made are to be found in the Society's library. The Society has set a good example, which should be followed in the case of all provincial museums.

INDIAN FISHING TRIBES IN VANCOUVER'S ISLAND.—The thirty-fifth annual report of the Bureau of American Ethnology for the year 1913–14 is somewhat belated owing to the war, but it contains matter of much importance. It is devoted to a monograph by Dr. Franz Boas on the Kwakiutl, a name applied to a group of Indians on the Pacific coast in the vicinity of Fort Rupert, Vancouver's Island. Dr. Boas has edited the material collected by Mr. G. Hunt, a mixed-blood Kwakiutl. This group of Indians now numbers about 2000 souls, but it is gradually decreasing. They speak languages of the Wakashan linguistic stock, closely allied to the Nootka. Many tribes on this part of the coast, gaining their livelihood by fishing, are distinct both in physical characteristics and language, but their culture is of an uniform type, and their industries, arts, beliefs, and customs are markedly different from those of all other Indian peoples. Closer study, however, discloses many elements peculiar to single tribes, which show that this culture is the natural result of a gradual and convergent development from several distinct sources or centres, every one of these tribes having added something peculiar to itself to the sum of this development. This monograph will hold a high place among the publications of the Bureau, and it is full of interest to the anthropologist, sociologist, and student of folk-lore. In particular, the account of food and cooking, due to Mrs. Hunt, an accomplished housewife, is admirable. The detail of fishing customs is more elaborate, and there are important sections on birth, in particular on the subject of twins, and the customs of distributing the trophies of the chase. For the philologist the text is supplied both in English and in the local dialect.

NEW SURVEYS ON THE ARCTIC COAST OF ASIA.—While exploring the North-east Passage in 1918–19, Capt. R. Amundsen wintered his vessel, the *Maud*, in lat. 77° 32′ 36″ N., long. 105° 40′ E., in the vicinity of Cape Chelyuskin, the most northerly point of the mainland of Asia. During the five months spent at Maud Haven a considerable amount of useful survey work was carried out in Taimir peninsula. Mr. H. U. Sverdrup, a member of the expedition, gives an account of this work, accompanied by a chart in *Naturen* (January-February 1922), the publication of the Bergen Museum. The previous map of Taimir Land was very incomplete, although considerable detail on the coast line was added by Vilkitski in 1913. The map now shows a long fjord on the east, where only a bay had been previously known. Toll Bay, on the south-west, also ends in two long narrow fjords. Exploration of the interior reveals a plateau-like structure where the range of the Birranga Mountains were formerly placed. Around the plateau lies a raised beach some five to twenty miles in width. Observations place Cape Chelyuskin in lat. 77° 43′ 26″ N., long. 104° 17′ E. No new surveys appear to have been made in Nikolas Land and Alexis Island, although the Norwegians visited the latter. The paper also contains a summary of the meteorological observations taken at Maud Haven.

RAINS OF FISHES.—For just on four hundred years circumstantial stories of fish falling with rain have appeared in various parts of the world. Naturally, such strange occurrences have given rise to much speculation and many even stranger theories by way of explanation. The whole subject is admirably reviewed by Dr. E. W. Gudger in the November-December issue of *Natural History*—the Official Organ of the American Museum of Natural History, which has just reached us. Dr. Gudger accepts such occurrences, and rightly, as well authenticated; he accounts for them as due to the agency of high winds, whirlwinds, and water-spouts, which could easily draw up either from the sea or rivers, shoals of small fishes swimming at the surface in the track of these uplifting agencies. As their force is spent they distribute their victims along their path.

BREEDING HABITS OF THE MERLIN.—A series of very valuable and interesting notes on the breeding habits of the merlin was commenced some time ago in *British Birds*. In the March issue, Mr. W. Rowan, the author, describes the rearing of the young.

The task of feeding them falls entirely upon the female, though the food is always brought to her by the male, who also feeds his mate. He brings her but two meals daily, one just after sunrise, the other just before sunset. But these are supplemented by small portions taken from the supply brought for the young. Titlarks formed 90 per cent. of the prey, which included also skylarks, thrushes, ring-ousel, and snipe. Invariably the victims were beheaded and deplumed at a distance from the nest. At times, however, some were brought partially plucked, when the female would give each youngster in turn a mouthful of feathers only, the mother herself partaking, apparently for digestive purposes. Mr. Rowan was never able to satisfy himself as to the means by which the transference of the prey from the male to his mate was effected. As he hove in sight she would fly out to meet him, then at incredible speed pass beneath him and seize the prey. But whether it was dropped, or snatched from his talons, he could never discover.

Shell-Structure in Foraminifera.—Prof. W. J. Sollas, from an examination of the widely known Carboniferous foraminifer, *Saccammina Carteri*, has been led to make a detailed study of the shells of calcareous foraminifera in general (*Quart. Journ. Geol. Soc., London*, vol. lxxvii. p. 193, 1921). He shows that the mineral in both perforate and imperforate types is calcite, and that some imperforate species have a vitreous appearance. In the ordinary vitreous foraminifera the shell is composed of minute prisms of calcite set with their longer axes perpendicular to the wall; in porcellanous types, no such regularity is shown by the calcite "fibrils" that are present, and these sometimes pass into a granular structure. Blind canals, but not perforations, occur in the walls of Peneroplis, and it is suggested, from observations by Douvillé, that the alleged perforations of the characteristic Upper Palæozoic genus Fusulina may be of the same nature. The author removes "*Saccammina*" *Carteri* from the arenaceous to the calcareous imperforata, and points out that the mosaic structure of its shell finds a counterpart in Spirillina. He proposes that the genus should now be called *Saccamminopsis*.

Climates of the Past.—In a brief but illuminating review of the climates of past geological periods, Dr. Charles Schuchert (*Amer. Journ. Sci.*, vol. cci., p. 320, 1921) concludes that climatic changes were "very slight during the middle parts of the geologic periods [as defined by faunistic changes], when the world has almost no temperature belts; and variably greatest during the earliest and latest parts. . . . To-day the variation on land between the tropics and the poles is roughly between 110° and -60° F., in the oceans between 85° and 31° F. In the geologic past the temperatures for the greater parts of the periods of the oceans was most often between 85° and 55° F., while on land it may have varied between 90° and 0° F. At rare intervals the extremes were undoubtedly as great as they are to-day." The author believes that for long epochs the greater part of the earth has had an almost uniformly mild climate, with no winters; but he opposes F. H. Knowlton's view that there was a continuous nonzonal arrangement of climate prior to the Pleistocene period. It will be remembered that Dr. Schuchert (see Nature, vol. cvii. p. 501) connects the limits between geological periods with diastrophic events, and the influence of these, when they are of world-wide importance, is probably effective in breaking up the conditions that tend to equality of climate. In the same journal (vol. ccii. p. 187) Mr. Knowlton replies to Dr. Schuchert, and also to a criticism by Prof. Coleman. He relies on a dual control of temperature in geological times by the internal heat and also by the sun, and believes that the earth was until recently surrounded by a cloud-envelope, maintained by the internal heat, but diminishing from time to time when this heat declined. Few geologists will agree with him in minimising the evidence for the occurrence of occasional epochs of clear air and unchecked sunlight. Surely, moreover, deposits of gypsum are not usually regarded as products of marine lagoons, and the difficulties raised on this matter by Mr. Knowlton seem mostly of his own making. If his cloud-envelope could be regarded as a reality, a good deal of biological as well as physical evidence would have to be reconsidered.

Rainfall in Latin America.—The United States *Monthly Weather Review* for October 1921 contains articles by Mr. E. Van Cleef and Mr. B. O. Weitz on "Rainfall Maps of Latin America," "Some Illustrative Types of Latin-American Rainfall," respectively. The first article, when dealing with the plotting of the data, mentions that the observations are not always for corresponding periods, and as no correction has been made for this the results are not always comparable, although in drawing the isohyets considerable judgment has been used. The author makes no pretence that the maps give a final statement of the distribution of rainfall, and he states that it may require another 75 years or longer before there is sufficient accumulated data to produce an accurate map. Average maps are given for the year and for the summer and winter. In addition to these there are short accounts explanatory of the rainfall over certain areas, viz. in Mexico, Central America and Panama, and South America. The problem of the *llanos* of Columbia and Venezuela is dealt with, and it concludes with the statement that the cause of the apparent dryness of *llanos* and the absence of trees in interstream areas must remain in the hypothetical stage. The second article is illustrated by graphs showing the annual and monthly averages of rainfall at 25 representative stations in Latin America. The article concludes by stating that the discussion has not covered the complexity of all rainfall types but only those which are most essential. A praiseworthy attempt has been made to associate the climatic controls with various rainfall types.

The Claude Ammonia Process.—In the Claude process, in which ammonia is synthesised from nitrogen and hydrogen under a working pressure of 1000 atmospheres, the heat produced in the reaction was at first removed by circulating molten lead round the reaction tubes. This was found, however, to lead to undue strain in the tubes leading to fractures (see Nature, February 16, p. 219), and a new method has been adopted, an account of which is given by M. Georges Claude in the *Comptes rendus* of the Paris Academy of Sciences for March 6. Uniformity in temperature of the reaction tubes is secured by jacketing them with asbestos or kieselguhr. The heat of combination of the two gases is utilised to heat the entering gas to about 500° C. No preliminary heating is now required, and the tubes are so proportioned that the gases are heated in the catalytic tube gradually as required by the reaction. Among other advantages, the head of the tube carrying the connecting screws is almost at room temperature and the external tube supporting the high pressure is only heated to a high temperature at one end, which can be appropriately strengthened. The method works excellently in practice and has been in use for over twelve months.

University Education in the United States of America.

THE advance sheets of the biennial survey of education in the United States for 1916–18, which constitute Bulletin, 1920, No. 34,[1] contain, in addition to the statistics for the period, an illuminative comparison with figures taken from the reports of earlier surveys which leaves no doubt as to the growth in popularity of higher and university education in America. Exhaustive information is given in the numerous tables, and a number of charts have also been constructed which naturally make a stronger appeal to the eye and emphasise the striking results disclosed by the statistics.

For the year ending June 1918, the Bureau of Education received reports from 672 universities, colleges, and professional schools, the latter term comprising schools of theology, law, medicine, veterinary medicine, dentistry, and pharmacy. Of this total, more than half did not enrol more than 300 students, while of the bigger institutions, only 37 enrolled more than 2000. Thirteen of the latter had from 2001 to 3000 students; nine, from 3001 to 4000; seven, from 4001 to 5000, and eight had more than 5000. Obviously there are many very small colleges and universities and few large institutions. In fact, 10 per cent. of the colleges enrolled 50 per cent. of the students in America and a half of the total number of schools took 87 per cent. of the student populace.

That the tendencies indicated by these figures are not transitory is borne out by Bulletin, 1921, No. 21, on higher education in 1918–20.[2] There it is stated that of 250 institutions supplying returns for the periods 1916–17 and 1919–20, the smallest institutions are showing the biggest percentage increases in enrolment; those enrolling less than 250 in 1910 increased 38 per cent., those with an enrolment of 250-499, 20·2 per cent., those with 500 to 999, 14·5 per cent., those with 1000 to 1999, 22·5 per cent., and those with 2000 and over, 29·4 per cent.

The teaching staff employed in 1917–18 consisted of 29,509 men and 7013 women; *i.e.* an aggregate of 36,522, of which nearly 81 per cent. are men. These figures, when compared with those for the public high schools, in which men constitute 35 per cent. of the teachers, and for the elementary schools, where they form 13·4 per cent. of the staff, show clearly that the tendency is for women to monopolise the elementary and secondary school work while men control the higher institutions. The argument is strengthened by the facts given in Bulletin, 1920, No. 48,[3] on the statistics of State universities and colleges for the year 1919–20, from which it appears that of a total of 13,951 professors and lecturers, 11,659 or 83·6 per cent. are men.

The salaries received by professors and others during the period 1918–20 is discussed in Bulletin, 1921, No. 21, where it is stated that, in privately supported institutions, professors received on an average about 460*l*. per annum and lecturers 240-360*l*., while in State colleges the salaries averaged 625*l*. and 280-420*l*. respectively. Caustic comment is made on the fact that structural-iron workers and railway employees were receiving more than many assistant professors in private institutions and almost as much as those in State colleges.

[1] Bulletin, 1920, No. 34. Statistics of Universities, Colleges, and Professional Schools, 1917–18. Prepared by the Statistical Division of the Bureau of Education under the supervision of H. R. Bonner. Government Printing Office, Washington, D.C. 1921. 20 cents.

[2] Bulletin, 1921, No. 21. Higher Education, 1918–20. By G. F. Zook. (Advance sheets from the Biennial Survey of Education in the United States, 1918–20.) 1921. 5 cents.

[3] Bulletin, 1920, No. 48. Statistics of State Universities and State Colleges for the year ended June 30, 1920. 5 cents.

The numbers attending universities and colleges have grown from 156,449 in 1890 to 375,359 in 1918, an increase of more than 139 per cent. Enrolment has outstript the growth of population, which has increased from nearly 63 to more than 105 millions, or 68 per cent. increase, but high-school enrolment has increased at an even greater rate. Colleges and universities have not succeeded in attracting, in recent years, so high a percentage of high-school students as formerly. It is thought that the vocational courses now offered by many of the larger high-schools may account for the decrease in the proportion of high-school students who enter the universities. According to Bulletin, 1921, No. 21, an attempt is to be made by the American Council of Education, and a council for education in management composed of representatives of industry, to develop a form of vocational education in the higher institutions which will familiarise men with the technical side of industrial work and also prepare them for managerial positions in industry.

The position of higher education, however, is indicated more clearly by an examination of the enrolment figures in comparison with the proportion of the population which was of college age. From this it appears that in 1898, 3·3 per cent. of the population of age 19-23 years attended college, while for 1916, 4·8 per cent. is recorded. Thereafter is a drop in the percentage, due to the war, but the curve illustrating the figures for the various two-year periods from 1890 onwards shows an unmistakable upward trend. The curve showing the proportion of the population of 23 years of age on which baccalaureate or first degrees were conferred shows a similar steady rise. In 1890, less than 1·3 per cent. graduated; in 1916, almost 2·2 per cent. of this group of the population received first degrees; in twenty-six years, therefore, the proportion of graduates was almost doubled. Moreover, the proportion of the total number of students in the universities and colleges that were graduates increased from 1·5 per cent. in 1890 to 4·3 per cent. in 1916, showing that an increasing amount of time was being spent on what may be termed post-graduate work.

The personnel of the student body has also changed considerably during the past thirty years. In collegiate and graduate departments, the number of men increased from 44,926 in 1890 to 164,075 in 1916, an increase of 265 per cent., and the number of women from 20,874 to 95,436, an increase of 357 per cent. If all the students in all departments are included, these increases are reduced to 143 per cent. and 156 per cent. respectively; in any case, however, it is noteworthy that the number of women students has increased more rapidly than the number of men.

A striking increase has also occurred in the number of first degrees conferred yearly during the twenty-six years ending 1916. For non-professional departments alone, the figures are 7319 for 1890 and 31,826 for 1916, an increase of 335 per cent., while the total population of the United States was increasing by 63 per cent. A graph constructed to compare the rates of increase in the total population and in the number of students receiving baccalaureate degrees from 1870 onwards makes this point very clear. If the number of students receiving first degrees is taken as a criterion of national education, the United States as a nation is undoubtedly becoming better educated year by year. In 1918, there were 28,052 baccalaureate, 3480 graduate, and 736 honorary degrees conferred, while 499 men and 63 women received the degree of doctor of philosophy by examination from 46 institutions.

An attempt has also been made to calculate the proportion of the population which American graduates form. The number of first degrees awarded in 1870–1918 is estimated as 1,058,527, and it is calculated that 908,469 of these graduates were alive in 1918. The total population in 1918 is estimated at 105,253,300, so there was one college graduate to every 116 persons in the country. Taking adults of 23 years and over, the figures become 1 in 61.

The extent of the work undertaken in the colleges and universities is indicated to some extent by the size of their libraries. In 1890, the average number of volumes in a college library was less than 7000. In 1918, this figure had grown to 42,000, while two universities had libraries of more than a million volumes each. The total number of volumes in all the libraries in 1918 was considerably more than twenty-three millions.

The financial position of institutions for higher education in the United States is of interest if only for the sake of comparison with the funds at the disposition of similar institutions in Great Britain. Some of the more outstanding figures have been converted into sterling at the rate of five dollars to the pound, and the results are given in round numbers. Endowments in 1890 amounted to some fifteen million pounds; in 1918, the total was more than ninety-six millions, a similar increase to that shown by the growth in the libraries. During this period, however, the number of students had increased and a better measure of the increase of productive funds is given by comparing the value of such per student enrolled. In 1890, the value was 98*l.* per head and in 1918 it was just over 256*l.*, an increase of 162 per cent. Thus it is doubtful if the increase per head in endowment has really kept pace with the increasing cost of higher education. This statement is borne out by the fact that the percentage of total income coming from endowment funds has steadily decreased during the past 28 years.

The gifts and benefactions reported for the year 1917–18 amounted to just over 5,500,000*l.*; of this amount about 1,100,000*l.* was for increasing plant, 1,000,000*l.* for current expenses, and 3,400,000*l.* for endowments. Thirty-six institutions received gifts of more than 20,000*l.*, and seven of these had benefactions exceeding 200,000*l.* Among these latter were Yale University and the University of Chicago, which received sums amounting to about 570,000*l.* and 420,000*l.* respectively. According to reports for the years 1918–20 received from 317 higher institutions, 27,600,000*l.* was received in benefactions, of which 8,900,000*l.* was for current expenses, 4,800,000*l.* for increase of equipment and plant, and 13,900,000*l.* for endowments. During this period, Harvard University received more than 2,000,000*l.*, Massachusetts Institute of Technology 1,200,000*l.*, and the University of Chicago nearly 1,000,000*l.*, to quote a few of the more noteworthy increases in endowment. These figures, of course, are exclusive of any grants received from Federal, State, or municipal resources.

The value of the property owned by colleges and universities during the period 1890–1918 was ascertained and figures are given for the average value per student. In 1890, this was 108*l.*, while in 1918 it had increased to 279*l.* The property value per student in 1918 was therefore more than two and a half times what it was in 1890, though the fact that the war had reduced the number of students slightly makes the figure for 1918 somewhat high.

The total receipts in 1918 of the universities, colleges, and professional schools in the United States were nearly 30,700,000*l.*, and of this sum about 27,400,000*l.* was reckoned as working income. The corresponding figures for 1892 were about 5,600,000*l.*, and 4,200,000*l.* The average working income per student, however, increased from 14*l.* in 1892 to 73*l.* in 1918; in other words, in 1918 it cost more than five times as much per year to provide education for a student as it did in 1892. Although slightly accentuated by the war, the cost of higher education has been increasing at a steady rate during the whole of this period of 26 years.

The percentages of the total income obtained from the various sources, Federal, State, municipal, students' fees, endowments, and benefactions, also changed considerably between 1892 and 1918. Students' fees have contributed a fairly steady 25 per cent.; the proportion from endowments has decreased steadily from 18·5 per cent. in 1892 to 14·6 per cent. in 1918, while benefactions have, on the whole, also provided a decreasing percentage. Grants from Federal funds increased in general, but the percentage of the total income derived from this source decreased steadily. The State and local authorities have provided a very variable proportion of the income; in 1896, it was only 10·6 per cent., but by 1918 it had risen to 27·2 per cent. Supplementary data for the year 1919–20 are given in Bulletin, 1920, No. 48, which, of course, refers solely to State institutions. The total working income of the 92 universities and colleges which furnished returns for that year was 18,200,000*l.*, of which some 1,800,000 was derived from students' fees, and 1,900,000 from private benefactions. Expressed as percentages, the varying proportions of the total income were contributed as follows: students' fees 9·6 per cent., private benefactions 10·3 per cent., Federal grants 9·0 per cent., State grants 60·6 per cent., and 10·5 per cent. was from miscellaneous sources. The proportion provided by the State is naturally large in State institutions, but the general trend of the figures supports the conclusion reached in Bulletin, 1920, No. 34, that higher education in the United States is coming to depend more and more upon the State or municipality and less on the income derived from productive funds, private benefactions, and Federal grants.

Marine Borers in San Francisco Bay.[1]

AN interesting progress report on the San Francisco Bay marine piling survey has recently been issued by a committee which affords an excellent example of co-operation between science and industry. The Committee was composed of representatives of the American Wood-preservers' Association, the Forest Service, and the Department of Zoology of the University of California, and the necessary funds were contributed by interested parties in the district.

Early in 1914 the activity of marine borers was noticed in the dykes of the Mare Island Navy Yard in San Pablo Bay—the northern arm of San Francisco Bay. The shores of San Pablo Bay have attracted

[1] Report on the San Francisco Bay Marine Piling Survey, prepared under the supervision of the San Francisco Bay Marine Piling Committee of the American Wood-preservers' Association. 1921. Pp. 104+36 plates.

many large industries, the water-front structures of which had been built on untreated piles because it was believed that the discharge into the bay of fresh water by the rivers would prevent invasion by salt water and therefore the advent of marine borers. The attack of 1914 appeared to be sporadic, like earlier ones which had been reported as far back as 1870, but in 1917, at Mare Island, attacks by the same "ship-worm" (Teredo) again occurred, and during the following years spread rapidly and increased in severity. By the latter part of 1919 the attacks had progressed to such an extent that parts of water-front structures, and, in some cases, whole docks, began to fail, and the report of the committee appointed to investigate the problem is now before us.

The marine borers at work in the area comprise the most widely known and most destructive representatives of the groups to which they belong, in addition to one other species which seems to be, as yet, purely Californian. Of the boring molluscs, the first considered is *Xylotrya setacea*, which, when full grown, reaches a length of two feet or more. Details are given of its external features and internal structure. Reference is made to the capacious pouch opening out of the stomach, which serves as a receptacle for the particles of wood rasped off the burrow by the shell. The mechanism of burrowing has been carefully studied, and it is shown that the contraction of the stout, reddish posterior adductor spreads the shell-valves apart and causes their edges to rasp away the wood; the return of the shell-valves to the initial position, ready for the next thrust, is accomplished by the small, weaker, anterior adductor muscle. The shell-valves are not attached to each other by a continuous dorsal hinge (as in the fresh-water mussel), but are widely separated except at two knob-shaped projections which meet in the middle line and serve as fulcra for the rocking movements of the two valves. The cutting action is due to the contact of the anterior face of the shell with the wood and the scraping of this finely ridged edge over the wood by the outward thrust of the shell as the powerful posterior adductor muscle contracts. The shell is held in contact with the bottom of the burrow by the sucker action of the foot. The chips cut away are not more than 0·01 mm. wide, and are several times as long as wide. Prof. Kofoid states that when the borers are active it is possible to hear the rasping of their tools on the wood by placing the ear against the top of the pile.

A short account is given of the life-history of Xylotrya. The eggs are expelled, and fertilisation takes place in the water; the larva forms a velum, develops a pair of shell-valves and a tongue-like protrusible foot. After swimming for about a month the larva, now about 0·75 mm. long, settles down, preferably on wood, and usually near the mud-line. It fastens itself to the wood by a sticky byssus thread, secreted by a gland in the base of the foot, the velum is absorbed, and the foot is transformed into a sucker; the adult type of shell is produced, the elongate siphons are formed, and the animal begins its boring operations. Thirty days after attachment it is about 63 mm. long, and begins breeding, and by the following summer it attains the length of two feet. The largest burrows of this species met with were $\frac{7}{8}$ in. in diameter in their lower portions, and more than 30 in. long.

A short notice is given of *Teredo diegensis*, the smallest of the molluscan borers in this area, which was distinguished from other species in 1916. It is only known from the Californian coast, and is of least importance from the economic standpoint.

The well-known "ship-worm," *Teredo navalis*, is considered more fully, as befits its greater importance. This species seems to reach sexual maturity in the first year of its growth. Prof. Kofoid records a heavy death-rate in the autumn, associated with falling salinity of the water, and there is also a heavy death-rate in the crowded territory near the mud-line. The eggs are reported to be retained in the female until they develop into larvæ, which, on liberation, become at once free-swimming. The larva may be carried by tidal currents for long distances, but Prof. Kofoid remarks that, so far as records are available, no evidence exists to show that *T. navalis* has heretofore been found on the Pacific coast; it is, however, only a question of time before this pest will appear in other ports on the Pacific coast. The number of larvæ which may settle on a given pile seems to be limited only by the surface; 437 were counted on a square inch.

Of the three well-known crustacean borers—Limnoria, Sphaeroma, and Chelura—which attack marine structures, only the first two have been found in San Francisco Bay. Limnoria (the gribble) produces few young, but these are not free-swimming, and are ready at once to dig in for themselves. The colony of Limnoria in timber extends peripherally and the burrows constantly deepen. A square inch of Douglas fir heavily attacked by Limnoria was found to contain 79 females, 82 males, and 221 young. Limnoria works at all levels in harbour waters, from near the mud-line to the uppermost tidal level, but is most active between tide-marks, often whittling away the piles to an hour-glass shape. It may be found at work even in the creosoted zone of a pile. Whether it has become slowly acclimatised to the repellent substance or whether creosoting was defective is not known, but Prof. Kofoid states that it is possible, by gradually increasing the strength of the solution, to acclimatise Limnoria experimentally to live and thrive in solutions which originally would have been deadly. *Sphaeroma pentodon* is of small economic importance.

In a general account of the biological indicators of Teredo, Prof. Kofoid points out that, as this mollusc enters the wood as a minute larva and there is only a pin-hole to mark its entry, a close inspection with a lens is necessary to reveal these small openings. But there are other marine animals easily identified and quickly recognised, which may be taken as indicators of conditions suitable for the occurrence of Teredo, and among these he names the barnacle and hydroids, which, from the results of the Californian survey, precede Teredo as part of an invading marine fauna. Their presence, therefore, indicates the possibility of invasion of the area by Teredo, but not the certainty that the latter has arrived. The occurrence of young mussels (Mytilus) on piling is also another danger-sign warning the engineer to look out for Teredo. As the result of the biological inquiry Prof. Kofoid suggests that it is necessary to restrict the uncontrolled use of untreated or unprotected timbers in marine structures, that harbours should not be used as a dumping-ground for waste wood, and that unused infected timber structures should be removed.

In a concluding summary the committee directs attention to certain other practical matters. In those parts of San Francisco Bay where the attack is severe the borers destroy untreated piling in six to eight months, but in other places untreated piling may last two to four years. A life of five to eight years may be expected from paint and batten protections if the work is well done and the covering not damaged by careless handling. Properly creosoted Douglas-fir piling, if carefully handed so that there is no injury extending through the "shell" of treated wood, may last twenty-five to thirty years, but, on account of the damage liable to occur during repeated handling, storage, and rafting, the average length of life has been considerably less. Most of the attacks on creosoted piling observed by the committee have begun where untreated wood has been exposed by damage in handling the piles, and it is urgently recommended that care be taken to reduce such damage to a minimum. Precast reinforced concrete piles and pile-casings which have been in serv ce for ten years show no evidence of deterioration,. and seem likely to be of use for a number of years to come.

Universities of Oxford and Cambridge.

Report of the Royal Commission.

THE report of the Royal Commission on the Universities of Oxford and Cambridge has been published as a Blue Book (Cmd. 1588, 6s. net), and we print below some of the more important recommendations. The Commission, which was appointed in November, 1919, under the chairmanship of Mr. H. H. Asquith, had as its object an inquiry into the financial resources of the Universities and the uses to which they were put, and in this respect the scope of the Commission was very different from those of 1850 and 1877. The immediate occasion for the appointment of the Commission was the application of the Universities for large-scale financial assistance, and the report is confined principally to this aspect of the present position of the Universities.

The first consideration is that the numbers in residence at Oxford and Cambridge have increased largely in recent years and the scope of the work undertaken has widened. As a consequence, the staffs of the Universities and colleges are heavily overworked in many cases and research is suffering. The Commissioners report that either (*a*) the number of students must be decreased, or (*b*) the staffs must be increased, or (*c*) the standard of learning must be allowed to go down.

Dealing with the new relation between science and national development, the conclusion has been reached "that technical education does not suffice. In order to get the greatest scientific results even of a practical character, investigations carried on with merely technical objects and in a merely utilitarian and commercial spirit will not achieve the highest results. The disinterested pursuit of scientific investigation affords the surest means by which the nation can ultimately command the resources of nature." For Oxford, it is suggested that a scheme should be drawn up for future scientific developments in the parks or on some other site near the Museum; for Cambridge, attention is directed to the question of establishing a central institution for training and research in surveying, hydrography, and geodesy. Light and cheaply built laboratories of one storey are also suggested for elementary work.

The financial difficulties which now threaten Oxford and Cambridge are ascribed to their great developments, and also to the change in the value of money. Reviewing possible methods of augmenting the Universities' incomes, the Commissioners are of opinion that raising fees would have the undesirable effect of turning Oxford and Cambridge into rich men's Universities. The real hope of future prosperity and development lies in private benefactions, but unfortunately there is no prospect of private benefactions being obtained sufficiently soon and in sufficient quantity to avert financial disaster. A State grant is therefore recommended, and the Commissioners state definitely that it is an absolute necessity in the public interest that an adequate grant should be made, even under the present financial conditions of the country. The report goes on :—" We recommend that each University receive, instead of the existing interim grant of 30,000*l*., an annual grant of 100,000*l*. a year, in addition to 10,000*l*. a year for special purposes (women's education and extramural work), and a lump sum for pension arrears, in order to enable them to fulfil their functions to the nation in a satisfactory manner."

The principal purposes to which the suggested grant should be devoted are as follows: — proper salaries and pensions for University teachers; the adequate maintenance of the University libraries and museums; the endowment of research and advanced teaching, including more professors, readers, and University or faculty lecturers, and more research studentships for young graduates; the most pressing needs of maintenance in respect of laboratories and departmental libraries; and the provision in both Universities of a Sites and Buildings Fund. The grants should be made to the University and not to the separate colleges.

Of the minor recommendations laid down in the report, a few only will be mentioned. Fellowships are considered to be valuable assets of the colleges, and in consequence the Commissioners recommend that Fellowships be divided into the following classes:— (*a*) Restricted to those who hold certain University posts; (*b*) Fellowships associated with official posts in the College, or with University lectureships or demonstratorships; (*c*) Old Fellows who have retired from active work; (*d*) Fellowships to which young graduates may be elected under conditions of research; and (*e*) Supernumerary Fellowships. (*b*) and (*d*) only should be stipendiary.

Dealing with pensions for members of the staffs of the Universities, the report advocates that the "federated superannuation system of the Universities" be applied, and that provision be made in College statutes for its adoption in all Colleges also, the cost to Colleges being met, if necessary, out of increased fees. It is suggested that the retiring age should be 65 for teachers and administrative officers, and 70 for heads of Colleges.

On the question of the position of women at Oxford and Cambridge the Commissioners express the opinion that ample facilities should be offered for the education of women and for their full participation in the life and work of the University. The Cambridge Committee recommend that women be entitled to be admitted on the same conditions as men to membership of the University subject to various limitations, which include the provision that the offices of the Chancellor, Vice-Chancellor, and Proctor be not open to women.

Finally, it is recommended that any facilities obtained by State grants, directly or indirectly, for the increase of College or Faculty staffs be used to secure more time for research and not to increase the provision for the individual teaching of undergraduates. It is also suggested that a central University Fund be created, assisted out of the general grants from public funds, to enable a specially qualified professor, reader, or lecturer to take a period of absence exceptionally for travel and research, without loss of income, on the recommendation of the proposed Board of Studies and Research. Both these suggestions have been made by the Commissioners with the idea of stimulating and increasing the value of research and advance work.

University and Educational Intelligence.

LEEDS.—The chair of civil and mechanical engineering in the University of Leeds will shortly be vacant owing to the resignation of Prof. J. Goodman, who has held the chair since 1890. Prof. Goodman proposes to give his time to research, and the University Council has assigned to him accommodation for this purpose.

LONDON.—Dr. C. A. Pannett has been appointed to the University Chair of Surgery tenable at St. Mary's Hospital Medical School. In 1920–21 Dr. Pannett was Hunterian Lecturer at the Royal College of Surgeons. He is the author of numerous papers on surgical operations and research.

Dr. C. A. Lovatt Evans has been appointed to the University Chair of Physiology tenable at St. Bartholomew's Hospital Medical College. He has carried out research work at the National Institute for Medical Research, at Freiburg, and at Cambridge; and is the author of numerous papers on Experimental and Chemical Physiology.

Dr. G. B. Jeffery has been appointed to the University Chair of Mathematics tenable at King's College. Since 1912 Dr. Jeffery has been Assistant in the Department of Applied Mathematics at University College, and was Acting Head of the Department from 1914 to 1917, in respect of which appointment the Senate conferred on him the title of Reader in Applied Mathematics. He has conducted research work in the Theory of Special Functions, Hydrodynamics, Elasticity, and the Theory of Relativity.

A resolution has been adopted by the Senate expressing great gratification at the establishment by the Worshipful Company of Cutlers of five Scholarships of 90*l.* a year for two years, to be awarded, on the recommendation of the Senate, to suitable candidates who have passed Part I. of the Final Examination for the B.Com. Degree and undertake to enter for Part II. These Scholarships will be "open for competition by young men of British nationality who intend to adopt a commercial, engineering, or metallurgical career, and propose to pursue the study of some foreign language or languages in France or Spain or such other country as may from time to time be approved by the Company."

The following Doctorates have been conferred:—*D.Sc. in Geology*: Mr. L. M. Parsons, an Internal Student, of the Imperial College—Royal College of Science, for a Thesis entitled "Dolomitization in the Carboniferous Limestone of the Midlands." *D.Sc. in Physics*: Miss A. C. Davies, an Internal Student, of Royal Holloway College, for a Thesis entitled "The Minimum Electron Energies Associated with the Excitation of the Spectra of Helium." *D.Sc. in Physiology*: Miss E. E. Hewer, an Internal Student, of Bedford College, for a Thesis entitled "Some Functions of the Suprarenal Glands."

MANCHESTER.—Prof. Arthur Lapworth, who has been, since 1913, professor of Organic Chemistry in the University, has been appointed Sir Samuel Hall professor of Chemistry and Director of the Chemical Laboratories in succession to Prof. H. B. Dixon.

PROF. K. H. VICKERS, professor of modern history in the University of Durham (Armstrong College, Newcastle), has been appointed Principal of University College, Southampton, in succession to Prof. Loveday, now Vice-Chancellor of the University of Bristol.

Calendar of Industrial Pioneers.

March 30, 1856. Sir William Symonds died.—Entering the Royal Navy in 1794, Symonds at the conclusion of the Napoleonic wars turned his attention to naval construction and in 1825 was permitted to build the brig *H.M.S. Columbine*, the success of which led to his appointment in 1823 as Surveyor of the Navy. During the succeeding fifteen years he was responsible for the design of over two hundred vessels. He introduced various improvements leading to greater speed, more stability, and increased stowage.

March 30, 1882. William Menelaus died.—Trained in Scotland as a millwright, Menelaus rose to be engineer and manager of the Dowlais Iron Works in South Wales, where some of the earliest work was done in connection with the Bessemer process of making steel. He served as President of the Iron and Steel Institute, and in 1881 was awarded the Bessemer Medal.

March 31, 1776. John Bird died.—One of the most famous astronomical instrument-makers of the eighteenth century, Bird began life as a cloth-weaver in the north of England. Coming to London in 1740 he worked for Sisson, and with Graham's assistance in 1745 he set up in business in the Strand. He introduced improved methods of dividing instruments, and supplied mural quadrants to Greenwich and to many of the continental observatories. He also constructed the standard yard measures kept in the House of Commons till destroyed in the fire of 1834.

March 31, 1846. Andreas Kurtz died.—Born in 1781 in Reutlingen, in Wurtemberg, Kurtz as a boy found his way to Paris, where he worked in the factories and gained an intimate knowledge of practical chemistry. After Napoleon's downfall he settled in England, and erected works in Manchester, Liverpool, and St. Helens.

April 1, 1910. Frederick Wicks died.—Known as one of the pioneers in the development of rapid and accurate type-casting and composing machinery, Wicks took out his first patent in 1879, but it was not till twenty years afterwards he achieved success. In 1900 the *Times* was printed from new type supplied fresh every day from a Wicks rotary machine.

April 3, 1667. Edward Somerset, Marquis of Worcester, died.—A zealous adherent to the cause of King Charles I., Somerset after the king's fall resided in France for a time, but returning to England was confined in the Tower. At the Restoration he recovered his estates and then gave himself up to mechanical experiments. In 1663 he published his "Century of Inventions," in which is to be found his plans for a steam pump, "an admirable and most forcible way to drive up water by fire."

April 3, 1871. James Sheridan Muspratt died.—A son of the founder of the alkali industry in Lancashire, Muspratt studied under Graham and Liebig, spent some years on the continent, made various chemical discoveries, and in 1848 established the Liverpool School of Chemistry. He was the author of a standard "Dictionary of Chemistry."

April 4, 1861. Sir James Caleb Anderson died.—Anderson took out several patents in connection with steam navigation and locomotives, and was well known as one of the early experimenters with steam road carriages.

April 4, 1883. Peter Cooper died.—One of the first constructors of locomotives in the United States, Cooper had large engineering works in Baltimore, and was the founder of the Cooper Institute in New York, where some 3000 students are trained in the mathematical and natural sciences.

E. C. S.

Societies and Academies.

LONDON.

Royal Society, March 9.—Sir Charles Sherrington, president, in the chair.—T. R. **Merton** and S. **Barratt**: The spectrum of hydrogen (Bakerian Lecture). The secondary spectrum is characteristic of pure hydrogen and feeble discharges. Impurities weaken it and enhance the Balmer series. The secondary lines are classified in different physically related groups which depend on the pressure of gas, the conditions of excitation, etc. The Balmer series appear in most celestial spectra. There is no evidence of the secondary spectrum in the solar spectrum. Measurements of the widths of the lines by a new method independent of estimates of "limiting visibility" show that the secondary spectrum is due to the molecule. When the current density of electrical discharges through vacuum tubes is great a partial separation of the gases is effected. This may have some bearing on the interpretation of certain celestial spectra. There is much evidence for a specific influence of neighbouring atoms on the spectra emitted. Helium modifies the secondary spectra of both hydrogen and carbon.

March 16.—Sir Charles Sherrington, president, in the chair.—H. H. **Dale** and C. H. **Kellaway**: Anaphylaxis and anaphylatoxins. Guinea-pigs were rendered passively anaphylactic to egg-albumin by injections two days previously of the precipitin for crystallized egg-albumin. Intravenous injection of a further dose of the same precipitin, a few minutes before a dose of egg-albumin, suppressed the anaphylactic reaction. Similarly, isolated plain muscle from anaphylactic guinea-pigs suspended in saline solution, was completely protected from the stimulating effect of egg-albumin by adding to the bath the precipitin which caused the anaphylactic condition. The toxicity of so-called "anaphylatoxins," produced by digesting serum with carbohydrate sols, etc., is due to the formation of complexes which keep the foreign colloid finely dispersed. They do not act on isolated plain muscle, as the anaphylactic antigen does, but are active only in the presence of the circulating blood. Their action is attributed to exposure of the blood to a large foreign surface.—J. C. **Bramwell** and A. V. **Hill**: The velocity of the pulse wave in man. The velocity of the pulse wave, relative to the blood in the vessel, is given in metres per second, $v = 3 \cdot 57 / \sqrt{\text{per cent. increase in vol.}}$ of vessel per mm. of Hg. increase of pressure. An observation of the velocity therefore gives the degree of extensibility of the vessel, and is one criterion of an efficient circulation. It is shown that pressure has a considerable effect on the velocity and that the calculated velocity is less than that observed in man. This is attributed to the "elastic after-action." Experiments on an isolated human artery gave a velocity comparable with that observed in man. The transmission of the pulse wave is purely mechanical, its velocity depending on the extensibility of the vessels as modified by any condition (muscular or otherwise) pertaining at the moment.—A. **Fleming**: On a new bacteriolytic element found in tissues and secretions. A substance termed a "microzyme" found in tissues and secretions is strongly bacterio-inhibitory, bactericidal, and bacteriolytic. It is precipitated from albuminous solutions by protein precipitants, is inhibited by 1/800 normal acid or alkali, and will not pass through a collodion membrane. Filters of porcelain, cotton wool or filter paper absorb microzyme from first portion of fluid filtered, but when saturated the microzyme passes freely. Microzyme affecting *Micrococcus lyticus* is present in most tissues of the human body. Normal urine, sweat, and cerebro-spinal fluid apparently contain none, but tissues of dog, rabbit, and guinea-pig contain microzyme for *M. lyticus*. Egg-white is very potent, showing lytic action at a dilution of 1 in 50 millions, and a small amount was found in the turnip. Human secretions contain microzyme exercising lytic action on most bacteria of the laboratory air, on bacteria pathogenic for animals but not pathogenic for man, and on many cocci isolated from the human body.—J. W. **Pickering** and J. A. **Hewitt**: The action of "peptone" on blood and immunity thereto. Typical inhibition of the coagulation of the blood can be obtained by the addition of "peptone" to blood *in vitro*, in quantities no greater than those required to produce inhibition *in vivo*, provided the disturbance of the surface conditions of the blood, incidental to shedding, is sufficiently reduced. Leucocytes play no part in the anti-coagulant action of "peptone" on blood. The slow injection of maximal amounts of "peptone" into cats, with the liver out of the circulation, produces typical immunity to anti-coagulant action. A physical explanation is suggested. In the interpretation of the coagulation of the blood it is unnecessary to assume the existence of antithrombin, proantithrombin, and antiprothrombin, and current "thrombin theories" become untenable.

Geological Society, March 8.—Mr. R. D. Oldham, vice-president, in the chair.—Baron Francis **Nopcsa**: On the geological importance of the primitive reptilian fauna in the Upper Cretaceous of Hungary. The Upper Cretaceous of Eastern Hungary can be divided into two horizons, the Cenomanian, Turonian, and Lower Senonian strata, and the uppermost Senonian and the Danian formation. The Danian is a freshwater deposit that passes downwards by means of brackish-water beds into the marine strata. The vertebrate fauna of the freshwater beds has, despite its Upper Cretaceous age, a strikingly Jurassic aspect. It contains primitive tortoises, a Camptosaurian Dinosaur, a primitive Trachodon, a Sauropodous Dinosaur, an armoured Dinosaur, and a Pterosaurian. Isolation during the whole of the Cretaceous Period caused a dwarfing of the larger animals (Dinosaurs) but did not affect the smaller forms (crocodiles and tortoises). In consequence of a general uplift at the dawn of the Eocene and the cooling of the climate, nearly the whole of this fauna became extinct. Crocodiles which were adapted to a warm-blooded diet survived until the Miocene Period, and only retired to the tropics when the climate became so cold that the palms vanished from Europe.

Optical Society, March 9.—Sir Frank Dyson, president, in the chair.—T. **Smith** and J. S. **Anderson**: A criticism of the nodal slide as an aid in testing photographic lenses. The nodal slide is only convenient for the examination of lenses over their entire field when these are of normal type unless supplemented by suitable linkages. Collimators and lenses should in general be so directed that all useful light passes through them as symmetrically about their axes as possible.—A. J. **Bull**: A non-polarising spectrophotometer. Uniform monochromatic patches of colour are compared, instead of the more usual arrangement of two portions of a spectrum. The upper half of a spectrum undergoes selective absorption by the material under test, and a region of the spectrum is selected by a slit. A split lens then forms two images of the dispersing prism face which are brought together by a rhomb-like prism with slightly unequal angles. Photometric balance is obtained by the partial closure of the lower portion of the selecting slit.—J. **Guild**: The photometry of optical instruments. A portable surface-brightness photometer of the polarisation type for the measurement of the fraction of the incident light transmitted or reflected by an optical instrument, and for the measurement of the relative brightness of different parts of a field of view was described. The instrument is a modified Wanner optical pyrometer.—T. **Smith**: A projective treatment of the submarine periscope. The optical events occurring in a periscope may be illustrated by homocentric projection. This affords a simple means of finding the relative advantages of different arrangements of the optical system.—A. J. **Dalladay**: Some measurements of the stresses produced at the surfaces of glass by grinding with loose abrasives. The stresses at the surface of a piece of "greyed" glass were measured and the relation is shown between the size of grains of the abrasive used and the stresses produced.

Linnean Society, March 16.—Dr. A. Smith Woodward, president, in the chair.—C. E. **Salmon**: (1) *Sagina filicaulis* Jord. It differs from *S. apetala* by its tapering sepals, and by their being appressed to the ripe capsule; from *S. ciliata* by being more glandular, sepals less acute, and shorter in proportion to the ripe capsule. (2) *Cerastium subtetrandrum* Murbeck. Occurs in Orkney and in W. Sutherland. It differs from *C. tetrandrum* by being both pentamerous and tetrandrous; the lower bracts are smaller than the stem-leaves, sepal tips are pointed, and seeds smaller. (3) *Arum italicum* Mill. Found in S. and S.W. England, it differs from *A. maculatum* by the petioles being much longer in proportion to the blade, spathes are longer compared with spadix, ovaries more numerous, and the spadix is differently shaped and larger.

Aristotelian Society, March 20.—Prof. G. Dawes Hicks in the chair.—R. F. A. **Hoernlé**: Some byways of the theory of knowledge. In the attempt to give scientific precision to their language, some philosophers have introduced into theory of knowledge a distinction between first-hand knowledge and second-hand knowledge (or knowledge mediated by symbols), alongside of the current distinctions between "knowledge by acquaintance" and "knowledge by description," or "immediate acquaintance" and "thought." Acquaintance and immediate experience are, in current theory, commonly characterised by absence of language and of analysis, whereas first-hand knowledge, *e.g.* a botanist engaged in research, may involve any amount of analysis and symbols. Yet there will be no divorce of description from acquaintance, or of thought from immediate data, but the data will be ordered and acquire significance, and their meaning will come to the investigator as fulfilled and realised, in a sense in which it cannot do so to one who merely reads his account at second-hand. The choice of a terminology is no mere matter of words, for it is a choice of meanings, and therefore of the qualities and relations which we affirm as "true" and "real" of the object under discussion. Definition merely leaves open the question whether anything bearing the character defined exists. The suggestion was made that a comparative and systematic study of philosophical languages is much to be desired as a preliminary to rational choice, and, in any case, as a help to mutual understanding.

Dublin.

Royal Irish Academy, February 13.—Prof. Sydney Young, president, in the chair.—S. **Young**: The vapour pressures and boiling points of non-miscible and miscible liquids and the composition of the vapours (distillates) from such heterogeneous and homogeneous mixtures. The formation of azeotropic mixtures of minimum and maximum boiling point was explained, and the case of ternary azeotropic mixtures was especially considered. A large number of these mixtures have been discovered since 1902, and by plotting the boiling points of known ternary and binary mixtures against the boiling points of the aliphatic alcohols it is possible to predict with some confidence whether the alcohols not yet examined will form binary azeotropic mixtures with benzene, normal hexane, or toluene, or ternary mixtures with one of these hydrocarbons and water.

Manchester.

Literary and Philosophical Society, March 7.—Mr. T. A. Coward, president, in the chair.—W. M. **Tattersall**: The sound-producing mechanisms of Crustacea. Some species of Crustacea from the shallow waters and shores of East Africa and others from Australia exhibit mechanisms for the production of sound. Three main types of sound-producing mechanism are found. (*a*) Popping Type: The sound is produced by the rapid withdrawal of a tightly fitting peg from a socket. (*b*) Fiddle and Bow Type. Rapid motion of a sharp smooth ridge or a row of granules across a row or series of rows of regularly arranged granules or tubercles or a file-like series of ridges or *vice-versa* produces the sound. (*c*) Plectrum Type. Two series of stiff, hollow spines are rubbed together. The first type is found in the snapping shrimps (Alpheus) characteristic of coral reefs; the second type in the spiny lobster of British coasts, some shore crabs from tropical waters like Matuta, Platyonichus, Pseudozius and the amphibious crabs, Ocypoda and Uca; and the third type only in certain river crabs in Africa. The stridulating organs occur in both sexes. The sound is probably a warning-note to keep intruders from a burrow already occupied.

Official Publications Received.

Département van Landbouw, Nijverheid en Handel. "'S Lands Plantentuin" ("Jardin Botanique de Buitenzorg"). Treubia. Recueil de travaux zoologiques, hydrobiologiques et océanographiques. Rédigé par Dr. W. M. Docters van Leeuwen, Dr. K. W. Dammerman et Dr. A. L. J. Sunier. Vol. 2, Livraison 1, Décembre. Pp. 155. (Buitenzorg: Archipel Druckkerij.)

The Indian Forest Records. Vol. 8, Part 3: The Beehole Borer of Teak: A Preliminary Note on the Ecology and Economic Status of *Duomitus ceramicus*, Wlk. in Burma. (*Lepidoptera, Cossidæ.*) By C. F. C. Beeson. Pp. iii+105+3 diagrams. 3 rupees. Vol. 8, Part 4: Notes on Artificial Regeneration in Bengal. By A. K. Glasson and others. Pp. iii+33+11 plates. 2 rupees. (Calcutta: Government Printing Office.)

Carnegie Institution of Washington. Year Book No. 20, 1921. Pp. xxii+475. (Washington.)

Records of the Botanical Survey of India. Vol. 8, No. 3: Flora Arabica. By Prof. E. Blatter. Part III: Campanulaceæ-Verbenaceæ. Pp. ii+283-365. 1.1 rupee. Vol. 9, No. 1: A Survey of the Flora of the Anaimalai Hills in the Coimbatore District, Madras Presidency. By C. E. C. Fischer. Pp. ii+218+xxi. 4.4 rupees. Vol. 9, No. 2: Euphorbiaceæ Novæ e Peninsula Malayana. By A. T. Gage. Pp. ii+219-250. 8 annas. (Calcutta: Government Printing Office.)

Report of the Proceedings of the Fourth Entomological Meeting held at Pusa on the 7th to 12th February 1921. Edited by T. Bainbridge Fletcher. Pp. xii+401. (Calcutta: Government Printing Office.) 7.8 rupees.

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia. Verhandelingen No. 8: Het Klimaat van Nederlandsch-Indië (The Climate of the Netherlands Indies). By Dr. C. Braak. Deel 1 (Vol. 1): Algemeene Hoofdstukken (General Chapters), Aflevering 2 (Part 2); With English Summaries. Pp. iii+65-147+50. (Batavia.)

The Rockefeller Institute for Medical Research. Organization and Equipment. Pp. 25. (New York.)

Library of Congress. Report of the Librarian of Congress and Report of the Superintendent of the Library Buildings and Grounds, for the Fiscal Year ending June 30, 1921. Pp. 207. (Washington: Government Printing Office.)

Publikationer fra det Danske Meteorologiske Institut. Aarbøger. Isforholdene i de Arktiske Have (The State of the Ice in the Arctic Seas) 1921. By Kapt. C. I. H. Speerschneider. Pp. 32+5 maps. (Kjøbenhavn: G. E. C. Gad.)

Diary of Societies.

FRIDAY, MARCH 31.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre, Imperial College of Science and Technology), at 2.30.—Dr. W. L. Balls: Advantages and Defects of Team Work in Economic Biology.—Dr. F. Kidd: Problems of Fruit Storage.
INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Prof. H. H. Jeffcott: The Milling of Screws, and other Problems in the Theory of Screw-threads.
INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 7.—J. S. Highfield: Presidential Address.
INSTITUTION OF AERONAUTICAL ENGINEERS (at Royal Society of Arts), at 7.30.—Mr. Folland: Aircraft Design.
JUNIOR INSTITUTION OF ENGINEERS, at 8.—D. P. Dickinson: The Steel Melting Shop.

SATURDAY, APRIL 1.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Radioactivity (5).

MONDAY, APRIL 3.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.
ROYAL SOCIETY OF ARTS, at 8.—G. Radcliffe: The Constituents of Essential Oils (Cantor Lectures), (3).
SOCIETY OF CHEMICAL INDUSTRY (London Section), (at Chemical Society), at 8.
ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—S. C. Ramsey: London Clubs.

TUESDAY, APRIL 4.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. J. W. Evans: Earth Movements (2).
ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—Sir Thomas Bilbe Robinson: New Zealand.
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. H. Mackenzie: Diseases of the Thyroid Gland (2).
ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—C. Tate Regan: Exhibition of lantern-slides illustrating Blind Fresh-water Fishes from Caves.—Dr. J. T. Cunningham: Mendelian Experiments on Fowls. III. Production of Dominant Pile Colour.—Dr. M. Khalil: A Revision of the Nematode Parasites of Elephants, with a description of four new Species.
INSTITUTION OF CIVIL ENGINEERS, at 6.—Sir Robert A. Hadfield, Bart.: Corrosion of Ferrous Metals.
RÖNTGEN SOCIETY (at Institution of Electrical Engineers), at 8.15.

WEDNESDAY, APRIL 5.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—Capt. J. H. Whittaker-Swinton: Provision of Power for Wireless Telegraphy.
SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—O. D. Roberts and H. T. Islip: The Constants of Indian Beeswax.—A. Chaston Chapman: Note on the Liver Oil of the "Tope"(*Galeus galeus*).—A. Chaston Chapman: Note on the Examination of Foods for the Presence of Sulphites.—S. H. Groom: Demonstration of Artificial Daylight for Laboratory Purposes (Sheringham System).—A. Bruce: A Tropical Milk Supply.—E. R. Bolton and D. G. Hewer: Certain Tropical Oilseeds.
ROYAL SOCIETY OF ARTS, at 8.—Prof. E. R. Matthews: Sea Encroachment and its Prevention.
ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

THURSDAY, APRIL 6.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. M. Hind: Landscape Etchers: New and Old (2).
ROYAL SOCIETY, at 4.30.—*Probable Papers*.—F. E. Smith: An Electromagnetic Method for the Measurement of the Horizontal Intensity of the Earth's Magnetic Field.—G. I. Taylor: Stability of a Viscous Liquid contained between two Rotating Cylinders. Part I. Theoretical. Part II. Experimental.—Prof. T. H. Havelock: Dispersion Formulæ and the Polarisation of Scattered Light: with Application to Hydrogen.—Dr. G. R. Goldsbrough: The Cause of Encke's Division in Saturn's Ring.—C. Spearman: Correlation between Arrays in a Table of Correlations.—Dr. W. L. Balls: Apparatus for determining the Standard Deviation Mechanically.
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. H. Mackenzie: Diseases of the Thyroid Gland (3).
LINNEAN SOCIETY OF LONDON, at 5.—Dr. A. B. Rendle: An Example of Regeneration of the Terminal Bud.—C. Turner: The Life-history of *Staurastrum Dickiei*, var. *parallelum* (Nordst.).—L. C. Borradaile: The Mouth-parts of the Shore-crab, with lantern-slides.
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—L. Brèguet: Aerodynamical Efficiency and the Reduction of Air Transport Costs.
CHILD STUDY SOCIETY (at Royal Sanitary Institute), at 6.—M. Yearsley: A Plea for the Deaf Child.
INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—J. A. Kuyser: Protective Apparatus for Turbo-Alternators.
CHEMICAL SOCIETY, at 8.—Prof. M. O. Forster and W. B. Saville: Constitution of Picrorocellin, a Nitrogenous Constituent of *Roccella fuciformis*.—S. Sugden: The Determination of Surface Tension from the Maximum Pressure in Bubbles.
CIVIC EDUCATION LEAGUE (at Leplay House, 65 Belgrave Road, S.W.1), at 8.15.—Miss M. M. Barker: Occupational Education.

FRIDAY, APRIL 7.

DIESEL ENGINE USERS' ASSOCIATION (at Institution of Electrical Engineers), at 3.—H. Moore: Some Characteristics of Petroleum Oil used in Diesel Engines.
ROYAL AERONAUTICAL SOCIETY (Students' Section) (at 7 Albemarle Street), at 6.45.—Prof. L. Bairstow: Some Aeronautical Problems of the Early Future.
JUNIOR INSTITUTION OF ENGINEERS, at 8.—J. W. Maple: Engineering in Southern Persia.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Ernest Rutherford: Evolution of the Elements.

SATURDAY, APRIL 8.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Radioactivity (6).

PUBLIC LECTURES.

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

SATURDAY, APRIL 1.

POLYTECHNIC (Regent Street, W.1), at 10.30 A.M.—Prof. H. E. Armstrong: The Wonders and Problems of Food.
HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. W. A. Cunnington: Woman's Sphere in Savage Africa.

WEDNESDAY, APRIL 5.

SCHOOL OF ORIENTAL STUDIES, at 12.—Miss Alice Werner: Bantu Mythology and Folk Lore (6).

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