NATURE

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The Aeronautical Research Committee.[1]

THE report of the Aeronautical Research Committee marks another milestone in the organisation of research in one of the comparatively newer fields. A study of this report, and the list of publications during the year, emphasises the progress that can be achieved by steady systematic team work.

Since the early days of aviation when the first bold pioneer steps were taken, there is scarcely a single outstanding achievement to the credit of any individual worker comparable with those that have occurred in other fields of scientific inquiry, and yet the progress that has been made is little short of wonderful. The modern aeroplane has acquired characteristics of speed and agility, stability and control, load-carrying capacity and strength of structure, a beauty of outline and a cleanness of design, that marks it out almost as belonging to a different species from its prehistoric ancestor of only twenty years ago. It is no criticism of the band of aeronautical enthusiasts to say that much of this result has been achieved in the main by the direct adaptation of well-recognised scientific knowledge and methods to a definite concrete end. An examination of the work of the Aeronautical Research Committee shows, in fact, that the main impetus has been received not so much from any specific first-class discovery of a purely aeronautical nature, but from the large number of points of contact the subject possesses with other branches of science.

Broadly speaking, the matter dealt with by the Committee on the technical side groups itself under the triple interlocking headings of aerodynamics, power, and materials, each of which embodies a network of specialised inquiry. Decentralisation is effected by six sub-committees, namely, aerodynamics, engine, materials and chemistry, accidents investigation, air transport, and structures. The separate branches of the work in each sub-committee are then dealt with in an appropriate panel of that sub-committee. The aerodynamics sub-committee, for example, has separate panels dealing with design, stability and control, airscrews, and seaplanes, while the materials and chemistry sub-committee branches out into panels on elasticity and fatigue, light alloys, fabrics and dopes.

A glance at this scheme of subdivision indicates the extensive range of subjects that bear directly on the specifically aeronautical field, and contribute towards its development. It is evident that the design and organisation of this scheme has been achieved only as a result of careful thought and mature experience. In itself it is an experiment in the organisation of research that is well worth study, while its success is borne out

[1] Report of the Aeronautical Research Committee for the Year 1924–1925. Pp. 44. (London: H.M. Stationery Office, 1925.) 1s. 6d. net.

by the imposing list of concrete advances that are recorded in each annual report.

Among the numerous important papers that have been published by the Committee during the present year, an interesting feature is the rapid progress that is at last being made in the prediction of aerofoil performance. Until the development of the Prandtl vortex theory, an impasse on the theoretical side of this subject had for all practical purposes been reached, and progress in aerofoil design was only to be sought by steady systematic, if arduous, wind channel tests. The development of the Prandtl vortex theory, unsatisfactory as it is in certain respects from an abstract theoretical point of view, has opened the way to classification of aerofoils and allied parts and prediction of performance to a remarkable degree of accuracy. The most recent investigations seem to suggest that even the aerodynamically complicated airscrew will yield up its properties to this remarkable theory.

One of the more important aeronautical problems of recent years is that associated with controllability, especially at low speeds or during stalling. As a result of investigations by the stability and control panel, the characteristics required in an aeroplane to make it controllable when stalled are now understood, and it has been demonstrated that these characteristics can be introduced by means of practical modifications in the organs of control. It appears that conventional aeroplanes are defective in two respects: they have insufficient rudder power, and the ailerons, when applied, effect a turning of the aeroplane and in so doing neutralise their direct effect on roll. It has been found by analysis, and verified by experiment, that either an increase of rudder power or the use of an aileron which does not turn the aeroplane would provide the pilot with sufficient power to regain an even keel from any position and so obviate the fatal spinning dive. The most successful device so far developed seems to be a combination of a Handley Page slot on the leading edge in conjunction with a balanced aileron of the Bristol-Frise type. This advance towards the elimination of one of the most potent causes of accidents is extremely encouraging.

In the actual constitution of the Aeronautical Research Committee, a change has this year been introduced which is likely to have a profound effect on the nature of the researches which are inaugurated. Future membership of the Committee is to be confined solely to members appointed in virtue of their scientific standing rather than as representatives of definite interests, such as, for example, the Society of British Aircraft Constructors. This change goes hand in hand with a modification in the nature of the duties of the Committee, which in future is to advise the Secretary of State for Air on scientific matters relating to aeronautics rather than on scientific and technical problems relating merely to the construction and navigation of aircraft. In view of the fact that one of the functions of the Committee is to supervise the aeronautical research at the National Physical Laboratory, it will be obvious how far-reaching this change may be in determining the nature and trend of that research.

The work of the Committee is not confined to that conducted at the recognised research stations. Grants amounting to 1500*l.* have been made to enable individual workers to pursue a number of special investigations—experimental research on redundant structures, wind tunnel and theoretical research on skin friction and on the problem of control at low speeds. A sum of 1000*l.* will be available for a similar purpose during 1925–26. From the point of view of widening the field of interested researchers in aeronautical science, no better method could be adopted. It would be interesting to know, however, what machinery there is, if any, for ensuring that such detached workers maintain sufficiently effective contact with the main body of work in progress in aeronautical inquiries adjacent to their own, as the interval between completion of an investigation and publication by H.M. Stationery Office of the numerous R. and M. Reports is often considerable.

Without the financial backing of the Air Ministry, it is evident that the greater part of this extremely valuable scientific work would never have been undertaken at this stage. In the days of its inception, the activities of the Aeronautical Research Committee were naturally dominated largely by military considerations. At the close of the War, when the need for an impetus to commercial aviation became apparent, the nature of these considerations underwent a gradual transformation. The latest orientation of the Committee, where it has practically thrown off the necessity for concentration on problems either of immediate military or of commercial utility, while still retaining intimate contact with both these spheres, is a great achievement for the scientific outlook. It was, moreover, inevitable.

Solar Sophistry.

Le Soleil: ses phénomènes les plus importants, leur littérature et leur explication. Par A. Brester, Jz. Préparé à la publication par les soins du Dr. T. van Lohuizen. Pp. iv+315. (La Haye: W. P. van Stockum et fils, 1924.) n.p.

DR. BRESTER died on June 25, 1919, and this great monograph with pages 9½ by 11¾ inches, is published after his death by his wife and daughter, and is edited by Dr. T. van Lohuizen. It would, therefore, be unseemly to criticise any defects in the

printing or accessories of the book. But since the author continually elaborated one fundamental theory, during the thirty years that he devoted to the making of the book, if this theory was wrong initially, he had time enough to go very far wrong indeed.

The theory is one that no solar observer could entertain for a moment, for it is this: that the sun is in a state of absolute calm; that there is a complete absence of all radial convective movements; that the different vapours in the photosphere and chromosphere are in a stratification that is invariable and undisturbed by currents; that the prominences are not eruptions —*ever*, they are entirely tranquil in spite of their seeming movements, whether these be outwards from the sun radially or in the line of sight; that the spots differ in no wise in temperature from the photosphere in which they appear. But it was Dr. Brester's pride that "this theory has been elaborated, not by some astronomer who has made observations all his life, but by an amateur theorist, who has never made any observations at all." For, he says, astronomers have chosen a method (by observation) for getting their knowledge of the constitution of the sun,

"which is still too imperfect to allow them to elaborate a solar theory. And, besides, since astronomers are eminently patient scholars, finding an entire satisfaction in the production of observations, letting themselves be delayed or even turned aside willingly by their noble ambition to discover new facts, they occupy themselves rather with the 'How' than with the 'Why' of the phenomena, and, in short, they work above all for posterity. But the amateur theorist is in more of a hurry. He has only a very mild interest in posterity . . . and not being in the conditions in which he can make observations, he can give all his time and energy to the more interesting task of interpreting other people's observations, and it is thus . . . that *this* theory has been able to be built up."

In this year, 1925, six years only after Dr. Brester completed the writing of this book, posterity, in the form of a solar observer, can judge of Dr. Brester's method of interpreting astronomical observation, and can come to a fair conclusion as to whether his "hurried Why" is legitimately based on the astronomers' "patient How." Such is the purpose of the following criticisms.

In the very beginning, in his introduction, the author falls foul of "Kirchhoff's law" and "Doppler's principle." He seems to think that physicists apply this principle blindly, and he complains that Kirchhoff's law has become "an excessively dangerous guide" since "it can only have reference to calorific rays," and "the luminosity of a gas does not necessarily depend upon temperature, but more often upon a *luminescence* which is independent of temperature and results directly from chemical or electrical phenomena in the luminous gas," and yet "the great majority of astronomers have never taken this sufficiently seriously." So he both uses and abuses the Doppler principle when giving an account of how the solar rotation is evidenced in the region of the reversing layer by the displacement of lines at the east and west limbs. These displacements are small and often very discordant, so he mentions four reasons that are usually accepted as explaining this, but urges most strongly a fifth of his own: "It seems due also to a *tenacious prejudice* that all the rays of the reversing layer ought to give the same rotation, and if they do not in fact do so, their mean will correspond to the real rotation."

Therefore, in accordance with this fifth reason, the author feels justified in dismissing observations of great weight, and accepting observations which the astronomers who made them deemed of little weight (as being few in number or made under bad conditions), because the former did not, and the latter did agree with what his theory set forth as to what the solar rotation should be. So he puts on one side the work done by Hastings, Young or Langley, and asserts that the measurement of spectral displacements only became of importance when Crew, in 1888, found from 10 chromospheric rays a slight polar acceleration instead of the polar retardation found by Carrington from sun-spots. But Brester complains that though Crew's measures were obviously insufficient and his conclusion carried no weight with solar astronomers, yet "this conclusion responded so well to my ideas, that I at once made it a principal foundation of my theory."

That is indeed the author's test of observation; on the plea of *tenacious prejudice* on the part of astronomers, a bad observation is admitted if it agrees with his ideas, a good observation incontinently rejected if it does not. In such a fashion he judges Dunér, Halm, and especially Adams. The latter's work published in 1907 Brester dismisses as of no account; that published in 1908, he declares, "gave a definitive solution to the problem," for the displacement of the H_α ray proved "that the rotation of the hydrogen atmosphere is precisely, as I had already described it in 1892, that is to say uniformly without polar retardation." In 1906–1907, also, Adams used 20 lines the displacement of which east and west were measured at 12 different latitudes, and, to Brester's indignation, he took the mean of these 20 lines in order to determine the variation of rotation with latitude, because their mean showed a polar retardation similar to that shown for the iron lines by Dunér. Still worse, Adams re-measured them in 1908, and in the case of the iron line 4291, which had previously given an *acceleration* of 0°·54 for latitudes 60°-80°, he now found a *retardation* of 1°·11,

Yet, Dr. Brester says, Adams considers the 1908 observations as "probably better" than those of 1907. Indeed, the author shows so little appreciation of the conditions of measurement that he does not perceive that so close to the solar poles, the accidental errors are so large in measurement that any such differences are negligible.

Such criticism as Dr. Brester makes of Adams's spectroscopic work may perhaps be dismissed as due to invincible obscurantism. Not so his habit of selecting only the observations which suit his theory, and ignoring in that connexion any that do not accord with it, even though these latter may be the special feature of the paper the authority of which he quotes. For example, in his section on the tranquillity of the reversing layer, he cites in proof of this a paper by Prof. Newall in the Monthly Notices of the Royal Astronomical Society for January 1907, that "*during the summer of 1906, which was a time of great solar activity, Newall and Hubrecht observed minutely the solar spectrum especially to try to discover any sign of movement; but they found not the smallest indication*" [the italics are Dr. Brester's]; "and it is therefore evident that the reversing layer, even during the period of spot maximum, is never traversed by such terrible radial currents as the partisans of the hypothesis of solar eruptions have always supposed." But the very point of this paper of Prof. Newall's was to emphasise that the year 1906 was abnormal in being quiet, since at the corresponding period of solar activity eleven years previously in 1895, the radial movements were very violent, as is usual at sunspot maximum.

Again and again, if we consult the authorities that Dr. Brester quotes, we find that he adopts this line of treatment: he suppresses all evidence that goes against his theory, and wrenches from its context anything that might, if isolated, appear to confirm it. One other example may suffice. On p. 143 he cites a note in the Journal of the British Astronomical Association for November 1916 by Prof. Eddington on "The Radiative Equilibrium of the Stars" to show "that it is wrong what every astronomer thought until quite recently, that convective currents are necessary to convey the heat from the centre to the surface." This is but a minor point in Prof. Eddington's work (though he does not affirm that convective currents play no part anywhere on the sun), but his main theme was that radiation-pressure plays a fundamental part in maintaining the radiative equilibrium of the sun and stars. Of this main theme, Dr. Brester makes no mention at all until p. 158, when he says we know of two forces which can have the effect of opposing gravity (where this is not great) at the sun's surface: (1) the pressure of radiation, and (2) the pressure of electrons continually projected from the whole solar surface. It is the second, his *electro-luminescent* theory, to which he continually returns during the remainder of the volume, and by this he explains the prominences, quiescent or eruptive, and the corona. The first he ignores except by a single phrase, "an impossible effect of radiation-pressure," on p. 233.

Dr. Brester read much: his Index Bibliographique occupies nearly fifty pages; but the above are samples of how he treats his authorities. In his reasoning on evidence, he is not even consistent with himself. He defines a facula as a blister, and a spot as the bursting of this blister; to explain the east over west predominance of sunspots, he assumes that all faculæ burst on their preceding side (p. 188); to explain the fact that magnetic storms occur as a rule after the spots with which they are connected have passed the central meridian, he assumes that all faculæ burst on their following side (p. 210).

After all, astronomers are right in working for posterity, since it is by the verdict of posterity that any theory stands or falls.

Rapid Air Surveys.

Aerial Surveying by Rapid Methods. By Prof. Bennett Melvill Jones and Major J. C. Griffiths. Pp. xvi+159+26 plates. (Cambridge: At the University Press, 1925.) 16*s.* net.

IN the course of the operations during the War in Palestine, it was found that a very practicable method of making maps was to take a series of air-photographs in long, straight strips, forming a framework of triangles, or other figures; the detail inside these strips of photographs being filled in by photographs taken in parallel flights, so close together that the photographs overlapped. In this system, instead of having three or four points on each photograph, of which the relative positions were accurately fixed, it was possible to work from points fixed at very wide intervals; instead of having four fixed points a square mile, let us say, it was possible to construct a very fairly accurate map with three or four fixed points in a hundred square miles, or even less. It was on this system that the map of Palestine was built up on the scale of 1 : 40,000.

The experience gained by Capt. Hamshaw Thomas, in making this flying map of Palestine, seemed to be applicable to civil uses, and the problem was taken up at Cambridge by Prof. Melvill Jones and the late Major J. C. Griffiths. The piloting was throughout in the hands of Flight-Lieutenant F. H. Coleman, Flying-Officer C. E. H. Allan, and Flight-Lieutenant D. L. Blackford. Those carrying out the experiments were always in close touch with Capt. Thomas. The investigations

were commenced in the autumn of 1920, and by the spring of 1923 enough had been done to justify the publication of the results and conclusions. Prof. Melvill Jones and Major Griffiths collaborated in the preparation of the book under review, but, alas! in October 1923, Major Griffiths was accidentally killed whilst flying at Coventry, and it has remained for Prof. Melvill Jones to complete the book alone.

The essence of the method described is the flying in straight courses, at a uniform height above ground, with wings level. Pioneer investigations of this kind must have a beginning, and the choice of the fairly flat country near Cambridge as a site for the experiments was a very wise one. It was certainly not desirable to complicate the problems involved by experimenting in a mountainous region. For it was not only desired to ascertain what accuracy could be reached, but also to examine into the character of the errors involved in the process, and to determine what kind of training was necessary—for the success of the method chiefly depends upon the pilot.

In the flying, one of the chief necessities is to cover the ground with photographs without any gaps, and the best way to effect this is to take the photographs during a series of parallel, straight flights. The book describes very clearly the difficulties that are met with in trying to accomplish this; not the least being the effect of horizontal acceleration in altering the pilot's estimation of the vertical. Then we have the necessity of flying over selected lines, the effect of the roll of the aeroplane, and so on. The method actually used was that the pilot "should bring his aeroplane accurately over a given point at the start of the photographic flight and, henceforward, proceed in the required direction by compass . . . without reference to the ground." It is abundantly clear that only specially trained men are likely to be successful.

As to the making of the map, the photographs are uncorrected, and are fitted together by an ingenious system which is fully described. The height of the aeroplane was usually about 10,000 feet above the ground; if local differences in level do not greatly exceed one-twentieth of the height of the aeroplane—say 500 feet in this case—the map is not seriously affected. Photographs were taken for these experiments over the Bedford level, and the tilt, azimuth, and height were determined, in order to study the elements of error. A series of most interesting diagrams is given, showing in eleven cases the actual plan of the track, the variations in azimuth of the aeroplane, its fore-and-aft and lateral tilts, and its variations in height. The net result is that it is possible to fly an aeroplane so that the tilt shall seldom exceed 2°, whilst the height seldom varies more than 100 feet from the mean value. The lens usually employed in the camera had a focal length of 6 inches, so that the scale of the photographs was about 1 : 20,000. Attached to the book is the resulting "mosaic" of 225 square miles on the reduced scale of 1·53 inches to 1 mile. As to the errors of the mosaic, a ten-mile square mosaic, of flattish country, should not show positional errors, when "fitted" to an accurate map, of more than a hundred yards.

A long chapter deals with navigational mapping and the joining up of mosaics. There are also excellent chapters on equipment and training, and useful mathematical appendices. It is an indispensable book for those interested in the subject of air survey.

C. F. C.

The Aborigines of Central and North Australia.

The Australian Aboriginal. By Dr. Herbert Basedow. Pp. xx+422+56 plates. (Adelaide: F. W. Preece and Sons, 1925.) 30*s*.

DR. H. BASEDOW has had exceptional opportunities for studying the mode of life and the customs of the aborigines of Australia, since in the exercise of his duties as State Geologist, and later as Chief Medical Officer and Chief Protector of the Aborigines for the Commonwealth Government in the Northern Territory, he has travelled widely and come into intimate contact with the natives. He has published a few papers on the anthropology of the Australians, and now presents us with a more comprehensive account of his observations on the natives, mainly of those of the Northern Territory. For reasons which he states in the preface, he has not consulted the previous literature, and thus he goes over ground which has been well covered by Spencer and Gillen in "Native Tribes of Central Australia" and "Across Australia," and by Spencer in "Native Tribes of Northern Territory." The reader therefore has to compare these four volumes in order to see where they agree and where differences occur, and in the latter case he will have to make up his own mind which is the better version.

The volume affords an excellent general survey of the ordinary life of the native, and where necessary the differences between various tribes are pointed out. The racial characteristics are dealt with fairly fully, but no measurements are given. The chapter on the "Likely Origin of the Australian Aboriginal" is by no means so satisfactory. The accounts of various mutilations and other subjects which would appeal to a medical observer are of value. The section dealing with social organisation is weak and of no interest to a student, and that on language is not much better;

the author does not appear to be acquainted with the work of Pater W. Schmidt.

There are some valuable suggestions in the chapter on religious ideas. Although phallic emblems have been found in various parts of Australia, the author claims that he was the first to observe ceremonies connected therewith. He says:

"One often reads, and I was under the same impression myself until I became better acquainted with the tribes, that the Australian natives do not connect the knowledge of conception with any intercourse which might have taken place between the sexes. This I find is not altogether correct, although usually the younger people are kept in complete ignorance of the subject. No doubt strangers are treated similarly when they put any pertinent questions to the old men on matters of sex. The old men believe in the duality of human creation, the spiritual and the material; sexuality is regarded as the stimulus of corporeal reproduction, but the spirit quantity is derived through mystic and abstract influences controlled by a 'totem'-spirit or Knaninja" (pp. 284-5).

Carveth Read says: "So far as ignorance exists, it is due to repression by opposing doctrines and desires" (Journ. Roy. Anthrop. Inst., 1918), and the psycho-analytic view has recently been stated by Roheim in "Australian Totemism." The author gives some information about the manufacture of stone implements.

The best chapter in the work is that on aboriginal art, in which the author gives numerous illustrations and elucidates the meanings of the designs; it will be seen by comparing these with the explanations given by Sir Baldwin Spencer that the same design may have several interpretations. The book is well illustrated, and it will have a lasting value as a record of the investigations of an independent observer. A. C. H.

The Mystery of Rhythm.

What is Rhythm? An Essay. By Prof. E. A. Sonnenschein. Accompanied by an Appendix on Experimental Syllable-Measurement, in which Stephen Jones and Eileen Macleod have co-operated. Pp. viii+228. (Oxford: Basil Blackwell, 1925.) 10*s.* 6*d.* net.

PROF. SONNENSCHEIN has made a substantial contribution to the subject of rhythm. There are very few persons who could have written this book, which shows a scholarly familiarity with the verse of many languages, with music, with phonetics, and with psychology.

In Chap. i. Prof. Sonnenschein leads up to a definition of rhythm by way of a discussion of the definitions offered by his forerunners—a discussion which brings home to the reader how necessary it is in all branches of exact knowledge to define our terms, if we are to avoid confusion of thought. Not a few controversies have arisen through a want of clearness, or from ambiguity in the essential terms used in the debate itself. Prof. Sonnenschein's definition is a development and, as we think, an improvement of that of the Greeks; it reads:

"Rhythm is that property of a sequence of events in time which produces on the mind of the observer the impression of proportion between the durations of the several events or groups of events of which the sequence is composed."

This is comprehensive; and it stands the "pragmatic test" when applied to various manifestations of rhythm dealt with in the subsequent chapters—rhythm in music, in isosyllabic verse, in Greek, Latin, French, and English verse. In all these fields Prof. Sonnenschein shows a wealth of learning and a minute acquaintance with previous research which commands the respect of the reader.

In his treatment of English verse the author strikes out on original lines; but a pleasing feature of his writing is its urbanity of tone.

The "war of the prosodists" has become a by-word: Prof. Sonnenschein, however, in differing from Dr. W. Thomson, Prof. Saintsbury, and the Poet Laureate, does so with moderation and courtesy. The most original and distinctive feature of his theory of English verse is that it is based on experimental observations, for he has measured the actual durations of the vowel sounds and of the consonantal sounds in hundredths of a second by means of the well-known physiological recording instrument, the kymograph. In this research Prof. Sonnenschein has been helped by the Superintendent of the Phonetics Laboratory at University College, London.

The results are summarised in Chap. viii.—"Syllable Measurement in English"—where we find simple and intelligible rules of quantity in English syllables based on the distinction between the relatively short and the relatively long, and analogous to the rules of quantity with which every schoolboy ought to be familiar in his Greek and Latin. Phoneticians and prosodists alike will have to study these experimental results, since they place the whole matter on an objective and statistical basis.

A shorter if less exact definition given is—"Rhythm is a recurrence of similar phenomena at regular intervals of time." This excellent "working" definition rules out of court the so-called "irregular" rhythms, which are, strictly speaking, contradictions in terms.

We venture to think that this treatise would have been made still more interesting and "popular" in the best sense of the word if, in an introductory chapter, the author had alluded to some of the rhythms in

Nature—the rhythms of the heavenly bodies, and the rhythms of the earthly. Rhythm rules in the interstellar spaces, rhythm throbs through living beings. A study of these cosmic and vital rhythms, respectively, teaches us that the absolute time-interval between the "events" is not of the essence of rhythmicality; for there is as true a rhythm in the return of a comet or the repetition of an eclipse, which involves years, as there is in the rhythm of the beating heart where, between successive systoles, there are only a few fractions of a second.

There is much to interest the psychologist in Prof. Sonnenschein's treatise; while the physiologist can learn something in it about the physics of speech. It would not be true to say that this book is easy to read; no work involving so much detail about a not very familiar subject could possibly be easy to read: but it is an enduring monument to the patience, the scholarship, and the fine appreciation of music and poetry on the part of the former professor of Greek and Latin in the University of Birmingham.

D. FRASER HARRIS.

Our Bookshelf.

(1) *Fishes.* By David Starr Jordan. Revised edition. Pp. xv+773+18 plates. (New York and London: D. Appleton and Co., 1925.) 30*s.* net.

(2) *The Fishes of the British Isles, both Fresh Water and Salt.* By Dr. J. Travis Jenkins. (Wayside and Woodland Series.) Pp. vii+376+143 plates. (London and New York: Frederick Warne and Co., Ltd., 1925.) 12*s.* 6*d.* net.

(1) D. JORDAN'S book on fishes, in two volumes, issued in 1904, was reviewed in NATURE soon after it appeared (vol. 72, p. 625, October 26, 1905). The present work, in one volume, does not call for an extended notice, as it differs from the former one only in the omission of certain chapters or sections of chapters. Of the thirty-five chapters in the first volume of the 1904 edition, eighteen have been left out entirely, and parts of four others; but nearly the whole of the second volume is retained. The book has evidently been reprinted from standing type and to describe it as a revised edition is misleading. There is one new paragraph (p. 184) inserted because the fitting together of parts of two chapters of the original book left a space that had to be filled; this paragraph refers to the recent discovery of a rudimentary sixth gill-arch in Heterodontus, and includes the statement that "the presence of five species in the Squalidae perhaps indicates affinity with Heterodontus"; here "five species" should obviously be "fin-spines."

(2) There is no modern work on British fishes, and Dr. Jenkins has attempted to supply this need by producing what is described as a handy pocket volume, dealing with the characteristics and habits of British fishes, both fresh-water and salt. The book is illustrated by so many as 143 plates, nearly half of which are coloured; most of the coloured representations of marine fish are reproduced from Smitt's "Scandinavian Fishes," and most of those of the fresh-water species from Grote, Vogt and Hofer's "Fresh-water Fishes of Central Europe." A number of the uncoloured figures are taken from Day's "Fishes of Great Britain and Ireland"; some of these are good and some rather poor, for although all the plates in this work were inscribed as drawn by Day, he employed two lithographers, one of whom was far superior to the other.

With the aid of the illustrations, and of the short diagnoses given by the author, the owner of Dr. Jenkins's book should be able to identify any fish he is likely to catch in British waters; having done so, he will find a certain amount of information about it, which may or may not include what he wants to know, as the treatment of the different species is rather unequal. In general it is the important food-fishes, such as the herring, cod, and plaice, that are most fully dealt with, and it is in his account of these that the author is most convincing.

The classification is nearly that of Günther's Catalogue; it is a little surprising to find a modern work on fishes beginning with the perch and ending with the Chimæridæ: these, we are told, "connect the cartilaginous fishes (Sharks and Rays) with the Ganoids (Sturgeons)." Even in the arrangement of the species there is often no regard to relationships; for example, the coal-fish and pollack are separated by the whiting, and the skate and the long-nosed skate by the bottle-nosed ray. This is, in our opinion, the most serious defect of the book. C. T. R.

Reports of the Progress of Applied Chemistry. Issued by the Society of Chemical Industry. Vol. 9, 1924. Pp. 700. (London: Society of Chemical Industry, 1925.) 7*s.* 6*d.*; to non-members, 12*s.* 6*d.*

THE ninth volume of these reports follows closely on the lines of preceding issues; it contains eighty more pages than the report for 1923; a report on the non-ferrous metals is not included, but that on photographic materials and processes makes a welcome reappearance. The occurrence of such slight changes suggests that, on occasion, nothing is lost by making a report cover a longer period than one year: space is saved, and the writer has a better chance to delineate the wood as well as the trees. Although the mass of material dealt with in each report is always great, the actual progress achieved is by no means always proportionate. In reading these reports, one is struck by the prodigious activity of those who are working to harness chemistry to industrial uses—in the present report, well over 3000 names appear in the name-index—and for this reason it is obviously impossible to give more than a cursory survey of most of the subjects treated. If the present increase in output continues, the annual volume will soon become unwieldy, and something in the nature of a quinquennial revaluation and digest will be called for; but the work of condensation would not be easy, as writers of the calibre of Hazlitt (who condensed seven volumes of Tucker's "Light of Nature Pursued" into one) are not common in the chemical profession. On the whole, it would appear better to issue such summaries in the form of monographs—a practice which has found favour in Germany.

No serious student of chemical technology can fail

to be interested in one or more of these excellent reports, the diversity in length of which varies far more than their merits. The report on plant and machinery is usually the least meritorious, mainly because sketches and diagrams are always omitted. This year the reporter has succeeded in infusing some life into the subject, although in doing so he has had to go a little outside his proper ambit. Among the subjects of up-to-date and general interest treated in the other reports are: low-temperature carbonisation, nitrogen-fixation (discussed by four writers), insecticides (a new and valuable feature), vitamins, preservatives in food-stuffs, and kinematography. Misspelt words are rather more numerous than one would expect in a work of this standing (*e.g.* "contributions" in lieu of "contributors" on the page facing the Contents, "molton," p. 57, "ashphalt," p. 99, "napthalene," p. 108); the use or non-use of hyphens is somewhat erratic (*e.g.* "cheap zinc blende acid," p. 180); and future issues might well include a list of the full titles of the journals referred to in the text, as some of them are little known and difficult to obtain.

Thamyris: or, Is there a Future for Poetry? By R. C. Trevelyan. (To-day and To-morrow Series.) Pp. v+89. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co., n.d.) 2*s.* 6*d.*

MR. TREVELYAN has written a careful and penetrating study of the present position of poetry, and of its possible—he is too hesitant to justify the word probable—development in the future. Superficially, the prospect is not hopeful. The dissociation of poetry from music and intonation, and the fact that poetry uttered to-day is spoken, not sung, coupled with the further fact that it is usually not uttered at all but silently read, cannot but have the effect of impairing the force of its emotional and purely sensuous appeal. The growth of the scientific habit of mind, expressing itself in prose as its appropriate medium, and the competition of the cinemas and broadcasting, are further influences tending to the supersession of poetry as the normal method of emotional communication between man and man.

At the same time, Mr. Trevelyan contends, poetry fulfils a function, which, so long as the heart of man remains fundamentally unchanged, will lead him still to find the satisfaction of certain ideal and imaginative needs in poetry, whatever may happen to his head. As opposed to prose, which depends for its significance primarily upon the intellectual content of the matter communicated, the value of poetry resides in the beauty of the medium itself, so that if poetry were proscribed by Act of Parliament, we should find ourselves trying to make shift with a clumsy substitute for it in the form of rhythmical prose.

The danger to poetry, which, driven off the popular stage by music, hurry, and the cinema, is forced to make its appeal to the cultured and leisured few, is that it should become precious and obscure, seeking in far-fetched allusiveness and merely verbal nicety to compensate for its divorce from the flowing stream of popular life. This danger, already manifest to-day, is likely to grow in the future, unless poets can find a new source of inspiration in the changing needs and interests of the time and the new aspects of the world revealed by modern science.

Industrial Poisons in the United States. By Prof. Alice Hamilton. Pp. x+590. (New York: The Macmillan Co., 1925.) 21*s.* net.

DR. HAMILTON writes with the authority which comes from great experience of diseases arising from the manufacture and use of poisonous substances, and it is satisfactory to learn from her that, on the whole, the incidence of such diseases is diminishing.

More than one-third of the book is devoted to lead poisoning; a good account is given of the industrial processes in which this hazard is experienced, the toxic symptoms are fully discussed, and the numerous controversial points are stated fairly and reasonably. The other inorganic poisons are dealt with similarly, and it is interesting to note that most of the modern industries have brought in their train new problems of this kind. Thus the alloys required for special steels have introduced manganese and vanadium poisoning, and the Mond nickel process has led to poisoning cases with nickel carbonyl.

Both in Great Britain and the United States the development of the fine chemical industry has brought the industrial physician into contact with new problems due to the toxicity of raw materials and intermediates used in producing dyes and explosives, and if the chemist is to help him in solving these, it is important that they should understand each other. Dr. Hamilton, unlike many of her medical colleagues, is reasonably familiar with chemical processes; rarely does she fail to use the tribal language of the chemist accurately, and she always translates factory slang into English. Even the academic chemist can, therefore, read this work with pleasure and profit, and if he is inclined to assist in biological and pathological investigations, he will find many problems suggested to him in its pages.

The author refers so constantly to European, and especially to British literature on this subject, that the book might well have been called "Industrial Poisons" without the geographical limitation implied in its present title. The one exceptional substance is "wood spirit," which is probably an industrial poison only in the United States, and that for peculiar and well-understood reasons. T. A. H.

Ionisation et résonance des gaz et des vapeurs. Par Dr. Léon Bloch. (Recueil des Conférences-Rapports de documentation sur la Physique. Vol. 11, 2e Série. Édité par la Société *Journal de Physique*.) Pp. 223. (Paris: Les Presses universitaires de France, 1925.) 25 francs.

IN few subjects is the difficulty of interpretation of the experimental evidence greater than in that which deals with the resonance and ionisation potentials of gases. It is, however, of such importance to the theory of atomic structure that a clear and critical survey of its present stage of development is to be welcomed. Such an account is to be found in the volume under notice. Prof. Bloch is well aware of the many pitfalls which beset the path of the experimenter and of the danger of too much speculation on too slender an experimental basis. He insists, again and again, on the fact that, without spectroscopic confirmation, the interpretation of the electrical measurements must always be somewhat uncertain.

The early chapters deal with the experimental

technique and the measurements of monatomic gases and vapours. It is here that the greatest success has been achieved in the association of critical potentials with the single line, double line, arc and spark spectra. Of particular interest is the evidence for the existence of atoms in metastable states. The possibility of a change from one state to another slightly less stable is likely to prove one of the most helpful ideas in the interpretation of both critical potentials and spectra. The diatomic gases present a much more difficult problem, as these molecules may dissociate or be disturbed in so many different ways.

The final chapters deal with the photoelectric effect and the statistical equilibrium between atoms, electrons, and radiation. The author points out the ever-increasing importance of the Wilson track photographs in this field. This volume, which forms the eleventh of the series of monographs issued under the auspices of La Société *Journal de Physique*, fully maintains the high standard set by its predecessors.

Forme della terra. Trattato di geologia morfologica (*Geomorfologia*). By Prof. Gaetano Rovereto. Vol. 1: *Basi e generalità*. Pp. xv + 641 + 16 tavole. Vol. 2: *Tipi regionali*. Pp. viii + 645-1188 + 22 tavole. (Milano: Ulrico Hoepli, 1924–25.) 150 lire.

PROF. ROVERETO, of the University of Genoa, has prepared an elaborate and beautifully illustrated text-book of geo-morphology which should be of wide service to geologists and geographers, owing to its authoritative account of the physical geology of Italy, its copious bibliographies thereon, and its clear explanation of Italian geological terminology. It also includes a wide selection of references to the cosmopolitan literature on the subject. As might be expected from the previous contributions of the author, the volume draws many illustrations from South America, and the section on mountain structure, which is illustrated by an instructive map of the tectonic divisions of Italy, is of especial interest.

The first volume deals with the general principles and processes of physical geology, and the second describes the chief regional types due to them, including coast lands, volcanic regions, glaciated areas, karsts and deserts, plains and mountains. The classifications adopted are in many cases more artificial and elaborate than those used by British geographers, but the book should be the standard authority in Italy, and elsewhere a convenient work of reference to recent work on the exceptionally interesting geography of the Italian peninsula.

The Vegetation of Burma from an Ecological Standpoint. By Prof. L. Dudley Stamp. (University of Rangoon Research Monographs, No. 1.) Pp. vi + 65 + 28 plates. (Calcutta: Thacker, Spink and Co., 1925.) 7 rupees.

THIS is one of the first presentations of a study of the vegetation of a British tropical dependency, based on present-day ecological methods. The author, in collaboration with Mr. Leslie Lord, has already given a more detailed study entitled "Part of the Riverine Tract of Burma." The present work shows this area in relation to the rest of the country and provides a general review of the distribution of the vegetation and its controlling factors. Of these, the chief are elevation, climate, and geology and soil. A brief discussion is given of the effect of each of these, after which the author enumerates, with brief descriptions, the main types of vegetation and their natural relationships. These types are classed under mountain vegetation with six types and lowland vegetation with twenty-five types. Four seral medial stages are also noted. The inter-relationships of the types are graphically indicated in tabular form, where it is clearly seen that with a very high rainfall soil has little effect, but with a rainfall of 40 inches and less its influence is paramount. The discussion on geology and soils is in more detail, and the general relationship of geology and ecology is discussed and summarised in the concluding chapter. The book is accompanied by several maps reproduced as text figures, and is profusely illustrated with photographs of the various types of vegetation discussed.

An Introduction to Economic Geography. By Wellington D. Jones and Derwent S. Whittlesey. Vol. 1: *Natural Environment as related to Economic Life*. Pp. xxxvii + 375 + 225 plates + 7 maps. (Chicago: University of Chicago Press; London: Cambridge University Press, 1925.) 5 dollars.

IN spite of its large size, this book covers only a small part of economic geography. It claims to deal in outline with the several factors of the natural environment as they affect human life. A second volume is to treat of the chief economic activities in relation to natural environment. The plan of the book is novel. In the first part a number of exercises are set which the student is to work out by reference to the "textual materials" in the second part and the illustrations and maps in the third part. Atlases, topographic maps of the United States, and outline maps are also to be used. The textual materials are short paragraphs and extracts from authoritative works dealing with different aspects of the subject. The exercises are well planned, and the paragraphs in Part 2 are accurate and fairly representative, and the book may be regarded as a useful introduction to the subject. Examples are mainly drawn from America. Illustrations and maps are clear and well chosen, and a full index is provided.

Block Diagrams and other Graphic Methods used in Geology and Geography. By Prof. A. K. Lobeck. Pp. xi + 206. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924.) 22*s*. 6*d*. net.

THE value of block diagrams in geographical and geological instruction cannot be questioned, but many teachers find these difficult to draw, especially on the blackboard, at short notice. Prof. Lobeck has written a volume that should prove most helpful and deserves to be widely known. By the help of several hundred diagrams and sketch maps, he explains the value of perspective and the construction of diagrams from maps and illustrations. Examples of various land forms are given, and it would be a dull teacher who fails to gain something advantageous from a study of the pages. Later chapters deal with isometric diagrams, sketching from photographs, and crystal drawing. Each step in the development of the art has a number of instructive practice exercises.

Letters to the Editor.

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

An Early Reference to Mendel's Work.

THE rediscovery of Mendel's classic "Versuche über Pflanzen-Hybriden" must undoubtedly be attributed to the references made to it by Focke in his "Pflanzenmischlinge" (Berlin, 1881). As Dr. Iltis points out in his recent life of Mendel, the fresh movement towards crossing experiments at the end of last century inevitably sent workers to the "Pflanzenmischlinge," where, unless they were either hasty or careless, they could scarcely fail to come across one or more of the half-dozen references to Mendel's name. But how came Focke to light upon a paper which was so securely buried? Apparently Dr. Iltis propounded this question to Focke himself, who replied that he had come across it in the literature of 1870, but could not then say where. ("Auf Mendels Arbeit bin ich durch die Literatur der 70er Jahre aufmerksam geworden, kann aber nicht sagen, wo ich sie erwähnt gefunden habe"—Iltis' "Life of Mendel," p. 204).

I wish to suggest that the reference which escaped Focke's memory is to be found in H. Hoffmann's "Untersuchungen zur Bestimmung des Werthes von Species und Varietät," Giessen, 1869. On p. 136 of this work Hoffmann refers to Mendel's "sexjährige Beobachtungen," though for him the point of most interest appears to have been the evidence that Pisum is generally self-fertilised. Mendel's results are dismissed in the brief sentence "Hybride besitzen die Neigung, in den folgenden Generationen in die Stammarten zurückzuschlagen." Prof. Hoffmann was evidently looking for something else.

It is worthy of note that he makes no mention of Mendel's experiments with Phaseolus, though a considerable part of his essay is taken up with his own experiments in growing and crossing different forms of this genus. These experiments of Hoffmann are discussed by Darwin in his "Cross- and Self-Fertilization" (2nd edition, 5th impression, p. 151), so that Darwin must have had in his hands a brochure which contained a reference to Mendel's work only four years after its publication. R. C. PUNNETT.

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Valence Theories and the Magnetic Properties of Complex Salts.

NATURE of September 5, containing the letter of one of us and the courteous criticisms of Dr. Jackson, reached the library of the Institute at the very time that we were engaged in a task suggested in Dr. Jackson's note. When writing on July 23, we were of the belief that it would be impossible to explain magnetic anomalies in complex salts until detailed information should become available regarding the orientations of the orbital planes. It was the explanation given by Oseen [1] of Ingersoll's non-magnetic nickel which suggested to us that the problem might be simpler. It suggested that we need only to consider the *number* of electrons in certain levels associated with the central metal atom, and that we may, for the present purpose, disregard the matter of orientation.

[1] *Zeit. f. Phys.*, 1925, 32, 940.

The Kossel and Lewis-Langmuir valence theories are a guide in determining the number of electrons which the central atom of the complex may obtain from or give to the groups or radicals in the compound. They have been used with success by several investigators to account for the behaviour of complex salts as electrolytes. We have made most use of a paper by Sidgwick,[2] but the reader should consult also the papers of Lowry,[3] Spiers,[4] and Brockman.[5] The ideas of electron sharing, or rather the sharing of orbits, and of electron transfer are explained and illustrated with examples by Sidgwick. Here we shall merely list the number of electrons given to or taken from the central atom by the groups or radicals.

Each NH_3, OH_2, C_2O_4 and $OC(NH_2)_2$ adds 2 electrons, 1 by sharing and 1 by transfer.

The en = $NH_2CH_2CH_2NH_2$

and pn = $NH_2CH_2CHNH_2CH_3$ groups add 4 electrons each.

Each univalent radical CN, NO_2, Cl, SCN, etc., within the complex adds 1 electron by sharing. The same radicals outside of the complex remove 1 electron by transfer. Similarly, the divalent SO_3 and SO_4 each remove 2.

K and Na add one by transfer.

Finally, it can be deduced from the "octet" theory that CO contributes 2 electrons by sharing, and that NO, when it enters the complex, contributes 3, 1 by transfer and 2 by sharing.

We shall now apply this scheme of addition and removal to many of the salts which have been studied magnetically, considering first the diamagnetic salts of iron. The iron, with 26 electrons, in the salts $K_4Fe(CN)_6$, $Na_3Fe(CN)_5NH_3$, $Na_4Fe(CN)_5NO_2$, $Na_2Fe(CN)_5NO$, and $Fe(CO)_5$ acquires 10 more, making 36 in all, and thus corresponds to the diamagnetic, rare gas krypton. The formula for another diamagnetic salt $Na_5Fe(CN)_5SO_3$ does not seem to be correct from our present point of view. From this view-point, also, $Na_3Fe(CN)_5OH_2$ should be diamagnetic. As mentioned in the previous letter we have had trouble with this salt, and some samples have been nearly neutral towards the magnet.

Next, consider the 64 cobalt compounds measured by Rosenbohm.[6] All but two are diamagnetic. The two exceptions are so slightly paramagnetic that the magneton number may be taken to be zero. Disregarding 8 of these cobalt compounds which are, as Rosenbohm remarks, of doubtful composition, we find, in all cases, that the cobalt atom acquires 9 electrons and attains the krypton configuration of 36.

The same investigator measured three salts of ruthenium and two of rhodium. In these the metal atom takes on the configuration of xenon, atomic number 54, since ruthenium obtains 10 electrons and rhodium 9 from the attached groups and atoms. He found the salts of iridium and of quadrivalent platinum to be diamagnetic. Considerations such as the foregoing show that iridium, atomic number 77, and platinum, atomic number 78, acquire 9 and 8 electrons, respectively; thus achieving the configuration of niton with 86 electrons. Two of Rosenbohm's four platinum salts in which the metal appears to be divalent, indicate that 6 electrons are added, giving the configuration of polonium with 84 electrons. We do not care to venture an opinion as to the possibility of the polonium configuration; nor are we informed as to its magnetic properties.

It is interesting to note that $Ni(CO)_4$, which, according to Oxley, is diamagnetic, and $K_3Co(CN)_6$,

[2] Jour. Chem. Soc., Trans., 1923, 123, 725.
[3] *Chem. and Ind.*, 1923, 42, 316.
[4] *Chem. and Ind.*, 1923, 42, 534.
[5] *Chem. and Ind.*, 1924, 43, 756.
[6] *Zeit. f. phys. Chem.*, 1919, 93, 693.

which we found to be diamagnetic, both lead to the configuration of krypton. In concluding this discussion of the diamagnetic salts, it may be mentioned that the nearly diamagnetic substances $KMnO_4$ and $K_2Cr_2O_7$ yield the configuration of argon if each oxygen removes 2 electrons and each potassium adds 1.

A slightly different treatment is required in the case of salts giving magneton numbers which are not zero and are different, very often, from the numbers obtained with the simple salts. Let us assume the existence of stable configurations other than those of the rare gases and let us see how the magneton numbers we may expect agree with the experimental values. Consider the ferric compounds, $K_3Fe(CN)_6$, $Na_2Fe(CN)_5NH_3$, $Na_3Fe(CN)_5NO_2$ and $Na_2Fe(CN)_5OH_2$. In these salts the iron atom acquires 9 electrons. Taking liberties in the distribution of electrons among the levels, we may assign 5 of the 9 to the N level, thus making it complete with 8, and then we shall assign the remaining 4 to the M level, giving us 17 in all in that level. This is exactly as required by the Bohr scheme in divalent copper, and divalent copper shows 9 to 10 magnetons in its simple salts. This is in fair agreement with the magneton numbers we have assigned to most complex ferric salts, considering the uncertainties in our numbers and the still rather large uncertainties about the divalent copper ion.

Rosenbohm made observations on many chromium complex salts and found in general 19 magnetons. The central atom acquires 9 electrons. Assigning 5 to complete the N level of trivalent chromium, we have 4 left to add to the 11 already in the M level. This corresponds to the M level of divalent cobalt. Experimentally, the divalent cobalt ion in simple salts gives 24-25 magnetons, but it is apparently anomalous and we should expect 19, as indicated in Fig. 2 of Sommerfeld's[7] paper, in which this anomaly is noted.

Seven of the nine nickel salts measured by Rosenbohm gave about 16 magnetons. The nickel atom obtains 10 electrons, which, added to its own 28, give the 38 corresponding to strontium. We have no magnetic data for strontium, but it is fair to infer that it is analogous to neutral calcium, which has been assigned 2 Bohr magnetons or 14·1 Weiss magnetons by Sommerfeld.

The copper salts of Rosenbohm gave 9 magnetons, and, according to the scheme proposed in this letter, the central atom gains 6 electrons. It will correspond to bromine of atomic number 35. Taking, again, the liberty of first filling up the N level with 8 electrons, we find 17 in the M level, as we do in simple divalent copper ion with its 9 magnetons.

It seems, then, that the chromium, nickel, and copper atoms can be just as "abnormal" in their complex salts as are those of iron, cobalt, and the others we have considered. The fact that we find in complex salts of chromium, nickel, and copper the same magneton numbers as in the simple salts, is due to the peculiarities or, perhaps better, to the orderliness of atomic structure and of the periodic system.

It is evident, if the assumptions which have been made can be maintained, that we have not only a solution of the problem of magnetic anomalies in complex salts, but also quantitative support for certain current theories of chemical valence.

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OSKAR BAUDISCH.

Rockefeller Institute for Medical Research,
New York, September 17.

[7] *Zeit. f. Phys.*, 1923, 19, 221.

Carnot's Cycle and the Efficiency of Heat Engines.

IN a paper on Carnot's Cycle and the Efficiency of Heat Engines, reported in NATURE, August 29, Dr. J. S. Haldane comes to the astonishing conclusion that "the Carnot cycle is radically inefficient" and gives a cycle of operations which has convinced him that the maximum efficiency of a heat engine is 50 per cent. Prof. A. W. Porter has already dealt with this claim in its more general aspects (NATURE, October 3), but it may be of interest to calculate directly the efficiency of Haldane's cycle and compare it with that of a Carnot cycle working between the same temperature limits.

Dr. Haldane takes a cylinder containing water and some aqueous vapour at the pressure corresponding to its temperature T_1 and carries out a cycle of operations consisting of three stages. (1) The temperature is raised to T_2 while the volume is kept constant. (2) The system is allowed to expand

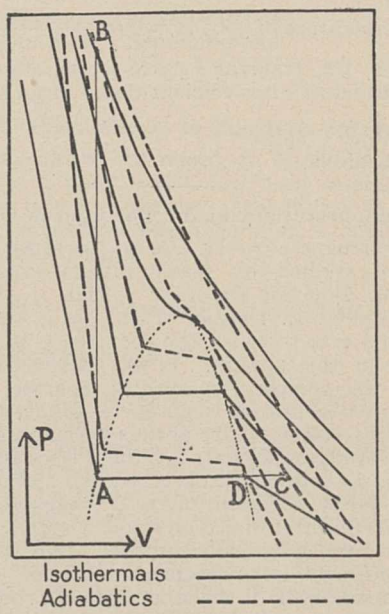

FIG. 1.

adiabatically until the pressure has fallen to the original pressure p_1. (3) It is brought into its original state by means only vaguely specified.

The nature of this cycle of operations will be gathered from Fig. 1.

With such a liquid-vapour system, a number of different cases are possible depending on the relative proportions of liquid and vapour, and on the temperature difference. We shall take a case ($ABCD$) in which complications in the calculation are reduced to a minimum.

We have then the following heat and work terms in the various stages:

(1) AB. Heat absorbed $\int_{T_1}^{T_2} C_v dT$. No work done.

(2) BC. Adiabatic expansion. Work done A. No heat absorbed.

(3) CD. Combination of infinitesimal isothermal and adiabatic stages. Heat absorbed $q = \int C_T^s dT$. Work done $-p_1\Delta' v$.

(4) DA. Isothermal condensation of vapour. Work done $-p_1\Delta'' v$. Heat absorbed $-L$. (L = latent heat of vaporisation of liquid at T_1.)

Equating the sum of the heat and work terms for the whole cycle to zero, we have :

$$\int_{T_1}^{T_2} C_v dT - L + q - (A - p_1\Delta' v - p_1\Delta'' v) = 0.$$

The "efficiency" of the cycle in Dr. Haldane's reckoning, *i.e.* the ratio of the work obtained in the whole cycle to the heat absorbed in stage (1), is

$$E = \frac{A - p_1\Delta v' - p_1\Delta v''}{\int_{T_1}^{T_2} C_v dT} = 1 - \frac{L}{\int_{T_1}^{T_2} C_v dT} + \frac{q}{\int_{T_1}^{T_2} C_v dT}.$$

Neglecting the third term, we have, to a first approximation,

$$E = 1 - \frac{L}{C_v(T_2 - T_1)}.$$

For water L is of the order of 540 calories per gram, C_v about 1 cal., therefore a temperature difference of about 1000° would be required for 50 per cent efficiency. The efficiency of a Carnot cycle working between the same temperature difference, for a cold body temperature of 300° K, would be $\frac{1300 - 300}{1300} = 77$ per cent. Dr. Haldane's cycle is therefore, in this case, considerably less efficient than Carnot's.

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Hermaphroditism in the Portuguese Oyster.

THE Portuguese oyster, *Ostrea* (*Gryphæa*) *angulata*, has been studied by many investigators, among others M. Bouchon-Brandley (1882), J. A. Ryder (1882), and J. L. Dantan (1912, 1914, 1918), but no one has ever recorded the occurrence of hermaphroditism in this species. It was believed that the sexes in this species were strictly separate, although other forms of Ostrea, such as *O. edulis*, *O. lurida*, and *O. denselamellosa*, are always hermaphroditic.

While studying oysters at the Plymouth Marine Biological Laboratory, I observed two hermaphrodite individuals in a batch of 75 Portuguese oysters, which were sent from Whitstable Oysterage, where they had been relaid and cultured. All the oysters were well-grown, large specimens and were kept alive in the outside tank of the laboratory for some time.

The dates of examination and the distribution of the sexes were as follows :

Date.	♂♂	♀♀	♂♀	
May 29 (1 day after arrival) .	2	9	0	
,, 30 . . .	1	5	0	
June 3 . . .	2	3	0	
,, 12 . . .	2	9	0	
,, 14 (examined by Prof. Awati)	1	9	0	
,, 15 (examined by Prof. Awati)	1	4	0	
July 3 . . .	1	2	1	
,, 16 . . .	4	18	1	
Total . . .	14	59	2	Σ = 75
Ratio per cent. .	18·6	78·6	2·6	

The sex-ratio differs from that observed by Dantan (43·6 per cent. ♂♂, 56·37 per cent. ♀♀) who examined a larger number of individuals. Of course, in the present case the numbers examined are not sufficient to warrant any conclusions being drawn, but the figures are worth noting.

The hermaphrodite specimens were examined whilst fresh under the microscope, and no differences were found in the nature of the eggs and sperm as compared with those taken from normal specimens in which the sexes are separate. The eggs were of the ordinary size and shape, and the sperm exhibited active movement. Sections of the hermaphrodite gonad showed male and female elements in the same tubule. Only mature sperm were present, although eggs were found in all stages of development up to complete maturity ; some of the latter were detached from the germinal layer and lay free in the sperm aggregates.

The diameters (μ) of a few of the eggs were found to be as follows : 73 × 86, 75 × 86, 79 × 79, 83 × 86, those of the nuclei being 23 × 26, 23 × 28, 24 × 28, and 25 × 28 respectively ; so that the size of the egg is nearly the same as that of other dicœcious oysters, and much smaller than that of all the true hermaphrodite forms mentioned above, in which the larger size of the egg is characteristic.

It is also noteworthy that the hermaphrodite specimens were found among animals which had been kept alive in the tank for more than a month, *i.e.* which had endured, so to speak, a prolonged period of starvation.

A parallel example would appear to be that of the American oyster, *O. virginica*, a species in which the sexes are distinct ; however, one hermaphrodite specimen has been recorded (Kellog, 1892). It was obtained from a rearing-batch of oysters at the Woods Hole Marine Laboratory. In view of this, I am inclined to suggest that possibly there exists some relation between nutritive conditions and hermaphroditism in those species of oysters in which the sexes are as a rule separate.

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October 2.

Apparently Anomalous Protection against Oxidation.

IN his address on "Catalysis and Oxidation," printed in NATURE for August 22, Prof. Henry E. Armstrong refers to surface peroxidation of metals as affording protection against further oxidation.

An interesting example of the interference of oxygen with oxidation came to my attention recently. In the course of a technical investigation of the blackening of copper, brass, and bronze in potassium persulphate solutions, it was noticed by my assistant, Mr. J. Schmitt, that when the strip of metal was dropped into the solution it blackened readily and completely. If, however, it was slowly lowered into the solution, at rates up to 14 linear inches per minute, blackening either did not take place or was very patchy and imperfect, generally not more than a tarnish.

E. Groschuff, in a valuable article on the blackening of copper and copper alloys by alkaline persulphate solutions (*Deutsch-Mechan. Zeit.*, 1910, p. 135), notes disturbances coming from oxide layers "which on account of their impermeability prevent the action of the colouring bath," and cites in this connexion the experiments of E. Muller (*Zeit. f. Elektrochem.*, 13, 137 (1907)) on passive copper, but does not note that a disturbing tempering layer may form on freshly cleaned metal if lowered slowly into the alkaline persulphate bath. The interference is still more marked with copper alloys than with pure copper. The solution used for this process is an alkaline solution of potassium persulphate, *e.g.* 1 to 2 per cent.

$K_2S_2O_8$, with 2 to 3 per cent. KOH. The persulphate is hydrolysed, according to the equation

$$K_2S_2O_8 + H_2O = 2KHSO_4 + O. \quad . \quad . \quad (1)$$

The excess alkali neutralises the acid salt and prevents the solution from becoming acid. Investigations on the velocity of decomposition of persulphate solutions (Green and Masson, J.C.S., 1910, 97, 2086; S. E. Sheppard, *Phot. Jour.*, 1921, 61, p. 454; G. I. Higson, J.C.S., 1921, 119, p. 2048) have shown that the reaction is monomolecular with regard to persulphate, so that equation (1) probably represents the course of the reaction, and atomic oxygen is liberated. The initial production of atomic oxygen is in agreement with the oxidation potential of persulphate solutions.

The simplest representation of the blackening of copper by persulphate would be

$$Cu + O \longrightarrow CuO, \quad . \quad . \quad . \quad (2)$$

but this undoubtedly only represents the initial and final results. That a more complex process occurs appears to be indicated by the structure of the oxide layer. This is formed as a soft velvety pile, which is not removed by gentle rubbing, but consolidates to a smooth and semi-lustrous layer. A further refinement of the oxidation process is to suppose that cuprous oxide is first formed; it has already been pointed out that the lattice structure of cuprous oxide is nearer that of copper metal than is that of cupric oxide. Hence we may write

$$Cu_2 + O \longrightarrow Cu_2O + O \longrightarrow 2CuO. \quad . \quad (3)$$

When the metal is slowly lowered into the persulphate solution, it is exposed for a longer time to the air : solution interface. This is the only difference in condition in the two cases. It appeared to me that concentration of molecular oxygen in this layer might be causing the interference. Protection of the surface, as by holding a glass rod against it, while passing the interface, was enough to remove the interference, the protected part blackening normally. Again, if a little antoxidising solution, as hydroquinone-sulphite of soda, were allowed to trickle over the metal just as it entered the persulphate solution, the blackening was of course at first delayed, but soon took place with full vigour. Finally, electrolytic generation of hydrogen at the interface also overcame the interference.

Molecular oxygen is of course accumulating at the interface from the discharge of $O + O \longrightarrow O_2$ produced by the hydrolysis of the persulphate. My tentative explanation of the oxygen interference was that cuprous peroxide is formed :

$$Cu_2O + O_2 \longrightarrow Cu_2O_3, \quad . \quad . \quad . \quad (4)$$

and that this paralyses the reaction, a passive layer being formed.

In line with Mouren's work, it may be possible that both cuprous and cupric peroxides are formed :

$$\begin{aligned} Cu_2O + O_2 &\longrightarrow Cu_2O_3, \\ CuO + O_2 &\longrightarrow CuO_3, \end{aligned} \quad . \quad . \quad . \quad (5)$$

and that these decompose each other, with mutual reduction :

$$Cu_2O_3 + CuO_3 \longrightarrow 3Cu + 3O_2. \quad . \quad . \quad (6)$$

Be that as it may, the facts appear to demonstrate another case of the impedance of oxidation by oxygen.

S. E. SHEPPARD.

Research Laboratory,
Eastman Kodak Company,
Rochester, N.Y., September 25.

The Adult Form of the "Harvest Bug."

THE adult form of the larval mite known as the "Harvest Bug" (*Leptus autumnalis* Shaw), which causes so much annoyance in many rural districts at this time of the year, has long been sought for. In the middle of August, Prof. F. V. Theobald and Mr. C. W. Goode, of Wye, sent me three chickens heavily infested with this larval mite. From these larvæ I have succeeded in rearing an adult mite closely allied to Trombicula, Berlese, and resembling that genus in having a deep constriction behind the anterior pairs of legs, but more elongated in form and with the setæ on the cephalothorax shorter and differently shaped. I propose the name *Trombicula* (*Neotrombicula*) *autumnale* for this adult mite, Neotrombicula being a new subgeneric name. The name Leptus was created by Latreille for *Acarus phalangi* (= *Achorolophus ignotus* Oudmns), now referred to the family Erythræidæ, and should not be used for the "harvest bug," which belongs to the family Trombidiidæ.

S. HIRST.

British Museum (Natural History),
London, S.W.7, September 26.

Gibbs' Phenomenon in Fourier's Integrals.

PROF. CARSLAW has raised, in NATURE of August 29, p. 312, a point which has been interesting me during the past few months. In addition to the case of Fourier's integral which he cites, I have noticed that Hankel's integral

$$f(x) = \int_0^\infty J_\nu(xu)udu \int_0^\infty J_\nu(tu)tf(t)dt,$$

and Titchmarsh's integral [1]

$$f(x) = \int_0^\infty \mathbf{H}_\nu(xu)udu \int_0^\infty Y_\nu(tu)tf(t)dt,$$

where $\mathbf{H}_\nu(z)$ is Struve's function, possess Gibbs' phenomena at points of discontinuity.

This can be shown by a method similar to that given by Prof. Carslaw, using the asymptotic forms for the functions concerned where necessary.

I may add that in the case of Hankel's integral this throws considerable light on the similar problem in the case of Fourier-Bessel series.

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The "Kennelly-Heaviside" Layer.

EVERY radio engineer is familiar with what is called the "Heaviside Layer" and its supposed functions. I find, however, that the hypothesis of an electrically conducting stratum in the upper air was clearly enunciated in an article by Prof. A. E. Kennelly, of Harvard University, published in the *Electrical World and Engineer* of New York on March 15, 1902. The official date of Heaviside's disclosure of his hypothesis is December 19, 1902. About the same date H. Poincaré, A. Blondel, and C. E. Guillaume made similar hypotheses. If names are to be attached to this hypothetical layer it should be called, in equity, the "Kennelly-Heaviside" layer, a name which is beginning to be used in America.

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[1] E. C. Titchmarsh, "Extensions of Fourier's Integral Formula to formulae involving Bessel Functions," Proc. London Math. Soc. (2), 23 (1925), xxii. (Records for Jan. 17, 1924.)

The Chemistry of Solids.[1]

By Prof. CECIL H. DESCH, F.R.S.

IT is remarkable how little we know with any certainty about the chemical properties of solids, although the idea of a solid is so fundamental. At the present time we always begin the study of chemistry with the gases on account of the simplicity of their mathematical treatment, but it must be remembered that this simplicity is the result of long study and of many discoveries. To the unscientific mind the solid is simpler, because more tangible. When men have tried to understand gases, they have expressed themselves in terms of solids. The atom, however attenuated it may have become in recent years, was in the first instance essentially a solid sphere, and the elasticity of gases has been explained in terms of the collision of elastic solid particles in motion.

Our conception of liquids has been based in the same way on the idea of moving particles, themselves thought of in terms of the solid state. Yet, of solids themselves, whilst our knowledge of their physical and mechanical properties is very extensive, our chemical information is of the most meagre kind. It was an old doctrine that chemical reactions could only proceed in the gaseous or liquid states, so that chemical action on a solid was always preceded by the tearing off of atoms from the surface under the influence of electrical forces. That view can no longer be maintained. Chemical reactions can occur within or at the surface of a solid, but the experimental difficulties are sometimes such as to make the exact investigation of the subject a difficult matter.

In the modern conception of a solid, the atoms are characterised by a regular arrangement in space, that arrangement being repeated so as to build up a crystalline lattice. Crystals and aggregates of crystals are thus the only true solids, glasses being regarded as under-cooled liquids of high viscosity. The X-ray method developed by Laue and by W. H. and W. L. Bragg has made it possible to determine, not only the class of a crystal, but also the exact lattice possible to crystals belonging to that class. The connexion between the chemical properties and the crystalline structure still remains indeterminate, although it must be very intimate.

There are many reasons why the chemical study of solids should receive greater attention. In metallurgy, although metals and alloys may, and most frequently do, pass through a molten stage in the course of their manufacture, they may undergo many important changes of structure and constitution at temperatures far below that at which the last liquid portions have completely solidified, and these changes may be so far-reaching as to convert an alloy into one seemingly of an entirely different class, although the gross chemical composition has not altered. The petrologist, especially when dealing with igneous and metamorphic rocks, has to consider reactions which proceed in the midst of solids of high rigidity. Several industries, such as that of cement, are based on reactions of the same kind as those with which the petrologist has to deal. Sintering is not always due to the presence of small quantities of molten material between the solid particles, and it is now certain that union of solid masses under pressure may occur without actual melting. This was shown by Spring forty years ago, but for long, although frequently quoted, his results received little consideration.

The most striking application of the principle is seen in the metallurgy of tungsten. This metal was formerly described as very hard and brittle, and it is not possible, by casting it and then annealing, to bring it to a ductile form. The method now adopted is to prepare it in the form of a pure powder, and then to bring it to a compact state by compressing, heating, and hammering while very hot, and finally drawing. As this process is continued, and as an originally thick rod becomes extended into a slender wire, the brittleness progressively disappears, and at last the tungsten is obtained in those beautiful filaments, drawn to extreme fineness, with which we are familiar in our electric light bulbs and wireless valves. A somewhat similar example is that of the adhesion of an electrolytically deposited metal to its support, which is sometimes so perfect as to approach the breaking strength of one of the metals, although interpenetration of crystals is not to be seen under the microscope.

There is another aspect of the chemistry of solids which will make an appeal to some who are not chemists, but amateur students of Nature. The great beauty of natural crystals has attracted the attention of poets and artists as well as men of science. Much of this beauty depends on the varying habit of one and the same crystal species. Even with such a common mineral as quartz, it is possible on entering a mineral collection to point to some of the crystals exposed, and to name their locality, when once the form has become familiar. The same is true of other minerals. Why should there be this variation, when the chemical composition of the distinct varieties may be identical, so far as analysis is able to give information?

Again, the crystalline system will not account for the differences in the building up of individuals to form aggregates. Rock salt and cuprite crystallise in cubes, and the space lattice has a very similar form in the two minerals; but when the salt forms multiple growths, the cubes arrange themselves in characteristic stepped pyramids, whilst the red oxide of copper may form the most beautiful hair-like threads, a tissue of scarlet silk, as Ruskin calls it. Neither mineral ever assumes a form which is characteristic of the other, the simple cube being once departed from. Why should this be? It is known that the presence of traces of foreign matter may cause differences of habit, the most famous example being that of the crystallisation of common salt in octahedra instead of cubes when a small quantity of urea is added to the solution, but the explanation of these facts is still imperfect.

The work of Johnsen and of Gross has shown that the appearance of a face on a crystal placed in a supersaturated solution is really determined by the velocity of growth in a direction normal to that face,

[1] From the presidential address delivered at Southampton on August 31 before Section B (Chemistry) of the British Association.

those faces being produced which have a minimum velocity of growth. Some light is thrown on the subject by a study of the growth of a crystal when solvent is completely excluded, the substance used being sublimed in a vacuum. This has been undertaken by Volmer, who finds that cadmium, zinc, and mercury crystals grow in this way in a high vacuum. When small nuclei are present, those grow which have the face with the smallest velocity of growth perpendicular to the stream of impinging molecules. The differences between different faces are large, so that under these conditions either flat tables or long prisms are usually formed, according to the direction of the original nucleus. The crystal grows by the addition of thin laminæ, probably only one molecule thick, which spread over the surface. This is likely to be the process when the crystal is growing in a solution or in a molten mass, as well as in the vapour; and, in fact, when cadmium or tin is being deposited electrolytically at a cathode, or when lead iodide is being formed from a solution of a lead salt and an iodide, the growth of the crystal may be watched under the microscope, when a thin film begins to form at some point on a face, and extends over the face, maintaining a uniform thickness throughout. It is realised that in the presence of a foreign substance, either molecules or ions may attach themselves to such a surface by their residual affinity, and this will necessarily affect the addition of further layers of the original substance. In other words, the velocity of crystallisation in a direction normal to that face will be changed. As the residual affinity of different faces of a crystal must, from the ordinary conception of an atomic space lattice, be different, the habit of the crystal, that is, the relative development of different faces, will be altered by the presence of a foreign substance. It is on these lines that an explanation of differences of habit must be sought.

When a face of a crystal is brought into contact with an etching reagent, such as water for rock salt, hydrofluoric acid for quartz, or cupric ammonium chloride for iron, the surface is not dissolved away evenly, leaving it smooth, but characteristic etching pits are produced, the sides of the pits being evidently crystal faces. This shows that chemical action proceeds more readily along certain planes of a crystal than along others, a fact which we should expect from the general properties of the space lattice. It is not explained, however, why these etching pits should appear at first separate from one another, the intervening portions of the surface being unattacked. Minute particles of some impurity, causing local electrolytic differences, suggest themselves as a possible cause, but it is unlikely that they would be so evenly scattered in, for example, a quartz crystal as to produce the regular distribution which is often observed. Minute inequalities of level, which may be of a periodic character, are more probable, and this suggestion is strengthened by the observation that a polished face of rock salt dissolves evenly in water, whilst a natural cleavage face shows etching pits.

It is now possible, when pursuing the study of solids, to eliminate one of the disturbing factors, the intercrystalline boundary, by making experiments with specimens composed of a single crystal. There are several ways of preparing single metallic crystals of such a size as to allow of the determination of their physical and mechanical properties. Even so brittle a metal as zinc has an extraordinary ductility in single crystals. The mechanism of deformation has been examined in detail by means of X-rays. There is now a large body of evidence as to the directions of slip in a crystal during deformation, and this knowledge is essential to any understanding of the nature of cohesion, with which the chemical properties are no doubt closely connected.

We may now turn to the subject of chemical reactions which take place in the interior of a solid, either originating at the surface or from nuclei which make a spontaneous appearance in the course of cooling below the melting point. A chemical change which has begun at some point in or at the surface of a homogeneous crystalline mass cannot advance unless the atoms are able in some way to change their places. Gross movements, represented in gases and liquids by convection currents, are out of the question, but the slower process of diffusion, by which atoms or molecules can make their way through the solid, must be possible. Experiment shows that diffusion in solids, whilst naturally a slow process in comparison with diffusion in liquids, proceeds at quite measurable rates.

The classical example of such measurements, and for many years the only one, is the study of the diffusion of gold in solid lead, undertaken by Roberts-Austen in 1896. A much simpler example is that of silver and gold, two metals which resemble one another closely in chemical character and in atomic volume, so that diffusion causes less change of properties than in any pair of less closely similar metals. The experimental results prove, as might have been anticipated, that diffusion is a much slower process when there is so little difference in chemical character. When the two kinds of atoms are closely alike, the tendency to diffuse must be small, but it is certainly not zero. By making use of an ingenious device, Hevesy has been able to determine the coefficient of self-diffusion of liquid and solid lead. Two isotopes should not differ appreciably in their rates of diffusion, so that when the radioactive isotope thorium B is allowed to diffuse in ordinary lead, the experiment is equivalent to selecting a certain number of lead atoms and attaching labels to them by which they may be identified in the course of their journey. In this way he found that the diffusion in liquid lead near to the melting point was of the order of that of salt in water, but that in the solid state it was very small. Further experiments, using a thin foil, proved that at 2° below the melting point the rate was 1/10,000 of that in molten lead.

When a liquid mixture of two substances which are miscible in the solid as well as in the molten condition, such as an alloy of copper and nickel or a fused mass of albite and anorthite, begins to solidify, the composition of the crystals has to adjust itself continuously in order to maintain equilibrium with the changing liquid phase, as was shown by Roozeboom in his classical work on solid solutions. Such an adjustment is only possible by means of diffusion, and when cooling is sufficiently slow, the adjustment does in fact keep pace with the change in the liquid, but with more rapid cooling the interior of each crystal differs in composition from its outer layers, there being a concentration

gradient from the centre to the boundary. This condition produces the "cored" crystals which are familiar to every metallurgist, and the "zoned" crystals of the mineralogist. In most alloys this want of homogeneity disappears after a sufficiently long period of heating at some temperature below that at which the first drops of liquid are formed, but alloys of bismuth and antimony fail to become uniform even after weeks of annealing, whilst the felspars and similar minerals have never been persuaded to lose their zoned structure by any methods known in the laboratory.

Bruni has shown and Vegard has confirmed the observation by the X-ray method, that true interdiffusion occurs between potassium and sodium chlorides when mixed and heated in the solid state. Electrolytic transport is observed in the solid halides of silver and in mixtures of silver and copper sulphides, but the modern view of the structure of such substances represents them as built up of ions rather than of neutral atoms, and this must be taken into account in any interpretation of the facts. The apparent absence of diffusion in minerals which have once solidified, even when given geological periods of time, is a serious difficulty in the way of any general theory of diffusion. Such examples of the passage of alkali metals through quartz and other silicious minerals under the influence of a difference of electric potential are probably not examples of true diffusion at all, but merely of the passage of traces of impurities through a mass which is not completely impervious.

A new field of investigation has been opened up by Tammann in his attempts to determine the arrangement of the atoms in solid solutions by purely chemical means, by studying the action of chemical reagents on the solid. It is a familiar fact that the "parting" of silver and gold in assaying, which consists in dissolving out the silver from the alloy by means of nitric or sulphuric acid, is only possible when the silver forms more than 60 per cent. of the alloy. When gold is present in excess of this proportion, only a little silver is removed from the surface, and the action then comes to a standstill, the acid being unable to penetrate to the interior. Assuming the alloy to be completely crystalline, the atoms of silver and gold will occupy the points of the space lattice, and as the two metals have face-centred lattices of only slightly differing dimensions, the amount of distortion will be small. There are, however, different ways of arranging the two kinds of atoms. They may be distributed at random, or they may be so regularly arranged as to form two interpenetrating cubic lattices.

The two forms of distribution may be distinguished by means of the X-rays, but Tammann has also drawn conclusions on the point from the action of various reagents on the alloys. He finds that each reagent which attacks silver ceases to act on the alloys when the proportion of gold atoms in solution exceeds a certain limit, which is not the same for different reagents, but he states that it is always capable of being expressed as 1/8, 2/8, 3/8, and so on, of the total number of atoms. The limits so found are not consistent with the distribution according to the laws of probability, but they may be accounted for by a regular distribution on the assumption that a certain number of inactive atoms is necessary to protect each atom of silver.

On the basis of these results, an ingenious theory of the action of reagents on solid solutions has been constructed, and although the accuracy of the experimentally determined limits is not high, and there are several exceptions to the rules, an interesting case has been made out.

If our knowledge of the chemical properties of the interior of a crystal be very incomplete, what are we to say of its surface? Of this we know still less. Even in a crystal of a pure metal there must be some difference in the structure at the immediate surface, on account of the unsymmetrical forces between the atoms in the outermost layer and its neighbours. For so far as the radius of sensible atomic forces extends, therefore, there must be a condition different from that which prevails at a depth below the surface. One consequence is that the surface has residual affinity, which shows itself in the ease with which foreign atoms or ions will attach themselves to it. That the forces acting are chemical is shown by the great effect on the extent of adsorption of the chemical character of the solid and of the adsorbed substance. Films, often one atom thick, attach themselves to the solid, and are only removed with the greatest difficulty. Their presence makes the investigation of the properties of a surface difficult, as the surface actually examined may be in reality quite different from that which is assumed to be present. In photochemical experiments with mercury it is usual to prepare a completely fresh surface of the liquid metal by causing it to flow continuously in a fountain, but this device cannot be applied to solids. Only rarely can experiments be made with perfectly defined solid surfaces. Films of metal prepared by sublimation or sputtering in a vacuum are probably the most under control, but other surfaces are commonly covered by invisible films.

Schumacher has recently shown that mercury wets glass and silica more and more readily as care is taken to remove films from them, and the property of not being wetted by mercury is probably not one of glass and silica, but of those substances coated with a film of gas. Metals most readily take up atoms of oxygen or other elements, forming persistent films, which play an important part in the phenomena of resistance to corrosion.

There is one way of preparing a fresh surface of a crystalline solid for examination, and that is by cleavage. A freshly cleaved plate of a mineral may be supposed to be clean at the moment of its formation, although it will rapidly take up foreign atoms from the surrounding gas. Tammann has made the interesting observation that a fresh surface of mica is more soluble in water than an older one. Washing with water immediately after cleaving extracts a quantity of alkali salts which is much above the normal solubility of mica, and later washings extract only the normal quantity. It is suggested that the separation of the flakes of mica exposes the alkaline part of the molecules, which would be more readily attacked by water than the silicious part. It will be interesting to see whether the X-ray examination of mica confirms this arrangement. Again, however, a word of warning as to the effect of possible impurities must be uttered. Natural minerals are not pure, and any uncombined alkaline salts present might well segregate along cleavage planes in the

process of crystallisation, and so give rise to the effect noticed above, but the figures recorded by Tammann are striking and suggestive.

In this hurried review of a large field it may seem that I have presented rather our ignorance than our knowledge, my intention having been to show how much remains to be done before we can understand the chemical relations of solids as we do those of liquids and gases. One department of research is, however, more advanced than might have been supposed from my brief references to it. That is the study of the internal changes in metallic alloys as revealed by the microscope and by thermal and electrical methods. Metallography has made wonderful progress since the days of Sorby, and it would repay students of physical chemistry to give some attention to its main results, even though they may not intend to make a special study of the subject. Nowhere are the benefits of the doctrine of phases of Willard Gibbs to be more clearly traced, whilst the recognition of every change of phase by microscopical examination, making use of a technique which has been brought to a high state of perfection, gives concrete reality to the study by direct verification of its conclusions.

To understand more thoroughly the mechanism of these changes in alloys and to extend its application to salts, minerals, and rocks, we need a fuller knowledge of the relation between crystal structure and chemical behaviour. Research on the mechanical side is discovering the direction of planes of slip in the atomic space lattice under stress, and it remains to determine the corresponding planes of greatest and least chemical activity towards a given reagent. Next follows the still unsolved query as to the nature of the intercrystalline boundary, and the solution of these two problems will make it possible to define exactly the chemical character of a given aggregate of crystals. The results will be of extreme interest for the study of metallurgy, of mineralogy, and of petrology, besides filling a serious gap in chemistry, serious because of the extent to which solids compose the world around us, and of the part which they play in our daily life.

The Meaning of Wages.[1]

By Miss LYNDA GRIER.

IT is as little within my intention as it is within my power to put forward a theory of wages. My business is one of analysis, not of construction, of restatement, not of creation. My purpose is twofold: first, to discuss certain aspects of wages, and then to review from those aspects certain payments made to or on behalf of employees.

Let us then consider three aspects of wages, each important in its way. First, there is the distributive or competitive aspect, from which wages are regarded as a factor determining where labour shall go, who shall command it, in what manner labour of certain types and given efficiency shall be employed. Competition between employers seeking the best workers is expressed in the wage they offer, and competition between workers seeking the best employer is expressed in the wage they accept. This competition tends to bring the wages of workers of equal efficiency to equality and to ensure that the wages of workers of unequal efficiency shall be unequal.

Taken alone, this idea of wages treats of the supply of labour as being fixed independently of the wage, and of the wage as powerful only in directing the available supply. It is therefore a short-period consideration, dealing with market price rather than normal value; as in all short-period considerations, stress is laid on the quantitative side, on the notion of value falling with an increase in the supply of labour and rising with a limitation of supply.

Secondly, there is the idea of wage payment which treats of work and wages as completely interdependent, since the product of each worker constitutes his payment. The product of each worker, represented by his wage, makes an effective demand for the produce of other workers. His addition to wealth is his claim upon it. Numbers are important only if with alteration in numbers there are consequent alterations in productive power per head, or if the proportions between the different types of labour required be ill-adjusted.

Finally, we may take the aspect of wage payments which is concerned with their effect on work and on the supply of workers, the wage being regarded as something that maintains the worker.

These three aspects of wages are not antagonistic. It is clear from the outset that there is no contradiction between the first two, between that from which they are regarded as a distributive force and that from which they are regarded as the actual product of the wage-earner. The idea that the worker produces so much wealth and that his work is paid in proportion to the wealth he produces is, indeed, associated with the idea that the demand for and supply of such labour as he has to offer determines its value. Wages so determined are known as "fair" or "normal": fair in that they are equal to those of other workers of similar capacity, normal in that they are the wages that tend to be paid under conditions of free competition.

Each worker on this reckoning tends to get what his work is worth. It may be worth little. This admission does not apply only to bad workers. It certainly does apply to them, whether the badness of their work be due to bad character, bad health, or bad mental equipment. But the question is one not only of efficiency but also of the type of ability and of the number of other workers possessed of that particular type. Work which is not entirely unskilled may be ill-paid if the numbers competent to do it are great. This is, perhaps, especially the case with women's work.

For the most part, earnings are low in occupations that offer no special attractions and are filled by workers who, thanks to heredity, or sex, or environment, have little chance of entering others. The able man or woman has not only the fun of being clever, but also the advantage of high earnings through belonging to a grade in which the numbers are relatively small.

[1] From the presidential address delivered at Southampton on August 28 before Section F (Economic Science and Statistics) of the British Association.

It is, perhaps, unfortunate that wages which reflect the value of the work done should be known as fair wages. It has already been stated that they are known as fair because they are equal, if mobility is perfect and competition free, to those of other workers of equal capacity and doing work offering equal attractions. It is the equality that has led to the epithet "fair." But it is a not very convincing fairness to the man receiving a low wage whose work is worth little through no fault of his own. For when the demand price sufficient to absorb all the workers in a given grade is small or, in more technical language, when the marginal net productivity of such workers is low, when the workers in that grade are neither bad nor careless, other members of the community gain by cheap goods as the workers lose in low pay.

Plenty is generally an advantage to the community. We rejoice if land is plentiful in proportion to the population and rents are low. We should like capital to be plentiful and cheap, competing for employment at a low rate of interest. We are aware also that the owner of a limited supply of a commodity that becomes plentiful loses wealth as the consumer gains it. It is one of the anomalies of economic measurement that when a country becomes richer through an increased supply of certain goods, wealth as represented by those goods may be calculated as being less than before, because of the lowering of this exchange value.

The owner of anything other than labour may be compensated, or more than compensated, by the greater amount he possesses. Not so the worker. Each worker is lord only of his own labour. Recognition of this leads to limitation of output. There are, roughly, two ways in which men may increase their own wealth: by increasing or by decreasing production. Adult workers who have their youth and their training behind them have little power of doing the first, and fall back on the second. Through limiting output, erecting barriers against new-comers into their trades, they may successfully maintain or raise their own wages. From this point of view the objection of men to opening to women any new branch of industry is perfectly logical. If women be found capable of doing work formerly reserved for men, and are allowed to do it without let or hindrance, they will tend to have a depressing effect on the wage; not because of their sex, but because of their number. Their exclusion from many trades makes their entry to any single trade formidable; they are jealously excluded from one type of work because they are jealously excluded from others; thus they come to be considered natural blacklegs.

It is not profitable to pursue this subject further, however, without discussing the third aspect of wages, and considering not merely the wage that a man is worth but also the wage that he needs. Wages, in addition to directing labour and being a return of goods and services to labour in exchange for the goods and services it supplies, are expected to maintain the worker. The owner of labour alone among owners of any agent of production is supposed to live on the product of the thing he owns. The economic fact that to a great extent he does so has been exalted, like many other economic facts, into a moral obligation; and when the normal wage is low without any discernible fault on the part of those who earn it, the moral obligation is shifted and it is said that the wage ought to be large enough for the worker to live on.

It being assumed that the worker lives on his wage, we concern ourselves greatly with the question of how far wages do or can be made to respond to needs. We are challenged daily, by proposals for minimum wage rates, cost of living standards, family allowances, contributory insurance schemes, to consider the connexion between the normal wage and a wage adjusted to the needs of the worker. The question is a complicated one.

It is far easier to see the connexion between the wage and "training and sustaining" the worker's energy than between the wage and the cost of rearing the worker. If labour be not adequately sustained during the period for which the worker is engaged the product will suffer. Diminution in the number of workers available, or in efficiency, or both, follow swiftly on lack of sustenance. Further, the wage must bear some relation to the cost of training, since so long as there are occupations which demand no training, or less training than others, those needing most will lack recruits if the earnings they offer are not relatively high.

The cost of rearing the worker raises different questions. It is clear that the individual worker does not pay for his own childhood; no bill of the cost is presented to him when he begins to work. It is equally clear that the childhood of most wage-earners is paid for from wages; part, and a considerable part, of the wage of many workers is devoted to the maintenance of their children. It may be said crudely, therefore, that unless wages cover the cost of rearing workers, there will be no workers. It cannot, however, be asserted that because a worker pays certain expenses from his wages those expenses are the cause of his wage, or of any part of it.

There is a tendency to assume that, while the efficient sustenance of labour during working days and hours is a prime cost of industry to be covered by the wage, sustenance in non-working days and hours, in sickness, during unemployment, in old age, and the maintenance of wife and children not only during but also after a man's working life, is a kind of supplementary cost for which provision should be made in respect of work done. This presupposes a vast amount of calculation both on the side of the employer and the employee.

First let us take the employee, as being the party to any wage contract most likely to reckon such costs. Here, roughly, we find workers divided into the calculating and non-calculating classes, those who expect security and those who do not: an expectation which probably makes a far sharper class distinction than that made by riches and poverty.

Arrangements for contributory insurance schemes have long been common in the professions. Contributory insurance schemes for the provision of pensions have, with the exception of some of the less exalted branches of the Civil Service, in the past been made compulsory among those classes who before their introduction attempted to make similar provision voluntarily. The same classes have perhaps more than others calculated the number of children whom their earnings would maintain. The fertility statistics of the last census show that the professional classes, who are very largely the calculating classes, have a

lower fertility rate than any other occupied section of the community: 0·90 being the average number of children under sixteen for married men in the professional classes as compared with 1·27 among all married men. These classes who calculate the future are but a small section of the community.

For most earners the exigencies of present maintenance exclude considerations of future maintenance. With dependents the case is somewhat different; more and more every class of the community tends to consider the possibility of making good provision for its children, and more and more do the parents of every class recognise that they can provide for their own needs by limiting the size of their families.

The effect on earnings of calculations made by the worker, either for his own future and that of his dependents or for the present needs of his dependents, is not easy to trace. A stimulus to activity which in effect raises the wage-earner to a higher grade, increasing his productivity and general wealth, makes him worth a higher wage. A limitation of numbers is slow in its action on supply, and, since it cannot be assumed that each grade or occupation is entirely self-recruiting, no positive result can be ascribed to it, except in so far as it is thought that a general increase or decrease of population is likely to cause a general rise or fall in wages.

Let us now turn to the question of how far such calculations affect the employer, purely from the business point of view. Employers have not reckoned the whole of the worker's life or maintenance of his dependents as an overhead charge. They do not pay adult male employees at a high rate because they have families dependent on them or because they must make provision for the future, but because their productivity is relatively high and because they are strong and experienced workers. They do not gravely reckon the average family of an average worker: they reckon what the man's work is worth.

Nor do the needs of the worker provide him directly with additional bargaining power. It has generally been recognised in foreign trade that needs are a weakness and not a strength in bargaining. It is the same with the worker. So far as fighting strength goes, bachelors who are without dependents can fight more effectively than men with families. The mere acquisition of a new set of needs, unless it stimulates activities and so is part of a higher standard of life, adds to misery and not to wages. To a certain extent it is notorious that dependents do stimulate activity, married workers being generally steadier and more regular than unmarried ones. Their higher productivity raises their earnings. But it is to be feared that bargaining power is in no way enhanced by the number of dependents, and every one present will call to mind cases of men who dare run no risk of losing their job because of their wives and children.

In view of this, we may think it fortunate that the workers who get low wages so often have few needs. Young untrained workers whose productivity is low have no dependents. They have often, in fact, just ceased from being dependents themselves and become contributors to the family wage. If women are crowded into a somewhat small number of occupations with low rates of pay, it is some comfort to remember that they have comparatively few dependents to suffer from those low rates.

If we agree that the normal wage in some cases rises above and in many falls below the wage required by the worker for his maintenance in the future as well as the present, and for the maintenance of his wife and family in both the present and future, what should be our attitude towards the many persons and bodies who are concerned with raising the wage rate, with charging provision for unemployment and the future on to wages, and with readjusting wage rates? It is clear that we cannot expect the approximation of normal wages to wages adequate for such maintenance to be the main preoccupation of social reformers or statesmen.

Measures concerned with wages may be put into three categories roughly coinciding with the three aspects of wages with which we began. First, there are those which are concerned with the mobility of labour, with seeing that labour is as swiftly as possible directed where it is most needed, by the dissemination of knowledge, by facilities for movement such as are offered by the employment exchanges, by vocational selection, by the efforts of trade unions to ensure that in every instance the rate received shall be at least the normal rate. Secondly, there are those which attempt to increase the productivity of the worker and raise him from one grade to another; such as measures of educational reform, improved social conditions, even, when wages are very low, minimum wage rates, which by improving the health of the worker increase his productive capacity. Thirdly, there are measures which attempt something further and try either to add to the normal wage rate or to "stretch" the rate so that it will pay for things that it did not previously pay for.

I do not propose to discuss the first two categories; their value is obvious. We are being forced, however, increasingly to discuss the third category. It includes schemes for fixing such minimum wage rates as do not increase productivity; cost of living standards when they attempt something other than the maintenance of the normal wage; schemes for subsidising certain sections of wage-earners, such as systems of family allowances; and schemes for stretching normal wages to cover certain costs, such as compulsory insurance schemes.

Where these schemes ensure a given rate of wages their advocates desire that it should be secured without unemployment ensuing. Where, as in compulsory and contributory insurance schemes, a charge is levied on employer and employed, it is presumably not desired that unemployment benefit should be provided by measures which, by making labour costs high, increase unemployment, or that hypothetical widows and fatherless children should be provided for by schemes which, by reducing wages, stint actual wives and the children whose fathers are living.

Minimum wage rates may be maintained without unemployment following when, as has already been suggested, through their reaction on efficiency they increase the value of the work done, and also where the demand for the labour employed is inelastic. Trade boards have proved this. It may further be argued that, when normal wages are too low to provide adequate maintenance for all workers belonging to a given grade,

it is better to enforce a wage adequate for the maintenance of a certain number, and, having so produced a certain amount of unemployment and defined the problem, take steps to deal with the unemployment.

When the question is one not of the minimum needed for efficient sustenance but of the relative rates in different occupations, according to the degree of skill required and the customary rates for work of a given kind, the problem becomes different, as in the case of cost of living standards. There is nothing sacred about relative wage rates; they are exceedingly arbitrary as between different occupations and between different types of skill in the same occupation. Wage rates normal in the past are not normal in the present and will not be normal in the future. They are subject to infinite variations. The balance is mobile and cannot be stereotyped. It is a pointed commentary on this fact that the Cave Committee reporting on the Trade Board Acts in 1922 advised that the boards should in future confine their activities to the settlement of wages when such wages are unduly low and no other adequate machinery exists for their effective regulation.

This report and consequent legislation marked the abandonment of one attempt to legislate on relative wage rates. But if one attempt was abandoned, others remain. The minimum wage rate in the coal-mining industry is being hotly discussed, and, apart from legislative enactments, cost of living standards as a basis not for wages but for fluctuations in nominal wages are commonly enforced by trade union action. A wage which is "above the normal" is in effect a subsidy given to the worker in respect of a particular type of work. In a sense, nomenclature matters little. We tend to call anything a wage which is given by an employer to a worker, and to call anything a subsidy which is given to a worker or an industry or any one or anything else by the State, and to dub as taxes revenue collected by the State. But when we analyse payments above or below normal wages, we find that we are generally tracing their incidence and dealing with transferences of wealth rather than with costs. Sir Alfred Mond's scheme is frankly a subsidy. Nor is there in effect much disguise about the "tax and subsidy" nature of the family allowance system. Bachelors are to be taxed, or to tax themselves, for the sake of men who have families. It is recognised that it is on the whole unwise to put the administration of the "tax and subsidy" in the hands of the employer, lest he should mistake a tax and subsidy scheme for a new wage system under which it would be greatly to his advantage to employ bachelors instead of married men. Once it is frankly admitted that large families neither force nor enable employers to pay high wages, we can if we wish settle down to a discussion of the ethical and economic advantages of family endowment; and we can contrast the advantages of making provision for families within each industry separately or through a more general scheme of taxation.

From the suggestion to tax certain wage-earners for the benefit of other wage-earners we may pass to the practice of taxing wage-earners for their own benefit, as embodied in unemployment and health insurance schemes, in the various pension schemes already adopted in the Civil Service, and as proposed in the Pensions Bill. It may be said that here we are not dealing with taxation but merely with deferred pay; that the contributions, covering as they do the workers' own risks, are a forcible method of saving, but cannot fairly be called taxation. This is perfectly true when the saving would or could be made voluntarily. But when wage-earners are too poor to save, enforced saving leaves them for the time being poorer than before, and Mr. Neville Chamberlain's hope that the Pensions Bill "would encourage people to try to add to the benefits and thus achieve complete independence for themselves" is likely to be frustrated by the reduction in their means. We are agreed that the benefits of these schemes must be secured. We are, I believe, agreed that they must be augmented. But the provision of future benefits by taxes on present wages may not be the best method of giving such benefits when wages are low. The wage may be too small to be deferred. Nor does the fact that employers pay a larger proportion when the wage is exceedingly low help those who are on the verge of unemployment and may by this arrangement be pushed over it.

It is to be feared that if normal wages be not adequate to cover calculations for the future, contributory schemes, however advantageous, may make things more difficult than before for workers belonging to a grade in which numbers are great in proportion to demand. It cannot be assumed that the demand for such labour is inelastic. In many instances it is, as when labour paid at a low rate is employed in co-operation with better-paid labour and in industries in which its cost is but a small proportion of total cost. But frequently the demand is elastic, as in agriculture, where we are constantly told that labour cannot profitably be employed even at minimum wage rates which seem to many of us less than moderate.

Contributory insurance schemes have occupied much attention lately, probably more than they deserve. The contributions demanded by each individual scheme are no great matter; even taken together they do not amount to a vast charge per worker. But, small as they are, they are of interest as being attempts to stretch the normal wage to meet the needs of maintenance when, in terms of that wage, the worker is not always worth a rate which will enable him to meet all the demands made upon him for his own immediate support and that of his family.

The normal wage is defiantly rigid. It is also brutally erratic. It will not be stretched to meet any but the most immediate needs of workers in low grades; it is capable in times of depression of falling below even that low standard. In the process of asserting itself it drives men ruthlessly from occupations for the products of which demand has fallen. The secret of its mastery lies in the fact that it offers the one price at which all labour of any given grade can be absorbed in the occupations to which it is admitted. Whatever be the rights of the coal dispute, it is true that a point may come at which any industry or any single firm in an industry may be unable to pay a living wage to all those occupied in it. The normal wage commonly offered in other occupations for the same grade of labour will only be given in such an industry when enough men have left it to make the rate even throughout the grade. In the meantime labour may suffer greatly, and the productive power of all industry may suffer, since nothing is

so destructive to a man's capacity or more likely to force him into a lower scale of labour than a prolonged spell of unemployment.

There are those who hope that in time the normal wage may in all ranks of labour be at least adequate to maintain workers and their families through all uncertainties and vicissitudes. They believe that the progress of invention will immensely increase productivity; that improved business methods on one side and rising standards of work on the other will make each worker more productive; that ultimately education will raise all workers to the ranks of those whose work is worth much. But until that Utopia arrives it is well to recognise that, except by making wages abnormal, we cannot at present expect them in all cases to do what is required of them.

It is blindness to pretend that the normal wage must necessarily provide for all needs, or that the worker is necessarily to blame if it does not. Those more fortunately placed among the workers, as well as among other classes of the community, often gain by the cheapness of the goods made by workers whose work is worth little because their numbers are great. But the community as a whole does not gain, because the workers receiving low wages are part of the community.

It is roughly true that the normal wage distributes labour well through distributing wealth ill. Redistribution of wealth is therefore necessary. Redistribution in the name of wages tends to interfere with the distribution of labour; for this reason it might be well to leave wages to mean normal wages and to redistribute wealth by other methods.

Obituary.

SIR WILLIAM SCHLICH, K.C.I.E., F.R.S.

THE death of Sir William Schlich, who succumbed to an attack of bronchitis on September 27, at eighty-five years of age, removes from the world of forestry one of its outstanding figures of the past half-century. A native of Hesse-Darmstadt, Schlich studied at the University of Giessen, taking his degree of Ph.D. in 1866. The same year he was offered and accepted a post in the Indian Forest Department, then in its infancy, and was posted to Burma, where he served as deputy conservator of forests until 1870, when he was transferred to Sind, where he remained for two years. In 1872 he was promoted to the conservatorship of Bengal, which in those days comprised the present provinces of Bengal, Assam, and Behar and Orissa. For seven years he threw himself with energy and conspicuous success into the arduous work of organising forest operations in this huge tract. After a spell of leave to Europe, followed by a short period of service as conservator of forests in the Punjab, he was appointed towards the end of 1881 to act as inspector-general of forests to the Government of India: he was confirmed in this appointment in 1883, when his predecessor, Dr. Brandis, retired from the service, and held it until 1885, when he proceeded to England to take up the post of professor of forestry in the newly created forestry branch at the Royal Indian Engineering College at Coopers Hill.

During Schlich's period of service in India, the work to be done consisted largely of preliminary organisation, and the conditions were by no means easy. In the earlier years the superior staff consisted for the most part of men without any scientific training in forestry, although by the time he left India matters had improved vastly, owing to the steady flow of British recruits trained at the Nancy Forest School in France, and to a smaller extent in Germany. These earlier years of the forest department were marked by strong opposition, not only from the timber trade and other interested parties, but also from Civil officials, many of whom regarded the conservation and national management of the forests as an uncalled-for innovation. Perhaps the most important advance which marked Schlich's term as head of the department was the creation of a special working plans branch in the office of the inspector-general of forests; this provided for the expert scrutiny of all forest working plans before they received final sanction, thus ensuring their preparation on correct lines.

So far as his work and activities were concerned, Schlich's appointment in 1885 to the professorship of forestry at Coopers Hill marked the beginning of a new era. From that year onwards he was destined to devote himself to the teaching of forestry, and it is in this sphere of activity that he was best known to the present generation. Combining sound knowledge and judgment with an enthusiasm for his subject which was infectious, and possessing a keen sense of humour and a remarkable capacity for winning the confidence and affection of his pupils, he was the embodiment of those qualities which go to make the ideal teacher. What the British Empire owes to him may be realised from the fact that his old pupils are to be found throughout its length and breadth. Immediately prior to the War, some ninety-five per cent. of the Indian Forest Service, from the inspector-general to the latest joined assistant conservator, were old pupils of his, while at the present time there is not a single senior officer of that service who was not trained by him.

Schlich became a naturalised British subject while at Coopers Hill. His educational duties there covered a period of twenty years, during which time he was responsible primarily for the training of recruits for the Indian Forest Service, although a few forestry students of the College obtained appointments in other parts of the Empire. On the abolition of Coopers Hill in 1905, its forestry branch was transferred to Oxford. Here Schlich, although sixty-five years of age, threw himself energetically into the work of organising the school of forestry in its new home and making it worthy of the great University which had adopted it. Through the generosity of St. John's College, aided by other benefactors, a building was erected with lecture rooms and a museum. In 1911 Schlich severed his official connexion with the India Office when he retired under the Civil Service rules; he was thereupon appointed reader and, by decree of Convocation, given the status of professor of forestry. By this time the Oxford school of forestry had fully established its reputation, and had become responsible for the training of numbers of forestry students destined not only for the Indian service, but also for many other parts of the empire. Schlich's

chief ambition while at Oxford was to bring forestry into line with the other main scientific departments of the University and to obtain for it that recognition which its growing importance deserved. He therefore set to work to collect funds for the endowment of a permanent chair of forestry, and his appeal met with a sympathetic response from various sources, both official and private. He had the satisfaction, not long after the conclusion of the War, of seeing the realisation of his dreams, for a permanent professorship of forestry was constituted in 1919, and in the same year a statute was passed placing forestry among the degree subjects; until then it had ranked as a diploma subject only. He finally laid down the reins of office on January 1, 1920, when he was succeeded by one of his old pupils.

Schlich was an honorary fellow of St. John's College, Oxford. He was elected a fellow of the Royal Society in 1901, and was created K.C.I.E. in 1909. His best-known work is his "Manual of Forestry," in five volumes, of which three were written by himself and two by his former colleague, the late W. R. Fisher. Among his other publications may be mentioned "Afforestation in Great Britain and Ireland," "Forestry in the United Kingdom," and a large number of papers, reports, and other writings. He was a member of the Forestry Sub-Committee of the Reconstruction Committee which was appointed in 1916 and issued its final report in 1918. He held the office of president of the Royal English Arboricultural Society in 1913–14, and was on the governing council of the Empire Forestry Association at the time of his death. In spite of his advanced age, he retained his mental vigour unimpaired until the end, and worked hard at the revision of his "Manual of Forestry" after retiring from his post at Oxford; he brought out new editions of vol. 1 in 1922 and vol. 3 in 1925. He was married twice, and is survived by a widow, a son, and four daughters. R. S. TROUP.

PROF. ANDREW GRAY, F.R.S.

THE many old students of emeritus Professor Andrew Gray, some of whom are scattered all over the world, will be sorry to hear of his death. His strong personality, ability as a teacher, and unwearying patience in explaining difficulties, must have endeared his memory to many thousands of students. There are few men who worked harder or have left a greater record of work. His life was a full and a happy one, and his sympathy with the early struggles of young men considerably lightened his onerous duties as a professor. He belonged to the diminishing band of mathematical physicists, and he once told the present writer that what he called the "Laodicean" attitude of many scientists towards mathematical physics was seriously discouraging research in this direction. In a letter some years ago, written when revising his "Absolute Measurements," he complained of feeling tired, but added that he must finish his work for ἔρχεται νύξ. The night has now come, and he sleeps well who toiled during many years to advance our knowledge of Nature.

Born in 1847 at Lochgelly, in Fifeshire, Gray began his mathematical studies in the subscription school at the time of the Indian Mutiny. His text-book was "Practical Mathematics," by John Davidson. Modern educationists might consider the book a collection of mathematical scraps, but Gray often spoke of the intense interest it excited in the boys. By means of a measured base line, 10,110 feet long, they could measure the distance of Nelson's monument on the Calton Hill at Edinburgh, the lighthouse on the island of Inchkeith, the Martello Tower at Leith Harbour, North Berwick Law, and so on. The solutions of such problems had an interest that no mere diagrams with their letters A, B, C . . . could ever give.

At the University of Glasgow, Gray studied very hard and gained many honours. He once told the writer the reason why he did not obtain more. On one or two occasions he had to leave a fortnight before the end of the term in order to assist in farming operations at home. On one occasion this probably lost him the gold medal which is given to the best student in the senior Greek class. He ever put duty before personal ambition. He graduated as M.A. with honours in mathematics and natural philosophy. Gray was an excellent classical scholar, and in his later years he derived much pleasure from reading Latin and Greek poetry. Like his friend Prof. Chrystal, he was a great admirer of Schiller's poems and knew many of them by heart. His Greek testament was his constant companion.

Gray was private secretary and assistant to Sir William Thomson (Lord Kelvin) from 1875 until 1880, and official assistant to him from 1880 until 1884. About this time electric lighting was gradually coming into use, and electrical measurements became of practical importance. Gray wrote a series of elementary papers on the subject for NATURE, which attracted considerable attention. They formed the nucleus of his treatise on "Absolute Measurements in Electricity and Magnetism."

To be an assistant to Lord Kelvin was not an easy post. Having many interests which took him away from home, his assistant could never tell before the lecture what aspect of the subject the professor was going to discuss or what apparatus he would want. He kept all his staff busy with his work and their individuality was apt to be submerged. In 1883 Gray published the first volume of "Absolute Measurements," which has been a great help to many. Kelvin told him that he ought not to have published it so long as he was his assistant. Nowadays this would be an impossible attitude for a professor to take up. No one, however, had a higher opinion of Kelvin's abilities than Gray, or more reverenced his memory.

In 1884 Gray was appointed to the chair of physics in the newly founded University College of North Wales. Amongst his new colleagues were Henry Jones, the distinguished philosopher, James J. Dobbie, later the principal of the Government Laboratory, and George Ballard Mathews, a mathematician possessed of rare gifts, with whom he co-operated in writing the well-known "Treatise on Bessel Functions." While in Wales he took the leading part in the foundation of the County School for Girls in Bangor, and championed the cause of the higher education of women. At this time he was also an enthusiastic mountaineer, and made weekly excursions with some of his colleagues into the Welsh hills.

On the death of Lord Kelvin in 1907, Gray was

installed as his successor to the Glasgow professorship. He delivered the University Oration in memory of Kelvin. This he later expanded in his book called "The Scientific Work of Lord Kelvin." In this book he gives an excellent account of the life and manifold activities of his famous predecessor.

Gray planned the present Natural Philosophy Institute of the University of Glasgow, a task which absorbed all his energies for several years. The Institute was opened eighteen years ago by the King and Queen, then Prince and Princess of Wales. He also took a leading part in arranging for the comfort of the students, a subject barely considered by the professors of fifty years ago.

Of Gray's literary work we can only mention his "Treatise on Magnetism and Electricity" (1898), "Dynamics, and Properties of Matter" (1901), which was translated into German by Prof. Auerbach, "A Treatise on Dynamics" (1911), in conjunction with his son, Dr. J. G. Gray, and "Gyrostatics and Rotational Motion" (1919). This last treatise stands as a monument to the vigour and industry of the author, and also to his thorough understanding of the fundamental principles. In 1921 he published a revised edition of his "Absolute Measurements." The work was practically rewritten and involved an immense amount of labour. The early edition was found to be a great help by those who determined our electrical standards at the National Physical Laboratory. The late Dr. Rosa also, of the U.S. Bureau of Standards, Washington, much appreciated his formulæ and constructed an electro-dynamometer to Gray's instructions, which was found most useful.

Gray communicated many papers and gave several lectures before learned societies. In particular, the writer remembers the sixth Kelvin lecture he gave to the Institution of Electrical Engineers. He showed the gyrostatic apparatus Kelvin used in his lectures, and explained clearly the dynamical principles which they illustrated. He also obtained complete solutions of, and generalised, some of Kelvin's theorems. In his opinion, the teaching of dynamics and gyrostatics was badly neglected in nearly every university, and in many cases the old Newtonian philosophy had become a byword. Young mathematicians and physicists revelled in discussing relativity and quanta: the former possibly leading to higher orders of relativity and the latter to fruitless metaphysics. He did not mind these metaphysical discussions, provided the speakers had a sound knowledge of rotational dynamics, but he was afraid that few of them had.

Prof. Gray was very happy in his home life. He is survived by his widow, three sons, and four daughters. There was an interesting family gathering when he and his wife celebrated their golden wedding five years ago. He was glad when his second son James gave up engineering and followed in his footsteps; a decision which has since been justified by the excellent work he has done in gyrostatics and his appointment as professor of applied physics in the University of Glasgow. His two youngest daughters are well known in musical circles in Glasgow.

Gray was a strong swimmer, and when he was at Bangor he rarely missed his morning bathe in the Menai Straits. In his later years he loved to spend his vacations in the Perthshire Highlands, where golden eagles are still to be seen holding their own in the struggle for existence. He always stood with deep reverence before the great problems of the soul and the destiny of man. What he said of Kelvin we can also say of him: "He believed that Nature, which he had sought all his life to know and understand, showed everywhere the handiwork of an infinite and beneficent intelligence, and he had faith that in the end all that appeared dark and perplexing would stand forth in fulness of light." ALEXANDER RUSSELL.

DR. CHARLES F. SONNTAG.

BY the sudden death of Dr. Sonntag on October 10—only two days before the thirty-eighth anniversary of his birth—the Zoological Society of London has lost a Prosector who by temperament and enthusiasm for patient anatomical investigation had ideal qualifications for this office. At University College, where since 1922 he had acted as a part-time demonstrator of anatomy, Sonntag endeared himself to students and colleagues by loyal service and geniality, and to a wider circle by the lucidity and interest of his public lectures on the evolution of man.

Dr. Sonntag was born in Glasgow, his father being a naturalised Swiss and his mother Scottish. He was educated in the University of Edinburgh, where he took the M.D. degree with honours in 1912. After a varied experience of hospital work he received a Commission in the Royal Army Medical Corps when War broke out. On active service at Salonika he had the misfortune to contract phthisis and was invalided home. When convalescent he resumed work at the Red Cross Clinic in London and afterwards (1917–1919) in the Special Military Orthopædic Hospital at Shepherd's Bush. There he attracted the attention of Prof. Wood Jones, who recommended him to apply for the vacant prosectorship of the Zoological Society.

Although Sonntag had been interested in zoology from boyhood and had attained distinction in anatomy as a medical student, he really began his serious apprenticeship to anatomical research in 1919, when he was elected to the prosectorship. The distinctive quality of his service to the Zoological Society and University College has been aptly described in the *Times* of October 12 in these words: "Sonntag was an indefatigable worker, apparently with no interest in life except dissection and the encouragement of other dissectors." In spite of his ill-health and physical weakness his intense enthusiasm sustained him during the brief six years of his career as an anatomist, which produced an enormous output of original observations in the Proceedings of the Zoological Society. For four years he contented himself with recording facts, apparently without any definite aim in view. But the discipline of preparing (in 1923) his book on "The Morphology and Evolution of the Apes and Man" seems to have shaped his purpose. In 1924 and 1925 he marshalled the evidence he had been accumulating since 1919 on the comparative anatomy of the tongue; and at the summer meeting of the Anatomical Society last July he gave a masterly exposition of his investigations, carefully building up his argument that certain easily observed features of the tongue could be used as trust-

worthy criteria of affinity in the Primates and other mammals and as tests of the presence or absence of specialisation. The skill and insight displayed in this discussion of the fundamental principles of mammalian evolution revealed the fact that Sonntag had suddenly attained the maturity of his powers. Hence the magnitude of the loss his death inflicts upon the science of anatomy is more readily appreciated.

WE regret to announce the following deaths:

Mr. J. Y. Buchanan, F.R.S., chemist and physicist to the *Challenger* Expedition and Vice-Président du Conseil de Perfectionnement de l'Institut océanographique de Paris, on October 16, aged eighty-one years.

Prof. E. D. Campbell, professor of chemical engineering and analytical chemistry in the University of Michigan, distinguished for his work on the constitution of steels and hydraulic cements, on September 16, aged sixty-two years.

Mr. J. S. Gamble, F.R.S., lately Conservator of Forests in India and Director of the Imperial Forest School, Dehra Dun, on October 16, aged seventy-eight years.

Prof. H. Maxwell-Lefroy, professor of entomology in the Imperial College of Science and Technology, South Kensington, on October 15, aged forty-eight years.

Prof. H. C. Lord, professor of astronomy since 1900 at the Ohio State University, who made contributions to our knowledge of stellar motion in the line of sight, on September 15, aged fifty-nine years.

Mr. A. R. McCulloch, curator of fishes in the Australian Museum at Sydney and chief fishery expert of Australia, on September 6, aged seventy years.

Prof. Urban Pritchard, emeritus professor of aural surgery at King's College, London, president in 1899 of the sixth International Congress of Otology, and author of a "Handbook of Diseases of the Ear" and of papers on the structure and function of the cochlea, on October 16, aged eighty years.

Current Topics and Events.

THE Right Hon. Sir Horace Curzon Plunkett, F.R.S., sometime vice-president of the Department of Agriculture and Technical Instruction for Ireland, enters on his seventy-second year on October 24. A member of one of the oldest pre-Cromwellian Anglo-Irish families, he was educated at Eton and University College, Oxford. Soon after attaining his majority he took up (and very successfully) the development of a ranch in Montana, gaining a mass of practical knowledge and full acquaintance with American agricultural methods. He returned to Ireland in 1889, and thereupon engaged in propaganda work embodying the need for economic legislation which might revive and encourage individual enterprise and promote practical rural education. The ultimate outcome was the establishment of a Department of Agriculture. From time to time Sir Horace met with much criticism and opposition from parliamentarians of the day, his ideals of a new civilisation in Ireland not being, apparently, consonant with their political vision. Nevertheless he can look back to many notable accomplishments. Sir Horace is an Hon. D.C.L. (Oxon.) and Hon. LL.D. (Dubl.).

SIR FREDERIC L. NATHAN, the new president of the Institution of Chemical Engineers, an authority in the chemistry of explosives, was born on February 10, 1861. Educated professionally at the Royal Military Academy, he entered the Royal Artillery in 1879. For the period 1888–1892 he was second assistant to the Director-General of Ordnance Factories, and afterwards became Superintendent of the Royal Gunpowder Factory, Waltham Abbey; later he went to Nobel Explosives Company's Ardeer Factory as works manager. He was attached to the Ministry of Munitions during the War. Sir Frederic had as a brother the late Sir Robert Nathan, distinguished for his War services in secret service work. In 1909 Sir Frederic Nathan delivered an evening lecture at the Royal Institution on "Improvements in Production and Application of Guncotton and Nitroglycerine."

PROF. J. P. POSTGATE, writing on "Our Classics To-day" in the October issue of the *Fortnightly Review*, expresses satisfaction that the position of the classics has greatly improved during the past twenty years; and he traces the improvement largely to the activities of the Classical Association, which now comprises 2300 members and possesses a dozen branches. During the War, he says, it seemed as if the fanatics of modern materialism must carry the day; but the report of the Government Committee on "The Classics in Education" gave welcome proof to the contrary. He adduces evidence of the revival of ancient learning, and is gratified that a committee of the British Association did not fail to consider the claims of Latin to be chosen as the international auxiliary language, though he omits to add that the committee unanimously rejected the claims. For our part, we also rejoice that modern materialism has not carried the day. Like the antagonism between religion and science, that between humanistic and scientific learning has lost much of its old venom, for we realise that truth has more than one aspect, and that the desire for perfection may be stimulated in more ways than one.

IN the past the autocracy of the classics was kept alive mainly by the force of tradition and the conservative instincts of our ruling classes; to-day classical learning is tending to rank side by side with natural knowledge as a master-key to the knowledge of man and as a superb implement for promoting accuracy of word and thought. Prof. Postgate views with approval the growth of literature designed for those who, not knowing Latin or Greek, yet desire to know about them; but he maintains that experiences recorded, thoughts intended, and speech employed constitute an indivisible trinity, and only through the last can the first two be reached. He laments the lack of Greek and Latin etymological dictionaries in English, condemns wholesale our school Latin dictionaries, and criticises the accentuation of Greek

and the want of appreciation of classical metre in our schools of to-day. Another object of criticism is the excessive cost of books for classical education, for which the intermediaries—the printer, book-binder, and book-vendor—are held to be responsible.

CONSIDERABLE interest has been aroused by the reports which have appeared of the performance of a novel type of flying-machine known as the Cierva autogiro. Test flights were made with the machine at Farnborough on October 19 by Capt. F. T. Courtney before representatives of the Air Ministry and a number of men of science and air-craft designers. The machine, which is the invention of Don J. de la Cierva, consists of an Avro fuselage with the wings removed, their functions being supplied by a four-winged windmill revolving freely on a central upright pillar. The four narrow wings, about 17 ft. in span, are pulled round by means of a wire in spinning-top fashion so that they revolve at about 120 revolutions per minute, and afterwards the forward speed of the machine keeps them moving at sufficient speed to give the lift required to maintain the machine in the air. The wings are articulated to allow them to rise and fall while the "windmill" is turning. Elevators and rudder are used as normally for control purposes. Capt. Courtney demonstrated that it is possible to land safely at a very steep angle, there being no need of great forward momentum as in other types of heavier-than-air machines. Descending at an angle of about 60° with the horizontal, the machine stopped in about two yards, while, when making a more normal descent, the machine came to rest within its own length. Another great advantage claimed is that, in the event of engine failure, the machine sinks downward and forward under the control of the elevators, and can be landed with safety.

THE September issue of the *Journal of Scientific Instruments* contains the address of Mr. F. Twyman, president of the British Optical Instrument Manufacturers Association, to the Association in July last. It deals with the present position of the optical industry in Britain, and it is most encouraging to find that, notwithstanding the small amount of business which is being done, the improvements in quality of the instruments produced in the last decade has been very great. The varieties of optical glass now available exceed 80 as against 26, and three British firms produce them as against one ten years ago. The work of the Research Association has given the industry a new and better abrasive, and has greatly improved the methods of colouring glass. The National Physical Laboratory has done work of a fundamental character on the theory of lenses and has turned out diffraction gratings of good quality. Microscopes, cameras, and telescopes have all been improved to a point which no foreign competitor has reached, and the testing of optical surfaces has been refined to such an extent that surfaces correct to one-millionth of an inch are obtained. An industry which shows so much vitality is bound to come through the present depression with its reputation enhanced.

IN addition to his many previous contributions to the science of spectroscopy, Prof. Kayser has now compiled a book of tables intended to lessen the labours of the ever-increasing number of workers in this field. Published by S. Hirzel of Leipzig under the title "Tabelle der Schwingungszahlen," the tables give the wave-numbers for wave-lengths between 2000 Å.U. and 10,000 Å.U. The wave-lengths have first been reduced to vacuúm and then the reciprocals calculated. In the region 2000 Å.U. to 7000 Å.U. the wave-numbers are tabulated, to eight significant figures, for every 0·1 Å.U., while convenient interpolation tables on each page enable the reading to be made for every 0·001 Å.U. Between 7000 Å.U. and 10,000 Å.U. the entries in the table correspond to each Ångström unit. In addition, the value of $n - 1$, where n is the refractive index of air for the wave-length in question, is given for every unit, and also that of $\lambda(n - 1)$, so that the wave-length *in vacuo* can be readily obtained. In view of the great importance of optical frequencies and frequency differences to the theory of atomic structure, an immense amount of work is being devoted to the theory of spectra; up till the present, owing to the lack of tables such as these, this work has involved a great deal of laborious calculation. Much of the time spent in this way will, in the future, be saved by the use of these tables.

MIDDLEMEN'S profits and the level of retail prices have recently become important subjects of discussion. The public feels that the gap between wholesale and retail prices is too great, and this impression has been strengthened by the evidence brought forward by the Food Council. Systematic study of the facts is essential since the economic problems involved are of considerable complexity. In the *Economic Journal* for September 1925, Mr. W. R. Dunlop essays such an investigation of "London's Retail Meat Trade." He states that in London the weekly consumption of butcher's meat is 2·41 lb. per capita. Retailers are in a strong position because both the demand and the supply are fairly constant, but in practice he considers that competition is preventing abuse of this power. It might, however, be objected that tacit agreement among the retailers may serve to keep prices higher than they need be. Mr. Dunlop directs attention to the State-owned butchers' shops in Queensland. There meat is sold at 1*d.* to 2*d.* per lb. cheaper than in the private shops and the average net profit has been 0·2*d.* per lb., while on turnover the profit is 4·05 per cent. as against say 0·75*d.* per lb. and 6 per cent. in London. He points out, however, that it is not safe to argue from this that municipal shops would give satisfaction in London. Difficulties would probably arise from temporary shortage of supplies and also during the Saturday "rush hours," since London shops are much busier than those of Queensland. Moreover, Queensland produces all its own meat and exports a surplus.

THE history of the dyestuffs industry in Great Britain affords an excellent example of the precept that it is not enough to practise patriotism in time

of war: by the exercise of judgement and foresight during peace, we must seek to stave off the evil day and to prepare for any possible emergency. Organic chemists and plant for making organic chemicals are every whit as important as the production of dyed fabrics to deck our persons and our surroundings; and it is therefore a matter of national importance to keep the electorate aware of the vital nature of such so-called key industries. The Worshipful Company of Dyers is one of several City companies that has given practical recognition to these truths; its latest effort in this direction is the organisation of a series of lectures on dyestuffs to be given in London during the coming winter. The course of lectures is as follows: October 22, Sir Max Muspratt: How Dyes are made; November 19, Dr. E. F. Ehrhardt: The Patent Law as it affects the Dye-making and Dye-using Industries; December 14, Prof. G. T. Morgan: Recent Researches on Mordant Dyes; January 11, Mr. C. M. Whittaker: Artificial Silk Dyeing; February 15, Mr. R. F. Thomson: Vat Dyes and some recent Developments; March 25, Dr. H. Levinstein: The Dyestuff Industry and the State. Tickets may be obtained free of charge from the Clerk, Dyers' Hall, Dowgate Hill, London, E.C.4.

MEMBERS of the British Association who took part in the Canadian visit, and who wish to be reminded in pleasant fashion of the delightful and varied vegetation of that vast dominion, cannot do better than read the entertaining article contributed to the Journal of the Royal Horticultural Society, Vol. 50, Part 2, by the Lady Byng of Vimy, under the title "Some of Canada's Wild Flowers." Whilst revealing the characteristic personality of the writer, and so written as to appeal to the non-botanist with an interest in flowers, this article gives an excellent account of the main type of vegetation met with in the trans-continental journey undertaken by the British Association, whilst the vivid phraseology conjures up charming pictures of Canadian scenery which for many of the British visitors must now remain in the mind as the background of a very pleasant "busman's holiday."

AT the fifth Congress of Industrial Chemistry, organised by the French Society of Chemical Industry, and recently held in Paris, a Chevreul medal was awarded to Prof. Henry E. Armstrong, and Sir Robert Hadfield, Bart., was elected an honorary member of the Society.

THE Baly Medal of the Royal College of Physicians, given for distinguished work in physiology, chiefly during the past two years, was presented on October 19 to Prof. R. Magnus, professor of pharmacognosy in the University of Utrecht.

UNDER the auspices of the Australian Salon of Photography (Box 298 F, G.P.O.), Sydney, New South Wales, the second International Exhibition of Pictorial Photography will be held on June 7–19 next. The latest date for receiving pictures will be May 3. Pictures from overseas may be mounted or unmounted, but must not be framed, and the Customs authorities require that a value should be placed on each.

IN Our Astronomical Column of September 19, p. 445, reference was made to the series of articles on the changes of view in astronomy during the past year or two, which Prof. H. N. Russell is contributing to the *Scientific American*, beginning with the September issue. We are informed by the associate editor of that journal that Prof. Russell has contributed a monthly signed article to the *Scientific American* on current trends in astronomy since 1900.

A PAPER on "Science and Industry; Some Impressions from the Early Experiences of the British Non-Ferrous Metals Association" is to be presented by Dr. R. S. Hutton and Dr. O. F. Hudson, before the London Local Section of the Institute of Metals, on November 12. The meeting will be held at the Royal School of Mines, South Kensington, S.W.7, at 7.30 P.M., and tickets can be obtained from the honorary secretary of the Section, Mr. W. T. Griffiths, Research Department, Woolwich, S.E.18.

THE ninth lecture of the series "Physics in Industry," being given under the auspices of the Institute of Physics, will be delivered by Dr. B. A. Keen, Assistant Director of the Rothamsted Experimental Station, who will deal with "The Physicist in Agriculture, with Special Reference to Soil Problems." The lecture, which will be open to the public, will be given in the rooms of the Chemical Society, Burlington House, London, on Wednesday, November 25, at 5.30, and the chair will be taken by Sir William Bragg, president of the Institute.

THE establishment of sanctuaries for birds in the Royal Parks in Scotland, at Duddingston Loch in Holyrood Park, Edinburgh, and at Linlithgow Loch, has recently had the consideration of Lord Peel, First Commissioner of H.M. Works and Buildings, and a small committee has been appointed to investigate the matter. The members of the Committee are: The Right Hon. Lord Elphinstone (chairman), Dr. W. Eagle Clarke, Dr. James Ritchie, Mr. W. Home Cook, Surgeon Rear-Admiral J. H. Stenhouse, and Councillor T. G. Nasmyth. Mr. W. Wright, H.M. Office of Works, 122 George Street, Edinburgh, will act as secretary to the Committee.

THE Council of the Institution of Civil Engineers has made the following awards for session 1924–1925 in respect of selected engineering papers, published without discussion: A Telford Gold Medal to Dr. Andrew Robertson (Bristol); a Telford Gold Medal and the Indian Premium to Mr. S. A. S. Bunting (Bombay); Telford Premiums to Messrs. A. D. Swan (Montreal), C. H. Cruttwell (New Ferry), J. W. McLaren (Newfoundland), and J. L. Hodgson (Eggington); and a Webb Prize to Mr. A. R. Johnson (Penang); and in respect of papers read at students' meetings in London or by students before meetings of local associations during the same session: The James Forrest Medal and a Miller Prize to Mr. E. J. Rang (Tynemouth); and Miller Prizes to Messrs. D. Lloyd (Liverpool), H. F. Lea (Birmingham), H. A. Macnab (Glasgow), T. W. Marsh (Rochester), C. R. Smith (Manchester), and W. C. Knill (Gateshead-on-Tyne).

SIR CHARLES SHERRINGTON, president of the Royal Society, unveiled on October 19 the bronze memorial tablet to Sir Charles Wheatstone which has been placed in St. Michael's Church, Gloucester, by the City authorities. The ceremony marked the fiftieth anniversary of the death of Wheatstone, the pioneer of the electric telegraph. A number of instruments and pieces of apparatus designed by Wheatstone himself, or in collaboration with Sir W. F. Cooke, are preserved in the Science Museum, South Kensington. These have been brought together on this occasion in Gallery XXVI. of the new buildings and will remain there as a special exhibit for a fortnight. Early examples of stereoscopic apparatus; of two-, four-, and five-needle telegraph instruments; of his automatic telegraphic transmitting and receiving instruments, and of typewriting machines, are among the exhibits.

THE Egyptian Government Almanac for 1925 has been carefully revised and contains much useful information, among which certain chapters are of scientific interest. Agriculture and industries are fully treated, and there is an account of the various measures for the improvement of crops and combating plant diseases which are being undertaken by the Ministry of Agriculture. A chapter on the Nile gives a condensed account of the regime of the river.

COLOURED pictorial supplements form a feature of recent numbers of the *World's Health*, the monthly review of the League of Red Cross Societies. They illustrate the posters which are issued by the League for health propaganda and are adapted for the respective countries where they are to be utilised. Thus, in the July number the poster reproduced is that for India, and depicts various scenes in native dress and surroundings illustrating common dangers to health, *e.g.* the risk from flies on food, the danger of sleeping with consumptives, etc.

THE Carnegie Institution of Washington has published an account by Dr. Chester Stock of the Cenozoic gravigrade edentates of western North America, in which the Megalonychidæ and Mylodontidæ of the celebrated Rancho La Bræa deposits come in for special consideration. The genera Nothrotherium, Megalonyx, and Mylodon are fully described from excellent material, and the account is fully illustrated by 47 plates and 120 text figures. Attention may be directed to the excellent quality of these text figures, both as to drawing and reproduction; the publication reflects great credit on author, as well as his artists and printer.

THE report of the annual meeting of the Indian Botanical Society held at Benares on January 12 last shows an active society in existence, with a membership of 171, which has assumed responsibility for the *Journal of Indian Botany*, edited by Prof. P. F. Fyson, and is doing its best to unite botanists in India in the task of promoting botanical survey and investigation. The report includes the presidential address by Prof. Shiv Ram Kashyap, an interesting account of the vegetation of the western Himalayas and western Tibet, illustrated by some striking photographs of the cushion-like, shrubby perennial plants which alone can thrive in the cold dry winds in many of the desert regions of the Tibetan plateau.

A FOURTH part of the important work "Trees and Shrubs of Mexico," published as volume 23 from the United States National Herbarium, has recently appeared. In this volume the families Passifloraceæ to Scrophulariaceæ are dealt with by Mr. Paul C. Standley, assistant curator to the Herbarium, but Mr. Ellsworth P. Killip deals with the family Passifloraceæ, whilst about 150 pages are devoted to an account of the Cactaceæ of Mexico by Dr. N. L. Britton and Dr. J. N. Rose. That these authorities could deal with the Cactaceæ is very fortunate, as a greater number of species of this family occur in Mexico than in any other part of the globe. The present volume contains pages 849-1312, with an index of species in an additional 39 pages.

THE annual report of the National Institute for the Blind (1924–25) supplies some interesting reading, which may come as a surprise to those unacquainted with its many-sided activities. There are homes for blind babies, a massage school, a college for blind girls, a guest house, and a hostel, in addition to departments concerned with the publication of Braille embossed books, with the training and after-care of the adult blind, with the supplying of materials for the blind to work with in their homes, etc.; in addition, technical and research work is undertaken with the object of still further alleviating the lot of the blind. The work is of the utmost importance, first, because by adequate training the separation of the blind from their fellows is minimised, and secondly, it is of interest to all scientific people, for by a study of those deprived of one sense we gain some insight into the part played by that sense in the normal person.

MR. CHARLES NOWELL, librarian of the Coventry Public Libraries, sends us a class-list of the periodical publications currently displayed in the city libraries. The list contains entries of no less than 623 publications, exclusive of annuals, and includes the large number of 60 periodicals devoted to motor engineering. Many of these works are no doubt presented to the library; but it is evident that Coventry does not stint expenditure in the purchase of the more expensive publications. For example, nine of the current co-operative periodical indexes and professional abstracts are taken in, such as the Subject Index to Periodicals, the Wilson Co.'s Indexes, Chemical Abstracts, and the Abstracts of the Metal Institute. Against the entry of each periodical in the list is a number indicating in which of these nine indexes and abstracts the periodical in question is analysed. This is a novel and valuable feature in class-lists of the above nature, and we commend it to the notice of other librarians. The list is being sent gratuitously to firms and individual residents who are likely to be interested in its contents. The work is well printed and arranged, and reflects credit upon all who have taken part in its compilation.

A CATALOGUE, recently issued by Messrs. J. W. Atha and Co., Winsley House, Wells Street, Oxford Street, London, W.1, the British agents for Messrs. Carl Zeiss of Jena, contains a description of all modern types of Zeiss microscopes and accessories. The particulars given indicate the many important changes that have been made by Messrs. Zeiss, during the past few years, in the construction of the optical and also the mechanical parts of their microscopes. A new form of mechanism is applied to all their stands for the production of the slow micrometer motion. In this mechanism, the motion is transmitted by accurately cut, toothed wheels. The reaction of a spring ensures continuous pressure in the direction of motion, so that there is no backlash. The component lenses of the objectives are now mounted in small cylinders, which are finally assembled one above the other within a hollow cylinder. This mode of mounting obviates such centring defects as were liable to be introduced in the course of the screw assemblage formerly adopted. The accessories have also been remodelled and improved, and many new and useful devices have been added. Among these may be mentioned the change-over condenser for bright and dark background illumination, the micromanipulator which enables an observer to operate on the smallest microscopically perceptible objects, and special eyepieces, such as the stereoscopic eyepieces, the photographic eyepiece, and the comparison eyepiece.

MESSRS. Reynolds and Branson, Ltd., of Leeds, have recently issued a new edition of their well-known catalogue of chemical and physical apparatus and chemicals. A feature of this publication is its division into sections, each complete in itself, which can be easily found by means of thumb-indexes distinctively marked and coloured; and the relatively small size of the book ($9\frac{1}{2}$ in. × 6 in.) makes it much more easy to handle than ordinary catalogues of this nature. Of the nine sections into which the book is divided, that on optical projection apparatus strikes one as being especially valuable and comprehensive, whilst the photographic reproductions and diagrammatic plans of chemical and physical laboratories, designed and fitted by this firm, cannot fail to interest all heads of departments in schools, colleges, and factories.

READERS interested in Latin America should apply to Mr. F. Edwards, 83a High Street, Marylebone, W.1, for Catalogue 472 relating to books, etc., dealing with Central and South America, British Guiana and the Falkland Islands. Nearly 700 works are offered for sale.

No. 797 of "Sotheran's Price Current of Literature" has just been circulated by Messrs H. Sotheran and Co., 140 Strand, W.C.2. Like its predecessors, it contains many bibliographic notes of interest and value on the works listed, of which there are some 1465 titles. The catalogue includes the library of the late Mr. J. E. Campbell, F.R.S., and a selection from that of Prof. A. R. Forsyth, F.R.S. It should be seen by all mathematicians on the look-out for additions to their libraries.

MESSRS. Bernard Quaritch, Ltd., 11 Grafton Street, W.1, have just issued Catalogue No. 394, which gives particulars of many rare books on astronomy, chemistry, engineering, mathematics and physics, offered for sale by that firm. An item of great interest in the catalogue is "The Wooden and Metal Numbering Rods called Napier's Bones," being the actual calculating instrument invented and used by Napier. The box containing the rods bears the inscription, "This box was the identical property of the author of ye Logs. Napier 1824."

MESSRS. Wheldon and Wesley, Ltd., 2 Arthur Street, W.C.2, have just issued Part 3—Invertebrata—of their Zoology Catalogue. It contains nearly 4000 titles arranged under the headings Mollusca, Insecta, Economic Entomology, Parasitology, Arachnida, Myriapoda, etc., Crustacea, Vermes, Echinodermata, Cœlenterata, Protozoa, Aquaria, Marine Biology, Microscopy, and Miscellanea. We notice that the same firm offer for sale as a whole the collection of pamphlets and separates mainly on entomology formed by the late Dr. Péringuey, of the South African Museum.

AN extensive variety of instruments is contained in a catalogue of second-hand scientific apparatus which has just been issued by Mr. C. Baker, 244 High Holborn, London, W.C.1. Microscopes and microscope accessories, surveying and drawing instruments, spectroscopes and projection apparatus, telescopes and binoculars, astronomical instruments ranging from students' models to large equatorials, and apparatus for general physical measurements, are detailed in classified lists, which contain, in all, about 2500 items, and each item is priced. The apparatus and instruments have all been tested and are guaranteed by the firm to be in perfect adjustment before being offered for sale. Copies of the catalogue can be obtained on application being made to the firm.

MESSRS. Dulau and Co., Ltd., 34 Margaret Street, W.1, have just circulated an interesting and useful catalogue (No. 132) of second-hand gardening books and botanical and horticultural works. Of the 1100 odd books offered for sale, many are from the libraries of the late Sir Isaac Bayley Balfour, Mr. C. Harman Payne, and Mr. William Watson. Copies of the catalogue can be obtained free upon application.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned: A lecturer in agriculture and farm costings at the Hertfordshire Agricultural Institute, Oaklands, St. Albans—Clerk of the County Council, 28 Castle Street, Hertford (November 3). A director of the botanical and plant-breeding section of the Ministry of Agriculture, Egypt, and an economic botanist—The Egyptian Legation, 7 Charles Street, W.1, or the Under-Secretary of State, Ministry of Agriculture, Cairo (November 20, endorsed "Research Staff"). A laboratory steward at the Central Secondary School, Sheffield—Headmaster.

Research Items.

THE "SUN GOD" IN INDIAN ART.—The development in the iconography of Sûrya in Brahmanical art is the subject of a study by Jitendra Nath Banerjee which appears in the September issue of the *Indian Antiquary*. In Vedic ceremonies symbols such as the spoked wheel, rayed disc, etc., were used to represent the sun. Anthropomorphic images of the sun god do not appear until late in Indian art owing to the disappearance of monuments, other than Bhuddist, prior in date to Asoka. The characteristic features of the type of the sun-god images which have been discovered in Northern India are top-boots, a close-fitting bodice-like garment, and a waist zone which has been identified with the sacred woollen girdle of the Zoroastrians. This type has been assumed to be Iranian, derived from Mithra; but the anthropomorphic representation of Mithra is due to the Hellenisation of Mithra and is derived from Apollo-Helios. The type first appears in India on a coin of Kaniṣka. The medieval booted sun god of India is thus derived from the Hellenistic Apollo with certain added characteristics—the boots and heavy tunic—to be attributed to the Scythian invaders who followed the Hellenes. Ingenious myths were invented to account for these alien characteristics. In Southern India they were forgotten, and the sun god is there represented without his boots and heavy draperies.

THE ETHNOLOGY OF NEW ZEALAND.—In Vol. 2 of the Cawthorn Lectures (Cawthorn Institute, Nelson, N.Z.) Te Rangi Hiroa (P. H. Buck) surveys present knowledge bearing upon the question of the origin and composition of the Maori and pre-Maori population of New Zealand. The traditional settlement of New Zealand is analysed into three periods: (1) a pre-Toi settlement occurring a fairly long time before A.D. 1150; (2) the Toi expedition of A.D. 1150; (3) the Hawaiki migration of A.D. 1350, which was composed of the Fleet of five vessels with the well-known canoes. The Toi people failed to bring cultivable food plants, though acquainted with them. As they were a mere handful among a numerous people of food gatherers, agriculture as well as a number of useful arts disappeared until introduced by the later migration. A detailed study of culture areas has still to be made, but the Southern culture appears more typically Polynesian than the Northern, which contains elements pointing to Western affinities from a non-Polynesian source. Among the Moriori of Chatham Island there are long-headed and broad-headed elements associated with a narrow nose; but there is complete absence of the broad-nosed Melanesian type. On the mainland, Melanesian and broad-headed elements of two types, which appear especially in remoter areas, are present. It thus appears that there were really two distinct waves of pre-Toi people coming from different regions and having distinct characteristics, one from Eastern Polynesia, the other from the Western Pacific area and bringing with it a culture with non-Polynesian elements.

SECTIONS OF THE HUMAN EYE.—A series of seven photomicrographs of sections of the human eye, the work of E. F. Fincham, are reproduced in the Transactions of the Optical Society, Vol. 26, No. 3. Several of these illustrate the distribution and size of the rods and cones in different areas of the retina. A transverse section through the bases of the rods and cones in a peripheral part of the retina shows their irregular arrangement. Here and there in this region two cones are in contact with one another, and there is a much greater number of rods than cones. The maximum diameter of the rods is 1·5μ, while that of the cones is 6μ. At the border of the fovea, the cones exceed the rods in number. Here the maximum diameter of the cones is 4·5μ. Nearer the centre of the fovea they are smaller, measuring only 3μ, and very few rods are present. The foveal cones shown in another photograph are thin and elongated, the maximum diameter being 2μ. No rods are seen in this area. The hexagonal section of the cones and their packing at the fovea, as described by Helmholtz, are well illustrated in a photograph (magnification, 1000) of a transverse section of the cones in that region. Another interesting photograph is that of a section of the ciliary region of the eye, which has been so cut as to expose a complete zonule fibre extending from the inner surface of the ciliary body towards the anterior capsule of the lens.

HERRING INVESTIGATIONS.—A first report on the investigations made by the Ministry of Agriculture and Fisheries with regard to the age, length, and maturity of the herrings of the southern North Sea is given us by Mr. W. C. Hodgson (Fish. Invest. Ser. ii., vol. 7, No. 8, 1924). The Norwegian scale theory has been accepted by the Ministry as a working hypothesis. The calculated sizes of the fish at the formation of the first winter ring show variations, and these group themselves about 8, 10, and 12 cm. For these three groups corresponding stages of young fish have been found in the winter. It is stated that a foundation for solid investigations will have been laid when the origin of these groups has been established and when it can be said a given year-class comes from a certain spawning. Growth, as shown by the scales, was found to begin in April and cease in September. The younger fish began their growth earlier and had a longer growing period than the older fish. From data obtained during the period May to October 1924, it is shown, for fish with four zones on the scales, that growth was most active during May and June, and in September it slowed down considerably. These data give a curve which shows close agreement with the observations made by Hardy on the feeding of the herring.

EVOLUTION BY HYBRIDISATION.—Dr. L. Cockayne states that amongst the vascular plants of New Zealand, 206 wild hybrids are known between Linnean species. In these circumstances it was a natural and happy idea to invite Dr. J. P. Lotsy to visit that dominion, study the vegetation, and give some lectures upon his views as to the part played by hybridisation in evolution. These lectures are now published by Canterbury College under the title "Evolution considered in the Light of Hybridisation," and provide a useful brief statement in English of the reasons why Dr. Lotsy attaches such significance to sexual reproduction and the possibility of hybridisation in connexion with the process of evolution. He precedes the statement of his own views with a very trenchant examination of theories of transmissible variability, whether neo-Lamarckian or mutationist.

THE SOURCE OF SANTONIN.—T. E. Wallis and Ellinor J. Mowat, of the Pharmacy Research Laboratory, have done a useful if laborious piece of work in clearing up the systematic position of various samples of Artemisia, the worm-seed of commerce from which santonin is prepared. Microscopic examination of the foliage leaves and the tracts of the flower head has made it clear that the true source of the drug is *Artemisia Cina* (Berg) Willkomm, which is a different species from that given in the British Pharmacopœia, whilst yet another species is given in the United States

Pharmacopœia. Seven commercial specimens devoid of santonin were examined and could be distinguished by the hairiness of the leaves and other minute characters. The specimens thus examined seemed all to be of the same species, but unfortunately it still remains unidentified.

INDIAN BAMBOOS FOR PAPER PULP.—*Indian Forest Records*, vol. 11, part ix., records the very successful large-scale trials by Mr. W. Raitt of his methods for utilising the bamboos and savannah grasses of India as material for paper pulp. The methods now successfully applied at the Forest Research Institute, Dehra Dun, with a small plant capable of handling 20 tons a week, are based on prolonged laboratory experiment, and, as is stated by Mr. R. S. Pearson, Forest Economist, in a preface, it appears that they "at once bring the utilisation of bamboo for paper pulp on to an absolutely sound foundation." The key to the method seems to lie in a process of "fractional digestion," in which a large bulk of soluble material, mainly carbohydrates, is got rid of by the use of dilute alkali, thus preventing dark-coloured decomposition products, which arise from these soluble compounds in time, from staining the final cellulose product. At the same time economy of alkali is effected as stronger percentages are only used on a smaller bulk of material at a later stage, whilst the high density of soda then used enables both time and temperature to be reduced in the process of lignin digestion, which follows upon the removal of the more soluble products. The lignin hydrolysis yields a clear liquid which can be removed from the pulp with great facility without leaving any stain. The large paper mills of India are said to be adapting their plant to this "Fractional Digestion" system. It deserves consideration outside the bounds of India: thus Prof. F. W. Oliver has described experiments on the utilisation for paper-making of spartina, the grass which is now colonising vast sheets of mud in the neighbourhood of Southampton, and was studied with interest by many members of the British Association this year. Prof. Mangham gives a brief account of this grass, with some striking photographs, in *Conquest* for September 1925.

AMMONITES OF THE FAMILY ECHIOCERATIDÆ.—The importance of Ammonites as zone fossils, and as affording clear evidence of evolutionary processes in the past, has led to their intensive study in an ever-increasing degree. Buckman's work on them in this direction is well known, and the studies initiated by him have been taken up by various successors. The latest and a most valuable contribution is one by Dr. Trueman and Miss Williams entitled "Studies in the Ammonites of the Family Echioceratidæ" (Trans. Roy. Soc., Edinburgh, 53, pt. 3), members of which have been most frequently recorded in the past as *Ammonites raricostatus*. After discussion of general considerations, the authors proceed to systematic descriptions. Here they increase the five genera which they found when they took up their investigations, by the addition of nine new ones. In making these genera, and in indicating their limits, attention was paid so far as possible to the presumed phylogeny of the family, but the authors suggest the possibility that further researches may entail the foundation of yet others. This implies, of course, the creation of additional new species to the thirty-three such named in the present paper. There is a short but sufficient section devoted to the stratigraphical distribution of the family as well as an altogether admirable series of excellent plates.

AN ARCTIC OIL OCCURRENCE.—In a short bulletin of the United States Geological Survey (No. 772), by Messrs. Paige, Foran, and Gilluly, some details are given of the results of an expedition to the Point Barrow region of extreme northern Alaska in 1923, made primarily to search "Naval Petroleum Reserve No. 4" for evidence of petroleum. The expedition seems to have been quite successful despite the remoteness of the area, inaccessibility, rigid climatic conditions, and other obstacles to routine survey, and two large oil seepages at Cape Simpson were discovered. Practically the entire area of this Naval Oil Reserve lies north of the sixty-ninth parallel, and thus comes well within the Arctic Circle. The Cape Simpson seepages seem to emanate from Mesozoic rocks (Upper Jurassic or Lower Cretaceous), which are the predominating rocks of the Point Barrow region, but owing to the drift and moss-covered character of the coastal plain country and absence of contiguous solid rock, it has so far been found impossible to discover definite relationships between the petroleum and local geology. It is clear from the tests carried out on samples of the oil, however, that it is much inspissated, and probably has migrated from considerable depths. It showed a specific gravity of 0·943 and contained 6·36 per cent. of sulphur and 7·5 per cent. of water; distillation indicated chiefly gas oil and lubricant fractions, lighter products having evaporated. The results of these tests, coupled with the available geological evidence, justify a continuation of the explorations, and a further expedition has been sent out at the instigation of the United States Naval Department to prove the value of the discovery.

UPPER AIR TEMPERATURES IN EGYPT.—The Meteorological Office, Air Ministry, in Professional Notes, No. 41 (London: H.M. Stationery Office, 3*d*. net), by Mr. E. V. Newnham, discusses upper air temperatures in Egypt. The discussion refers to observations made at Ismailia and at Helwan. Mean values of temperature corresponding with pressures of 950 or 900 to 650 or 600 millibars are given, and these are taken to be also the means corresponding with the average heights at which these pressures occurred. The difference between the mean temperatures for January and August are given, these being the months with lowest and highest means at all heights, and some figures for south-east England are added. The range with height is seen to be rather greater in Egypt than in south-east England. At a height of about 3300 ft. the lowest temperatures occur generally with winds having at least some component from north and often with nearly due north winds; the directions corresponding with the highest temperature are very variable. At 12,000 ft. and 14,000 ft. the fluctuations of temperature are much smaller, and they do not correspond very closely with the fluctuations lower down. The discussion is a praiseworthy effort to advance our knowledge of the general circulation of the atmosphere.

A HIGH ALTITUDE OZONE LAYER IN THE ATMOSPHERE.—In the *Comptes rendus Acad. Sci.*, Paris, August 24, Messrs. J. Cabannes and J. Dufay describe observations on absorption bands due to ozone in the spectrum of the sky at the zenith, in the middle of the day and towards evening, in which their relative intensities were compared. The mass of ozone traversed by vertical rays reaching the ground is equivalent to a layer of the pure gas at atmospheric pressure with a mean thickness of 0·3 cm., and if this gas were uniformly distributed in the atmosphere the amount in that portion of it in which ordinary determinations can be made would be about ten times as great as that actually observed. The natural conclusion is that the amount of ozone is greater at high elevations than lower down, and since the light

passing through this high layer of ozone strikes it more nearly perpendicularly in the middle of the day than in the early morning or the evening, the absorptions will differ. In either case the light passing through this layer will be diffused by the air into which it passes, and will be observed as sky light. The authors deduce from their measurements a height of about 50 km. for the ozone-rich layer of the atmosphere, 48 km. from observations on March 10, 53 km. for June 4, and 48 km. for June 8.

RADIATION DUE TO ELECTRONIC BOMBARDMENT.—An article in the *Zeitschrift für Physik* for July 18, by Prof. G. Mie, deals with the relation between the radiation produced by bombardment with swift electrons (*Bremsstrahlung*) and the new emission theory of Bohr, Kramers, and Slater. It is difficult to reconcile the existence of this "braking radiation" with the new theory. When an electron enters an atom with a high velocity it travels in a hyperbolical orbit, and may jump from this into a hyperbolical orbit with smaller energy, or even into an elliptical orbit, with an emission of braking radiation. According to the new theory of emission, radiation takes place during the time before the jump, when the electron is moving in the higher orbit; but it is difficult to see how this can take place for the braking radiation, since an electron moving in a straight line with uniform velocity certainly does not radiate, and the short time during which it remains in the hyperbolical orbit near the nucleus will not suffice for the emission of a long wave train. It seems necessary to assume that the electron itself can act as an oscillator, and that a free electron at a distance from any atom can take on an infinite number of conditions in each of which it contains a different amount of internal energy. In an ordinary stream of electrons, each of them is in the most stable condition and does not radiate, but when one of them meets an atom it may undergo a collision of the first kind and a portion of its kinetic energy will be suddenly converted into internal energy, the electron passing into a higher valued condition. It will at once begin to radiate with constant intensity, and with a definite wavelength, until it either falls back into the most stable condition at the end of the natural "life" (*Verweilzeit*), or possibly until before this it loses its capability of vibration as the result of a collision of the second kind, and again gains kinetic energy. Collisions are also possible in which the atom absorbs or gives out energy. Compton's scattered radiation is the fluorescent radiation of the free electrons, which are excited by optical resonance. If they radiate undisturbed to the end they form the recoil electrons; if their radiation is stopped by a collision of the second order they form the swift photo-electrons.

TERNARY ALLOYS OF IRON, CARBON, AND NICKEL.—Owing to their industrial importance, many papers have been published on the constitution of nickel steels, but there has as yet been no systematic study of the ternary alloys of iron, carbon, and nickel. T. Kaser, in the 104th Report from the Institute for Iron, Steel, and other Metals, Japan, gives an account of his investigations on the equilibrium of this system. The chief previous investigations on the binary alloys have been carried out by Ruer and Schütz, and by D. and H. Hanson. The present author has also investigated the binary systems, iron-nickel and nickel-carbon. He finds that carbon and nickel form a eutectic at a concentration of 2·22 per cent. of carbon and a temperature of 1318° C. The solubility of carbon and nickel is 0·55 per cent. at the eutectic temperature, and about 0·25 per cent. at room temperature. In the ternary system the author finds no ternary eutectic, but a binary eutectic of a solid solution consisting of iron-nickel and carbon. The sum of the combined and dissolved carbons in the ternary alloys at room temperature rapidly decreases to 0·30 per cent. in 30 per cent. nickel-steel, and afterwards remains constant. The field representing the existence of cementite in the ternary alloys has been determined. It almost coincides with the range in which combined or dissolved carbon exists. With the addition of nickel the A1 transformation is lowered and is scarcely visible at 10 per cent. As the nickel content increases, the carbon content in the eutectoid compound decreases down to 0·30 per cent. at about 35 per cent. of nickel.

A NEW LOCAL ANÆSTHETIC.—The British Drug Houses, Ltd., have prepared a new substitute for cocaine, called borocaine, which is an efficient, non-toxic, surface anæsthetic. The original paper on borocaine, by Copeland and Notton, appeared in the *British Medical Journal* for September 25. It is prepared as a soluble white crystalline powder and is the borate of ethocaine.

A SIMPLE PRECISION CRYOSTAT.—In the Journal of the American Chemical Society for September a simple precision cryostat is described, a modification of that of Henning, able to maintain any required temperature from 0° to −180° for three hours. The liquid in the bath, gasoline for temperatures to −140° and butane for temperatures to −180°, is cooled by aged liquid air flowing through a copper spiral, under pressure of a hand-regulated water-head, at such a rate that the bath tends to become too cold. Temperature change is shown by a sensitive galvanometer used as a null instrument, a heating coil in the bath being operated by a switch to restore the needle to zero. The maximum error at −150° is 0·01° and at −180° is 0·015°.

ESTIMATION OF OXYGEN.—It has been known since 1863 that the estimation of oxygen of high purity by adsorption in alkaline pyrogallol solution is rendered inaccurate by the liberation of carbon monoxide. The results of some work on this subject by Drakely and Nicol appear in the Journal of the Society of Chemical Industry for September 25, 1925. They recommend the use of a solution prepared by adding 15 gm. of pyrogallol to 100 cc. of potash solution of d. = 1·55, in the usual gas analysis vessels; agitation is of utmost importance; the solution must not be used after absorbing one-tenth of its specific adsorption volume, and the oxygen content of the gas should be reduced to 25 per cent. with nitrogen. With these precautions the analysis may be considered sufficiently exact for industrial purposes.

CATALYTIC ACTIVITY OF THIN FILMS.—The results of some experiments on the catalytic activity of thin films of nickel and platinum in the reaction $C_2H_4 + H_2 \rightarrow C_2H_6$ are published in the September Journal of the American Chemical Society. Thin films of nickel and platinum were deposited on glass wool in evacuated vessels by electrical heating of filaments coated with these metals. The mixture of gases containing 20 per cent. ethylene and the catalyst were heated to 200°, but no reaction was observed. Similar negative results were obtained when oxygen and water vapour were admitted. The results indicate that the importance of the extent of surface has been overestimated. From the method of preparation of the surface it is likely that the electronic configuration of the molecules in the film is the same as that in the bulk metal and differs from that in the catalyst prepared by the reduction of the oxide. It is supposed that the surface of the catalyst consists of molecules having electrons on different energy levels from those in the crystalline metal.

Palæontologists at Weimar.

THE annual meeting of the international Palæontological Society, which, as already announced in NATURE, was held in Weimar on September 24 to 30, was attended by about sixty members. Germans naturally predominated, but Austria, England, Hungary, Russia, and Sweden were also represented.

FIG. 1.—At the bottom of the Kämpfe Quarry in the travertine of the Ilm terrace near Ehringsdorf, Weimar. The white paper label marks the level of the Mousterian culture-layer.

Weimar is a delightful town in which to stay, but the historical interest of the best available meeting-room scarcely outweighed its unsuitability for a modern scientific conference, nor did the rainy weather conduce to the pleasure of the excursions. On the other hand, the immediate neighbourhood has, during the past few years, furnished the Weimar Museum für Urgeschichte with a remarkable series of Pleistocene remains, which have been studied and arranged mainly by Prof. W. Soergel and Custos Moeller. These come from the travertine and gravel deposits of the Ilm valley. An excursion had been planned to the travertine quarries of Ehringsdorf, where in the lower beds is to be seen a culture layer of Mousterian age. In clearing a fresh surface of this layer for inspection by the palæontologists, the unexpected discovery was made of a battered skull of Neanderthal type embedded among the charred fragments of wood and bone. The mode of occurrence suggested that this might be a case of cannibalism. Another recent find, announced by Prof. Freudenberg, was of human bones from Mauer, possibly belonging to the original *Homo heidelbergensis*.

Inspired by the morphology of Goethe, Prof. Jaekel opened the proceedings with a most interesting lecture on the problem of the skull. His main conclusion was that the primitive skull consisted of four parts, two in the cranium, two in the lower jaw, with the addition of a quadrate. Prof. Sewertzoff, on the other hand, claimed for the primitive cranium a large number of ossification centres. The Russian morphologist also discussed the origin of the quadrupeds. Dr. Ehrenberg attempted, from his studies of cave-bears, to throw some light on the epiphysis found at the back of the head in young skulls. Prof. Jaekel introduced a Devonian fossil as a direct ancestor of the sturgeons, in which case the Liassic sturgeons would be a side-branch. Prof. Wiman discussed minor points in the skeleton of Mesosauria, Dr. Gürich showed photographs of Triassic Deinosaur foot-prints from German S.W. Africa, and Dr. Schmidtgen described a huge *Elephas trogontherii*, with a pelvis 183 cm. wide, recently obtained by the Mainz museum. The most fundamental paper on vertebrate anatomy (scarcely palæontology) was by Prof. Weidenreich of Mannheim, who demonstrated a continuity of the organic stroma from bone, through dentine, right into the enamel of the teeth.

Among the papers on fossil invertebrates may be mentioned Prof. Kessler on the siphonal structures of various cephalopod shells, illustrated by many preparations, including some transparent specimens from Spitsbergen; Dr. Scheurlen on pustulate ammonites from the Upper Brown Jura, showing that various species of Strigoceras were really growth-stages of a single species; and Dr. Beurlen on some stratigraphical and palethological questions concerning Jurassic Crustacea, in which Eryon was regarded as tending towards Brachyura. Arenicoloides was the subject of papers by Prof. K. Andrée and F. A. Bather, the former regarding it as identical with Diplocraterion (Torell) and Arthraria (Billings), the latter seeking to explain it by similar structures in the Yorkshire estuarine oolites. The curious markings and other peculiarities of the Flysch were held by Prof. Abel to indicate formation under the conditions of a Florida imangrove-swamp.

Two papers of historical interest directed attention to modern evolutionary views in pre-Darwinian works,

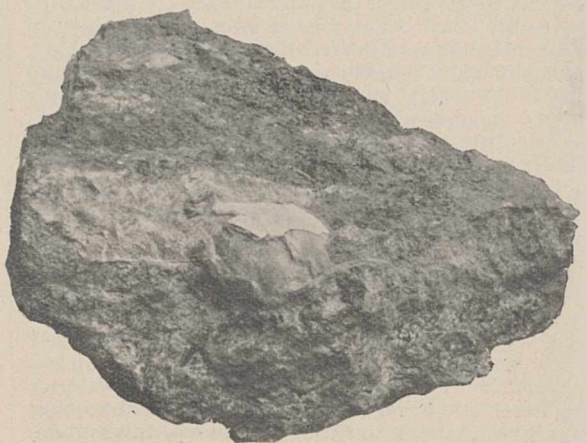

FIG. 2.—A block of the Mousterian culture-layer showing the battered Neanderthal cranium *in situ* as found.

Prof. Wüst dealing with Ludwig Rütimeyer (1825–1895) and Prof. Pompeckj with Reinecke (1818).

The meeting was brought to a close by an excursion to Jena, where members were invited to a special demonstration of the marvellous Zeiss planetarium; that at Munich was described in NATURE (December 27, 1924), and we believe there will soon be one in London. Then followed an inspection of the Phyletic

Museum, under the guidance of Prof. L. von Plate. In the afternoon members examined the Muschelkalk at Göschwitz, where the rock is worked on the plateau in a succession of funnel-shaped quarries. A tunnel leads to the bottom of each funnel and the rock is tumbled down into the waiting waggons, which are transported by an aerial line to the cement works in the valley. Since the rock is cut out in steps, each quarry resembles a Roman amphitheatre, but with no arena. Thus ended an exceedingly interesting meeting, at which one would like to have seen more palæontologists from the British Isles.

Cotton-Growing in the British Empire.

A USEFUL account of the present position of cotton-growing in Uganda is given by Col. C. N. French in a recently published report to the Empire Cotton-Growing Corporation on his tour through the cotton areas of Uganda, Kenya, and the Mwanza district of Tanganyika. The rise and promise of Uganda as a cotton-producing region are well known. Under the careful guidance of the agricultural department, cotton has become by far the most important export of the country, the annual production amounting to nearly 200,000 bales. Practically the whole of the crop is raised by the natives, who send their seed cotton to the ginneries established at convenient centres under European or Indian control. The type at present grown is a variety of the famous "Nyasaland Upland." The quality of the cotton is good and the yield not unsatisfactory, while so far no serious pests have been encountered. Col. French considers that for the time being the producing area should not be extended, but efforts made to consolidate the present position by the application of science and improved agricultural methods with the view of producing increased quantities of cotton of better and more uniform quality from the area already under cultivation. He believes that the most immediate need for the attainment of this object is the strengthening of the scientific side of the agricultural department, and he puts forward suggestions for the reorganisation he considers desirable.

A further illustration of the work of the Empire Cotton-Growing Corporation is afforded by the "Reports from the Experiment Stations for the Seasons 1923, 1924, and 1925 (South Africa only)." In South Africa, F. R. Parnell has established the fact that resistance of the cotton plant to the attacks of "jassid" (*Chlorita fascialis*, a small winged bug forming a menace to cotton-growing in the lower veldt) is hereditary, and considerable progress has been made in the direction of breeding a jassid-resistant variety of cotton. R. C. Wood reports on the selection and other experimental work carried out at Mpanganya (Tanganyika). One of the varieties resulting from the selections made in 1922 will be the first seed to go out into general cultivation (it is hoped) in the season 1926–27. The work of establishing and laying out the experiment station at Makwapala (Nyasaland) during 1924 is described by H. C. Sampson; while details of a variety test with Sea Island cotton in St. Vincent, B.W.I., are recorded by L. H. Burd. This latter work was undertaken with the object of investigating the relationship, if any, existing between the yield and other "growing" qualities of the cotton plant, and the spinning characters of the fibre. The inconclusive results illustrate the difficulty of complicated work of this nature, but an encouraging practical outcome of the experiments is the evidence afforded by the spinning tests (carried out by the Experimental Department of the Fine Spinners' and Doublers' Association) of the superiority of all the strains of cotton tested over the control standard sample of West Indian cotton: reduction of comber waste was considerable, and in one case a superiority of 47 per cent. over the control cotton as regards the relationship between hair strength and weight of lint was recorded.

The Empire Cotton-Growing Corporation has evidently recruited men of overseas experience in addition to scientific knowledge in their task of widening the area under cotton cultivation in the British Dominions Overseas. The October number of the *Empire Cotton Growing Review* contains reports of their activities in all parts of the Empire. H. C. Sampson points out how cultivation implements adapted from Indian experience may be applied to cultivation with native labour in East Africa, whilst Col. C. N. French discusses the possibility of adapting the methods of administration of large-scale estates in the Punjab to the problems of cotton-growing in the Mandated Territory of Tanganyika. Mr. Youngman describes the short staple Oomras cotton and the factors leading to the cultivation of this coarse type of cotton in a vast area of Central India. It is thus once more apparent what a reservoir of experience to be applied in problems of tropical administration is rendered available through Britain's long responsibility for India's development. In a review dealing with cotton-growing, insect pests are naturally well to the fore, and H. A. Ballou discusses them in general relation to cotton; F. R. Parnell's work on breeding jassid-resistant cottons is also described, whilst incidentally, in discussing insect pests under Australian conditions, E. Ballard gives it as his experience that jassid infestation is only serious when the soil is very poor, *e.g.* deficient in potash.

University and Educational Intelligence.

APPLICATIONS are invited by the Harveian Society of London for the Buckston Browne prize, consisting of a medal and 50*l.*, for the best essay on "The Etiology of High Blood Pressure and of the Respiratory Phenomena associated with High Blood Pressure and Chronic Nephritis." The latest date for the receipt of essays is November 1, 1926. Particulars of the competition may be obtained from Dr. G. de Bec Turtle, 81 Cambridge Terrace, Hyde Park, W.2.

THE President of the Board of Education and the Minister of Labour have appointed a committee "to inquire into and advise upon the public system of education in England and Wales in relation to the requirements of trade and industry, with particular reference to the adequacy of the arrangements for enabling young persons to enter into and retain suitable employment." The committee consists of Mr. Dougal O. Malcolm, Miss Violet Markham (Mrs. Carruthers), Mr. Max J. Bonn, Mr. W. B. Kenrick, Mr. Arthur Shaw, Mr. Christopher H. Turnor, and Mr. D. Milne Watson. Mr. H. B. Wallis, Board of Education, and Mr. W. H. Lowe Watson, Ministry of Labour, are joint secretaries, and all communications should be addressed to them at the Ministry of Labour, Montagu House, Whitehall, S.W.1. The absence from the committee of any one familiar with the place of science in education, or education in science, is particularly noteworthy. Oxford and Balliol predominate in the membership of the committee, and they represent the characteristic official attitude towards scientific teaching or its relation to modern needs.

A NEW Diploma Course in Agriculture is announced by the Edinburgh and East of Scotland College of Agriculture. Hitherto the College diploma course has extended over three years, like the degree course, from which it has differed but little in scope. Neither course has attracted more than a very few prospective

farmers. Nearly all those who have taken them have done so with the view of becoming teachers or departmental officials. The college authorities have determined that the new diploma course shall meet so far as practicable the needs of the ordinary farmer, and have therefore limited it to two winter sessions, and reduced to a minimum the purely theoretical instruction. The new regulations appear in full in the College Calendar for 1925–26. The subjects are agriculture, agricultural chemistry, agricultural botany, agricultural zoology, farm accounting and agricultural economics, land surveying and agricultural engineering, veterinary science, and agricultural law. The Calendar shows that during the past session the central classes were attended by 407 students, namely—day classes, 121 ; evening classes, 184 ; rural schools' course, 86, and farmers' class, 16.

THE government of the Welsh National School of Medicine has formed the subject of prolonged consideration by the Council of the University of Wales, which has come to the conclusion that the School, at present governed by the Council of the University College of South Wales and Monmouthshire, assisted by a Board of Medicine and a Faculty of Medicine, should be constituted an independent School of the University. At a special meeting of the Court of the University presided over by the pro-chancellor, Lord Kenyon, on October 16, a resolution to this effect was submitted by Mr. William George, of Criccieth. It was asserted, as one of the grounds of the motion, that unless the School was made truly national it would be difficult and perhaps impossible to secure rate aid from the North Wales councils, and the Privy Council grant of 7000*l.* would not be available. The motion was opposed by Principal Trow, of the University College of South Wales. After discussion it was carried by 71 votes to 41. It is proposed to petition the Privy Council for a charter of incorporation for the School, the status of which in the University of Wales would thus approximate to that of the College of Medicine, Newcastle-on-Tyne, in the University of Durham.

THE University of Leeds has launched a public appeal for half a million pounds for structural expansion and increased equipment. This sum is not far short of the total of the donations and subscriptions (excluding those of the Clothworkers' Company, amounting to about a quarter of a million) received by the University and the Yorkshire College of Science during the past fifty years. The appeal organisers have set themselves the task of raising it in ten years, hoping that it may be possible to proceed with the building programme meanwhile at the rate of 50,000*l.* a year. The staffing of the University has, in the past, been treated always as of first importance, and to this policy is largely due the substantial success it has achieved in the pursuit of its aims, but a situation has now been reached in which "its present efficiency is severely hampered and its future efficiency is imperilled both by the want of accommodation and by the unsuitability of much of the existing accommodation." In particular a new library building with accommodation for 200,000 volumes, new laboratories for the medical school, new buildings for nine or ten departments, new residential hostels, and a properly equipped students' union building are urgently needed. With the appeal, which is addressed especially to the local patriotism of Yorkshiremen, is circulated a booklet prepared for the jubilee celebrations of last year, giving an account of the growth of the University and a summary statement of its activities. The first list of subscriptions in reply to the appeal includes donations and promises amounting to more than 110,000*l.*

Early Science at Oxford.

October 24, 1683. Several members of the Royal Society and others, met at Oxford for making experiments. There was communicated an observation of the weight of the earth of the Nile about the time of the overflowing of that river, but especially a relenting of a piece of nitroon or nitre, brought from Ægypt, which continually wet the papers, on which it lay, both in rains and dry weather, from the middle of June till about the end of September.—There was also an intimation of fish having lived in a cistern upon rain-water only for half a year, till upon the freezing of the water they died by breaking of the ice.—There was also mention made of a probable way of tinging white marble black.

October 26, 1683. The Company meeting, in ye Naturall History School, desired Dr. Wallis, to take on him ye trouble of ye Chair ; and appointed Mr. Musgrave, to take ye Minutes of their discourse ; after which, Dr. Plot made a learned Discourse on Earths. Upon ye account of the last branch of his Scheme, it was ordered by ye company, that some person should try, whether Boles burnt will apply to ye magnet ? Dr. Plot was pleased to take this province on him : This gave occasion to a farther discourse concerning Magnetism ; twas delivered as an observation, by Mr. Ballard, that a magnet, carried up, and down, in his pocket, has been found to attract sometimes more, then at other times.

'Twas ordered to be tryed, whether bricks, heated, and afterwards growing cold, in a posture North, and South, will acquire a verticity ? Mr. Ballard promised ye Society to try this experiment.

After this, an enquiry was made into ye nature, and reason, of striking fire ; 'twas proposed as a quære ? how tobacco-pipes (in which there is not ye least suspition of a Sulphur) come to strike fire ? 'Twas given in as an observation, that hardened iron (such as horse-shoes are made of) will yeild flakes of fire, larger, and of a deeper red, than steel will ? *This* led ye Company to discourse of hardening Iron.

Dr. Plot was desired to give an account of ye methods used by ye smiths at Wolverhampton in these cases : 'Twas observed, that an ingenious smith of Oxford, us'd to soften his iron, by heating it moderately, then dawbing it over with tallow, and afterwards heating it red hot, and letting it cool gradually in the fire as that went out.

October 27, 1685. The Company being small no papers were read.

October 28, 1684. A bottle of water, sent the Society, by Mr. Maunder, from a well near Milton-Abby in Dorsetshire, was delivered in at our meeting by Mr. Crouch ; and ordered to be examined as to its principles ; which office Mr. Welsteed took on him. The well from whence this water came, does sometime purge, sometimes vomit, and is said to cure ye gout.

Dr. Plot communicated an abstract of a letter dated from Minehead, October 17, 1684, in which Mr. Cole acquaints ye Doctor, that he was lately met with a shellfish on ye Severn shore, containing a white viscous phlegm, which being laid on cloth, turns *greenish*, within a minute or two ; then being put out into ye Sun, for a little while, turns to a deep red, which growes somewhat lighter by ye first washing, but after that never decays, tho ye cloth be often washt. He adds farther, that this Tincture is extremely fetid, so that the ill smell is not easily taken away. He was pleas'd to send us Patterns of ye green, ye deep, and lighter Reds, which sufficiently answered their descriptions. The thanks of the Society were ordered to be returned him, for this considerable peice of newes.

Societies and Academies.

LONDON.

Royal Anthropological Institute, October 6.—Geza **Roheim**: Hungarian calendar customs. Three groups of customs connected with the calendar were discussed. In Hungarian winter dances a bull plays a conspicuous part. One of the performers may be called a bull, or the bull is a musical instrument used by these dancers. The identity of a demon and a musical instrument reminds us of primitive initiation ceremonies, and the Hungarian rites in question are actually connected with the initiation of lads. The fertility customs of St. George's day are based on the unconscious concept of birth, and it is in this sense that the Palilia, the Roman prototype of St. George's day, was the birthday of the community. The kings and queens of Whitsuntide in Hungary show that these embodiments of fertility are really the survivals of primitive divine kings, for even in the seventeenth and eighteenth centuries, Hungarian Whitsuntide kings enjoyed certain privileges and wielded authority over the lads of their village for a year.

NAPLES.

Academy of Physical and Mathematical Sciences.—Among the papers published in the issue of the *Rendiconti* of the Academy for April-August 1925, are the following: (1) Prof. R. **Biazzo** describes a modification of the thiocyanate method of determining the proportion of copper in commercial copper sulphate, in which the excess of thiocyanate used is ascertained by titration with permanganate in the presence of sulphuric acid. The iron present is previously eliminated by oxidation with chlorine and precipitation as ferric hydroxide, and, for the reduction of the copper to the cuprous state, potassium cyanide must be used in place of sulphurous acid. (2) Arnaldo **Piutti** is unable to find any relationship between the hafnium contents of samples of zircon from different localities and the densities of the minerals, but confirms von Hevesy's observation that a connexion exists between the proportion of hafnium present and the degree of radioactivity. (3) From the capacity of certain samarium minerals to form homogeneous mixed crystals with the corresponding compounds of calcium, strontium, and lead, Dr. G. **Carobbi** concludes that the isomorphism of samarium towards metals of the isomorphogenic calcium group is more pronounced than that exhibited by other metals of the cerium group. Such conclusion is in accord with the existence of the chloride, $SmCl_2$, and the iodide, SmI_2. (4) Antonio **Carrelli** extends to the phenomenon of diffusion of electromagnetic waves the method given by Lorentz for visible radiations and for X-rays, account being taken of the index of refraction, the existence of which Compton has demonstrated for such waves. In this manner he arrives at Rayleigh's classic formula for the coefficient of diffusion, and shows also that, in the case of X-rays, this formula coincides with that derived by Debye on the hypothesis that the wave-length of the radiations is not excessively small.

ROME.

Royal Academy of the Lincei: Communications received during the vacation.—Achille **Russo**: A siderophilic substance emitted from the micro-nucleus of the impure gametes derived from the second division of the impure gametogens in *Cryptochilum echini*, and its destination.—Alfredo **Sabbatini**: Singularity of the solution of integral equations with variable limits.—Lubomir **Tchacaloff**: A general property of differential equations (a theorem of Ernesto Pascal).—B. **Caldonazzo**: Movements of a liquid which leave unaltered the local distribution of the pressures.—E. **Persico**: Experiments on the amplitude of the oscillations produced by a three-electrode lamp.—Carlo **Perrier**: Method for the determination of the principal refractive indices of birefractive substances by means of Federow's plate.—Luigi **Rolla** and Giorgio **Piccardi**: Chemical statics of electronic phenomena. A simple method is outlined for the determination of the dissociation coefficient and the equilibrium constant of the reaction, $A \leftrightarrows A^+ +$ electron.—G. **Bargellini**: β-Phenylcoumarins.—G. **Bargellini** and P. **Leone**: Glucosides of chalkones.—G. R. **Levi** and G. **Natta**: Crystalline structure of perowskite. Röntgenographic examination by the Debye-Scherrer method indicates for perowskite a face-centred cubic lattice, but the symmetry is only pseudo-cubic, the pseudo-cube being composed of the two rhombic forms (001) and (110). The apparently higher symmetry of the crystals is possibly the result of superposition of differently orientated lamellæ.—R. **Perotti**: Root bacilli of *Diplotaxis erucoides*.—Roberto **Savelli**: A collateral effect, and a rapid method of study of the ionolysis of pollen.—P. **Pasquini**: Genesis of the pecten in the development of the eye in birds.—C. **Jucci**: Hereditary behaviour of the type of larval development in crosses between silkworms of three and four mutations.—Ettore **Remotti**: Embryonic metabolism of the Teleostei. The amino-acids derived from the degradation of the capsule and their relation to the embryo.—Mariannina **Levi**: The excitability of the retina in relation to the duration of the stimulus.

Official Publications Received.

Quaternary Climates. Geologic History of Lake Lahontan, by J Claude Jones; On the Pleistocene History of the Great Basin, by Ernst Antevs; The Big Tree as a Climatic Measure, by Ernst Antevs; Tree Growth and Climatic Interpretations, by Ellsworth Huntington. (Publication No. 352.) Pp. v+212+10 plates. (Washington: Carnegie Institution.)

Physiological Features of Roots, with Especial Reference to the Relation of Roots to Aeration of the Soil. By William Austin Cannon. With a Chapter on Differences between Nitrogen and Helium as Inert Gases in Anaerobic Experiments on Plants, by Edward Elway Free. (Publication No. 368.) Pp. iii+168. (Washington: Carnegie Institution.)

Ministerio de Agricultura de la Nación República Argentina. Memoria correspondiente al ejercicio de 1924: Dirección Meteorológica. Pp. 17. (Buenos Aires.)

Union of South Africa: Department of Agriculture. Bulletin No. 2 of 1925: Some Further Remarks on Tobacco Cultivation for Nicotine. By J. Vernell Cutler and J. J. Theron and J. du P. Oosthuizen. Pp. 23. (Pretoria: Government Printing and Stationery Office.) 3d.

S.A. Sugar Association. Proceedings of the Third Annual Congress held on March 25th, 26th and 27th, 1925, at Umbogintwini, Mount Edgecombe and Durban. Pp. 72. (Durban: South African Sugar Association.)

Proceedings of the Royal Irish Academy. Vol. 37, Section B, No. 6: The Brachiopoda of the Coasts of Ireland. By Anne L. Massy. Pp. 37-46. 1s. Vol. 37, Section B, Nos. 7, 8: The Action of Hydrazine on the Halogen Derivatives of Malonamides and Acetoacetic Esters, by Dr. Edmund Langley Hirst, Dr. Alexander Killen Macbeth and David Traill; Condensation Reactions of Indoxyl and 3-Oxy (1) thionaphyten, by Dr. Alexander Killen Macbeth and Dr. James Craik. Pp. 47-57. 1s. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.)

Contributions to Palæontology from the Carnegie Institution of Washington. Additions to the Tertiary History of the Pelagic Mammals on the Pacific Coast of North America. By Remington Kellogg. (Publication No. 348.) Pp. iii+120+13 plates. (Washington: Carnegie Institution.)

History of Agriculture in the Northern United States, 1620-1860. By Dr. Percy Wells Bidwell and Prof. John I. Falconer. (Publication No. 358.) Pp. xii+512. (Washington: Carnegie Institution.)

The Volcanic Activity and Hot Springs of Lassen Peak. By Arthur L. Day and E. T. Allen. (Publication No. 360.) Pp. viii+190+13 plates. (Washington: Carnegie Institution.)

Reversible Variations in Volume, Pressure and Movements of Sap in Trees. By D. T. MacDougal. (Publication No. 365.) Pp. iii+90+5 plates. (Washington: Carnegie Institution.) 1 dollar.

Contributions to the Geology and Palæontology of the West Indies. Miocene Mollusks from Bowden, Jamaica: Pelecypods and Scaphopods. By Wendell P. Woodring. (Publication No. 366.) Pp. vi+222+28 plates. (Washington: Carnegie Institution.)

Annual Report for the Year 1924 of the South African Institute for Medical Research, Johannesburg. Pp. 31+2 plates. (Johannesburg.)

British Museum (Natural History). British Birds: Residents. Series No. 1, Set C15. 5 cards in colour. 1s. Series No. 2, Set C16. 5 cards in colour. 1s. Coloured cards not included in any Set. Mammals, B91-B97. 2d. each. Birds, C96-C97. 2d. each. (London: British Museum (Natural History).)

Tables annueleles de constantes et données numériques de chimie, de physique et de technologie. Publiées sous le patronage du Conseil International des Recherches (Bruxelles 1922) et de l'Union Internationale de la Chimie pure et appliquée (Rome 1920) par le Comité International institué par le VIIe Congrès de Chimie appliquée (Londres 1909). Rapport général présenté au nom de la Commission permanente du Comité International pour l'année 1924: General Report presented in the name of the Permanent Commission of the International Committee for the Year 1924. Pp. 22. (Paris 6e.)

The Botanical Society and Exchange Club of the British Isles. Vol. 7, Part 3: Report for 1924. By G. Claridge Druce. Pp. 415-702. (Arbroath: T. Buncle and Co.) 10s.

Ministère de l'Instruction publique et des Beaux-arts. Enquêtes et documents relatifs à l'enseignement supérieur. 120: Rapports sur les Observatoires astronomiques de Province, année 1924. Pp. 99. (Paris: Imprimerie Nationale.)

University of London: University College. Calendar, Session 1925–1926. Pp. clxxviii+10+458+34. (London: Taylor and Francis.)

Fifth Annual Report of the Scientific and Industrial Research Council of Alberta, 1924. (Report No. 12.) Pp. 67. (Edmonton, Alba.: J. W. Jeffery.) 35 cents.

University of California Publications in American Archæology and Ethnology. Vol. 21, No. 4: The Uhle Pottery Collections from Ancon. By William Duncan Strong. Pp. 135-190+plates 41-49. (Berkeley: University of California Press; London: Cambridge University Press.) 90 cents.

Journal of the Indian Institute of Science. Vol. 8A, Part 12: (1) An Examination of some Gum-Enzymes, by Gilbert J. Fowler and M. A. Malandkar; (2) Chemical Constitution of the Gum from "Boswellia serrata," by M. A. Malandkar. Pp. 221-243. (Bangalore.) 1 rupee.

Report of the Council of the Natural History Society of Northumberland, Durham and Newcastle-upon-Tyne, intended to be Presented at the Annual Meeting of the Society, 19th October 1925. Pp. 42. (Newcastle-upon-Tyne.)

Astrographic Catalogue, 1900·0. Sydney Section, Dec. −51° to −65°. From Photographs taken at the Sydney Observatory, New South Wales, Australia. Vol. 1: R.A. 0h to 6h, Dec. −51° to −53°, Plate Centres Dec. −52°. Pp. 25. Vol. 2: R.A. 6h to 12h, Dec. −51° to −53°, Plate Centres Dec. −52°. Pp. 85. (Sydney: Alfred James Kent.)

Advisory Committee for Aeronautics. Reports and Memoranda, No. 425: Model Drogue Experiments. By G. S. Baker. (A.3.k. Model Experiments—Misc., 14.) Pp. 12+8 plates. (London: H.M. Stationery Office.) 9d. net.

Aeronautical Research Committee, No. 974 (M.29): Report on the Use of Artificial Sources of Light as a Substitute in the Weathering of Fabric, Part 1. By W. G. Glendinning. (B.1.c. Fabrics-Aeroplanes, 61—T. 1931, revd.) Pp. 5+1 plate. (London: H.M. Stationery Office.) 6d. net.

Diary of Societies.

SATURDAY, OCTOBER 24.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South-Western District) (at Bridgwater), at 11.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Newcastle-upon-Tyne), at 2.30.—A. M. Hedley: Presidential Inaugural Address.—H. T. Foster: Rescue Work in Mines.—Discussion upon Papers by P. S. Lea on A Few Notes on the "Safety First" Movement, and W. McLaren, C. N. Kemp, and J. L. Thomson on The Scientific Control of Coal-Washing by the Combined Application of Ash Characteristic Curves and X-Ray Examination.

BRITISH PSYCHOLOGICAL SOCIETY (at King's College), at 3.15.—B. Stevanovic: Conational Phenomena in Processes of Judgment.—Miss Ethel Stoneman: Apparatus used to investigate Electrical Changes accompanying Emotional States in the Insane. The Waller Emotometer and the Godefroy Tachogram.

MONDAY, OCTOBER 26.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Mr. Shattock: Demonstration of Cysts.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—R. A. Chattock and others: Discussion on How can the Cost of Distribution be Cheapened?

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—R. W. Gregory: Chairman's Address.

INSTITUTION OF AUTOMOBILE ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—H. K. Thomas: The Automobile Engineer (Presidential Address).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—J. L. Payne: Presidential Address.—A. T. Pitts and J. H. Mummery: A Melanotic Epithelial Odontome in a Child.

MEDICAL SOCIETY OF LONDON, at 8.30.—Clinical Evening.

INSTITUTE OF CHEMISTRY (Manchester and District Section) (Annual General Meeting, at Manchester).—F. Scholefield: Account of the Discussion on the Registration of Chemists at the York Conference.

TUESDAY, OCTOBER 27.

ROYAL SOCIETY OF MEDICINE (Medicine Section) (at Middlesex Hospital), at 5.30.—Clinical Meeting.

INSTITUTION OF AERONAUTICAL ENGINEERS (at Junior Institution of Engineers), at 6.30.—Dr. A. P. Thurston: The International Aircraft Navigation Congress.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at the College, Loughborough), at 6.45.—H. D. Symonds: Insulation.

INSTITUTION OF AUTOMOBILE ENGINEERS (Informal Meeting) (at 83 Pall Mall), at 7.—Discussion on Petrol Gauges.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—T. W. Ridley: Railways.

ROYAL ANTHROPOLOGICAL INSTITUTE (Indian Section), at 8.15.—S. M. Edwardes: The Population of the City of Bombay: a Few Facts concerning its Origin and Growth.

ROYAL SOCIETY OF MEDICINE, at 9.30.—Sir St. Clair Thomson: Shakespeare as a Guide in the Art and Practice of Medicine.

WEDNESDAY, OCTOBER 28.

ROYAL SOCIETY OF MEDICINE (Comparative Medicine Section), at 5.—F. T. G. Hobday: Presidential Address.—Dr. W. H. Andrews: Some Recent Advances in our Knowledge of Plant Poisoning, followed by a discussion.

INSTITUTION OF AUTOMOBILE ENGINEERS (North of England Centre) (at 244 Deansgate, Manchester), at 6.30.—H. K. Thomas: The Automobile Engineer (Presidential Address).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.—Chairman's Address.

SOCIETY OF CHEMICAL INDUSTRY (Newcastle Section) (at Armstrong College), at 7.30.—Prof. H. V. A. Briscoe: The Phenomena of Intensive Drying and their Significance.

ROYAL MICROSCOPICAL SOCIETY (Industrial Applications of the Microscope Section), at 7.30.—Dr. F. J. Brislee: Dark-Ground Illumination for the Examination of Textile Fibres.—J. F. Strachan: The Microscopical Structure of Paper-making Fibres in Relationship to their Manufacturing Properties.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (jointly with the Psychiatry Section of the Royal Society of Medicine) (at 1 Wimpole Street), at 8.30.—Symposium on The Early Treatment of Mental Disorders:—For the Royal Society of Medicine, Psychiatry Section: Sir Maurice Craig; for the British Psychological Society, Medical Section: Dr. W. Brown.

THURSDAY, OCTOBER 29.

ROYAL AERONAUTICAL SOCIETY (at 7 Albemarle Street), at 5.30.—W. L. Cowley: Aircraft Transport Economy.

INSTITUTION OF CIVIL ENGINEERS (jointly with Institution of Mechanical Engineers, Institution of Electrical Engineers, Institution of Naval Architects, Institute of Marine Engineers, North-East Coast Institution of Engineers and Shipbuilders, Institution of Engineers and Shipbuilders in Scotland, Institute of Chemistry of Great Britain and Ireland, Institution of Gas Engineers, British Electrical and Allied Manufacturers' Association, British Engineers' Association, Admiralty, War Office, and Air Ministry), at 6.—G. J. Wells: Standard Codes for Tabulating the Results of Trials of Gas-Engines and Gas-Producers.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Miss Marjorie Guillan: The Teaching of Poetry.

INSTITUTION OF LOCOMOTIVE ENGINEERS (at Engineers' Club, Coventry Street), at 7.—R. W. Reid: Presidential Address.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—R. H. J. Swan: Some Reflections upon Villous-covered Tumours of the Bladder (Presidential Address).

INSTITUTE OF CHEMISTRY (Glasgow Section) (at Glasgow).—Annual General Meeting.

FRIDAY, OCTOBER 30.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of Preparations and Dissections to illustrate the Evolution of the Human Mechanism of Hearing.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—L. Pendred and others: Discussion on Recent Locomotive Progress at Home and Abroad.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—The Construction and Assembly of 50,000 K.W. Turbo-alternator Plant for Chicago at the Works of Messrs. C. A. Parsons and Co., Ltd. (Kinematograph Lecture).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch, Graduate Section) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—G. Jervis: Manufacture of Coal By-products.

DENTAL BOARD OF THE UNITED KINGDOM (at Royal Society of Medicine), at 8.30.—Prof. L. Hill: Circulatory Changes in Anæsthesia, and the Use of Oxygen.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

PUBLIC LECTURES.

SATURDAY, OCTOBER 24.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: The Defences of Animals.

MONDAY, OCTOBER 26.

KING'S COLLEGE, at 5.30.—Rev. Dr. F. A. P. Aveling: Psychology and Industry.

WEDNESDAY, OCTOBER 28.

UNIVERSITY COLLEGE, at 5.30.—Viscount Grey of Fallodon: The Open Air Sanctuaries of the National Trust.—At 5.30.—Dr. E. A. Baker: The Use of Reference Books.

THURSDAY, OCTOBER 29.

BEDFORD COLLEGE FOR WOMEN, at 5.15.—H. Peake: Cave Art and some Modern Counterparts.

KING'S COLLEGE, at 5.30.—Prof. T. P. Nunn: The Influence of Education and Tradition in Social Hygiene.

UNIVERSITY COLLEGE, at 5.30.—Prof. E. G. Gardner: Italian Universities in the Middle Ages.

SATURDAY, OCTOBER 31.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—C. D. Forde: Stone Age Man in Brittany.