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## Problems of Science Teaching

TWO striking addresses dealing, *inter alia*, with the teaching of science in secondary schools have recently appeared—the Pedler lecture of the British Science Guild, by Prof. Irvine Masson,[1] and the presidential address to the Science Masters' Association, by the headmaster of Harrow.[2] They go back once more to the views of Huxley, to those of the representative committees of the British Association of 1917 and 1928, under the chairmanship of Sir Richard Gregory,[3] and to those of the Prime Minister's Committee of 1916–18 presided over by Sir J. J. Thomson,[4] when they suggest that for the vast majority of boys (and girls) what is needed is an all-round training in science, broad and simple, and including not only physics and chemistry, but also biology, geology, and astronomy.

The change would involve sacrifices both on the literary side and, for pupils who already take science, on the scientific side. On the scientific side, Prof. Masson suggests that the prematurely intensive study of a particular science at school is directly harmful to the later study of the science itself. This proposal, however, raises other problems, and some of fundamental importance not obvious at once, both in education, in its narrower sense, and also in citizenship. Like Dr. Norwood, we hear the contemptuous 'Smattering!' of some of our readers; nor are we unmindful of 'H. E. A.'s' courageous and reiterated demand that what should be taught in secondary schools is 'scientific method',[5] and his plea that in the right kind of scientific teaching the principle must be insisted on that 'nothing may be taken for granted'.

The doctrine is a simple one—unfortunately, too simple for truth. Even the author of the epoch-making "Discours de la méthode", Descartes, did not suspect all the things he took for granted; and the 'deductions' cheerfully made by a schoolboy from the simplest scientific experiment may be matters still under discussion by the keenest scientific intellects of our time. Imagine a teacher working through the more important books on method published since Mach's "Science of Mechanics"—we have in mind authors like Karl Pearson, Poincaré, James Ward, Russell, White-

[1] Published by the British Science Guild, 6 John Street, Adelphi, W.C.2. 1*s*.
[2] *School Science Review* for March 1932.
[3] Report on Science in School Certificate Examinations, with syllabuses by various teachers. London: British Association for the Advancement of Science. 1*s*.
[4] Natural Science in Education (§§ 41, 49, and *passim*). London: H.M. Stationery Office. 1*s*. 6*d*. net.
[5] See "The Teaching of Scientific Method, and Other Papers on Education", by H. E. Armstrong (2nd edition, 1925, pp. 1-10, and 256-7), and the two articles on "National Needs" by 'H. E. A' in NATURE for Nov. 14 and Dec. 26, 1931.

head, T. P. Nunn, N. R. Campbell, Meyerson, H. Levy, and the quite recent books by Dr. Herbert Dingle on "Science and Human Experience" and by Dr. Harold Jeffreys on "Scientific Induction"—and then trying to tell a class of schoolboys what is meant by such phrases as 'cause and effect', 'scientific explanation', or 'error of experiment' (purposely omitting the old terms we used to think so simple, such as 'mass', 'energy', 'atom'). Could he possibly assure them that in his teaching 'nothing was taken for granted'?

In every example of scientific experiment which a teacher will give to his pupils, not few but many assumptions will be made, if he is not utterly to bewilder them at this stage. Newton's famous "hypotheses non fingo" is probably largely responsible for the notion that 'nothing is taken for granted' in teaching physical science. The phrase occurs in the penultimate paragraph of the "Principia"; it was intended by Newton only to apply to part of his work; and it is in striking contrast with the final paragraph of the "Principia" itself, and with what Priestley calls the "bold", "eccentric" notions of the "Opticks", with its "Queries". The fundamental distinction between verifiable and unverifiable hypotheses drawn by writers like Nunn [6] and Dingle,[7] and the fruitfulness of the great 'unverifiable' hypotheses, such as those of the atom and electron, elevated by some of our most distinguished men of science to the rank of 'ultimate realities'—all these are things which the school-teacher of science ought to have at the back of his mind. To explain them in detail to his pupils would, however, be an impossible task. The 'common-sense' of science is the most elusive of concepts.[8]

While differing from 'H. E. A.' in his views of scientific method, we are in warm agreement with his recent utterances on the artistic aspects of science, aspects of the utmost value to the teacher trying to secure the interest of his pupils. If we agree with Dingle that the material of science consists of the elements of our experience actually or potentially common to all normal people (whereas art and religion are concerned with experiences which may or may not be shared by others), we nevertheless see the *advances* of science have in them something individual, giving to many pupils, if adequately presented, an artistic emotion. In the Report of the British Association Committee of 1917 on Science Teaching in Secondary Schools, of which Prof. Armstrong himself was a member, it is suggested that teachers should not fail to give scope in their teaching to the 'wonder-motive', the 'utility-motive', and the 'systematising-motive'. By 'wonder-motive' is not meant the desire to wonder at astronomical immensities or the infinitely small, but at the achievements of individual men in overcoming difficulties; a wonder to be excited as much by the binomial theorem as by the cure for hydrophobia or by wireless telephony. "Execution", says Blake somewhere, "is the chariot of genius." The achievements of genius may be inspiring to many a boy or girl who would be unable to follow a logical analysis of method, of which the author himself may have been unconscious in making his discovery. Prof. S. Alexander has recently put forward views of which Blake's may be an anticipation.

From these general considerations we turn to another aspect of the matter, not less important. Dr. Norwood demands that "windows should be opened in the pupils' minds in all directions". The blindness of the average man to the problems of biology apparent in our educational and administrative systems may, to quote a recent utterance of Dr. H. H. Dale, "become a real danger to our civilisation". "An intelligent appreciation of the fundamental facts of biology is not yet regarded as a necessary part of the equipment of an educated man."[9] About the fact there can be no doubt. The statistics of the School Certificate Examination published by the second British Association Committee under the chairmanship of Sir Richard Gregory, and by Dr. Masson, show that only about one per cent of the candidates present themselves in biology or zoology (though a much larger proportion, mostly girls, take botany); and under present conditions the examination-room may be regarded as an approximate reflex of the class-room. There are some schools in which this is not the case, but they are few. We have quoted several authorities in favour of the policy advocated by Dr. Masson and Dr. Norwood: one other may be cited—the recent Report of the Prime Minister's Committee on the Education and Supply of Biologists, presided over by Lord Chelmsford.[10] "We hold strongly", the Report says, "that no boy should be allowed to leave school without having been introduced to biology" (loc. cit., p. 23).

Are there in English education at this moment

[6] "The Aims of Scientific Method" (1907), pp. 129, 130.
[7] "Science and Human Experience" (1931), pp. 46-50.
[8] In his interesting B.B.C. pamphlet on "Science in Perspective" (1931), Prof. H. Levy gives what he himself terms "the dim outline of a method".
[9] "Biology and Civilisation", the Norman Lockyer Lecture for 1931 (p. 17). British Science Guild, John Street, Adelphi, W.C.2. 1*s*.
[10] Published by H.M. Stationery Office, 1932, for the Economic Advisory Council. 1*s*. net.

any powers capable of securing this result? The Chelmsford Committee is conscious of the impotent, not to say ridiculous, delay that has followed the recommendations of its predecessors. The Committee wants steps to be taken by the Board of Education, in concert with the other Government departments. It wants the universities and great public schools to be consulted; but it strangely omits to mention by name the bodies which of all are the most important, if any large number of pupils are to be affected, the local education authorities. Is anything being done? P. J. H.

## Seismology

*Handbuch der Geophysik.* Herausgegeben von Prof. Dr. B. Gutenberg. Band 4 (Lieferung 1): *Theorie der Erdbebenwellen; Beobachtungen; Bodenunruhe.* Von Prof. Dr. B. Gutenberg. Pp. 298. 30 gold marks. Lieferung 2: *Seismometer, Auswertung der Diagramme,* von Dr. H. P. Berlage, Jr.; *Geologie der Erdbeben,* von Prof. Dr. A. Sieberg. Pp. 299-686. 45 gold marks. (Berlin: Gebrüder Borntraeger, 1929–1930.)

PROF. B. GUTENBERG, a very distinguished seismologist, is general editor and chief author of what our German colleagues call a handbook of geophysics, in ten mighty volumes. There are more than forty other contributors. The two parts under review form the first instalment. The whole, when complete, should be a very comprehensive account of the whole of geophysics, particularly welcome on account of the scattered nature of the literature of the subject.

The first part is entirely by Prof. Gutenberg, and half the second by Dr. H. P. Berlage. These cover the whole of instrumental seismology, beginning with the theory of elastic waves, and proceeding to an account of the use of the instrumental records to infer the structure of the earth. The types of seismograph used are described in detail. The accounts given are very full. In places the reviewer might wish them fuller, and a few items are included, with little or no comment, which scarcely seem worth preserving in a work of permanent value. But on the whole we must welcome the most complete account of modern seismology yet published. Very little of any importance has escaped mention and discussion, and the references to original papers in all languages are abundant. This will be the standard work of reference for many years.

The remaining half of the second part, by Prof. A. Sieberg, is entitled "Geology of Earthquakes", and deals with macroseismology, or, as the author says, the study of earthquakes in the popular sense: their destructive effects on buildings, the visible effects on the earth's surface features, the movements felt by man, the sea waves produced, and so on. If I devote most attention to this part it is because I have learnt most from it.

The connexion between the local effects in the 'shaken region', that is, the region where motion can be felt, and the movements produced in instruments at a safe distance, has received very little discussion hitherto; and it seems to me that most important advances in both sides of the subject must develop from the study of their interrelations. As a specimen of the degree of separation that exists, it may be mentioned that Dr. C. Davison's excellent book, "The Founders of Seismology", contains no reference to Poisson or Rayleigh, who predicted theoretically the three principal types of elastic waves; and Davison might justly reply that none of my own works mentions Mallet or Mercalli. Yet the movement that is felt and in many cases shakes down houses is merely an elastic wave of great intensity; and on the other hand, the waves observed at a great distance have been produced in the shaken region, and must show traces of its properties.

The relation is already becoming an acute problem in instrumental seismology; hitherto we have concentrated attention on the various plutonic layers, but it is becoming clear that the sedimentary layer produces a controlling influence on some phenomena. I hinted very tentatively that some pulses observed in the Jersey earthquake of 1926 might be compressional waves in the sedimentary layer. Tillotson and Mourant have obtained confirmatory evidence, while Stoneley detects signs of an influence of the sedimentary layer on the shorter distortional waves. Now if there are bodily waves transmitted horizontally in the sedimentary layer, the focus must be in that layer. But most continental seismologists (including Gutenberg), in the cases they have investigated, claim to have found foci in the granitic layer at depths of the order of 30 km. I consider these estimates excessive, even on the actual data used; but clearly they are out of the question if the foci are not in the granitic layer at all.

It is here that macroseismology may provide a criterion, and abundant data are given by Prof. Sieberg. If the crust were uniform, the intensity would be greatest at the epicentre, and would fall off steadily with distance. This is not confirmed

by observation. There is, of course, a general decrease with distance, but the exceptions are numerous. Usually there are isolated patches of high intensity; in one case (p. 620) the region of greatest intensity actually encloses three separate regions of lower intensity. Sieberg with good reason attributes these variations to differences in the nature and structure of the local sediments. But could they exist if the focus was below the sedimentary layer? The waves at distances comparable with the depth of focus would be incident at high angles on the interface between the sedimentary and granitic layers, and at still higher angles on the outer surface. Great variations in these circumstances seem unlikely. Certainly they are less likely than if the waves felt are transmitted nearly horizontally in the sedimentary layer and subject to its irregularities through the whole of their path. Sieberg does not discuss this point directly, but he contributes much evidence that most earthquakes are due to motion on visible faults, or to infalls of rock in caves, when the focus is certainly in the sedimentary layer; and it does not appear that the seismograms of earthquakes known to be of these types differ from those of the near earthquakes studied in most discussions.

The earthquakes believed by Prof. Turner to have had foci at depths of the order of 300 km. are, of course, in another class, and it cannot be said yet that we have any clear idea as to their cause; but the recent work of Stoneley and Scrase has, at any rate, put their existence on a secure footing.

The book is well and abundantly illustrated, both by diagrams and maps and by actual photographs of the effects of earthquakes. The value of the maps would have been greater if all of them, instead of only a few, had been accompanied by scales of distance.

It is assumed, a little too naïvely, I think, that the felt intensity and the destructive effect depend only on the acceleration of the ground. In many cases this is probably true, as, for example, in the house shown on p. 572, where the inertia of a too heavy upper story has made it slide horizontally over the lower through about a yard. But there may be cases where the determining factor is the range of variation of velocity; and there must be some where it is the final displacement. C. Haussmann is quoted on p. 612 as finding a displacement of 20 metres in $2\frac{1}{2}$ years on a known fault, without any earthquake in the usual sense, and therefore negligible acceleration; yet if a building had been over this fault it would have been destroyed as effectively as any in the San Francisco earthquake. R. D. Oldham's work on this question (*Q. J. Geol. Soc.*, **82**, 67-92; 1926) has apparently not come to the author's notice. Again, while too great an acceleration of the ground may break a building fastened to it, it may not throw a man off his feet if it is reversed before he has had time to fall; then the range of velocity will give a better criterion than the acceleration. So far as the criteria agree, they indicate a rough constancy in the period of the motion.

Many and varied are the geographical effects described. On p. 581 is a map of a recent earthquake in Bulgaria, showing the actual development of a miniature rift valley. There are fault scarps, landslips, waterfalls, sand and mud cones, and sea waves. One occasion is mentioned when an earthquake caused a landslip, which blocked a stream and formed a lake, in which mosquitoes bred and led to an epidemic of malaria.

The author is everywhere critical, and his work can be recommended as a stimulating contribution to a complicated subject.

HAROLD JEFFREYS.

## The Wild Roses of Central Europe

*Synopsis Rosarum Spontanearum Europæ Mediæ: Übersicht über die mitteleuropäischen Wildrosen mit besonderer Berücksichtigung ihrer schweizerischen Fundorte.* Von Dr. Robert Keller. (Denkschriften der Schweizerischen Naturforschenden Gesellschaft, Band 65.) Pp. xii + 796 + 40 Tafeln. (Zürich: Gebrüder Fretz A.-G., 1931.)

THE publication of this monograph marks a definite stage in the history of the taxonomy of *Rosa* and also raises important questions of more general interest. It represents the consistent labours of half a century of the eminent rhodologist, Dr. Robert Keller, of Winterthur, who is to be congratulated on the crowning achievement of his life's work. It is probably the last word on the problem of species in *Rosa* of the purely morphological school of taxonomy before the new genetical taxonomy takes up its inevitable position as an exact science on an experimental basis. In his foreword, Dr. Keller remarks that the parents of the 428 natural hybrids described have been determined morphologically and not experimentally. That expresses in a sentence the fundamental difference between the old and the new taxonomy.

The main object of this Synopsis is, no doubt, to enable collectors to identify and name their specimens. Dr. Keller has achieved this end with distinction, and any wild rose from Central Europe

that cannot be traced in his synopsis of 2407 forms may with high probability be regarded as new to science. There is, however, another important aspect of this monograph which is of interest to biologists as a whole, and that is Keller's concept of a species. Dr. Keller, unlike some of his contemporaries—for example, Gandoger, who made 5549 'species' of the genus—has no illusions about the status of the European species, notwithstanding the prolixity of forms that he has distinguished by name. He prefers to take a broader view even than Crépin did in his later years, by reducing the number of Central European species to 26, although, unlike Crépin, he admits 15 subspecies and about 100 varieties and forms of each species.

Except for the subspecies, this is a wise and satisfactory classification. Keller divides the Central European roses into two main groups, *Sociales* and *Arcuatæ*, while *Sociales* is further divided into *Erectæ* and *Erecto-arcuatæ*. In many respects this grouping is natural, although at least 6 of the 22 species in *Arcuatæ* are social in root-habit, with erect stems, as in the *Erectæ* of the *Sociales*. The 7 sections of the genus with their 6 subsections are natural groups, except that the pentaploid *Stylosæ* and the hexaploid *Jundzilliæ* might well have been placed as subsections of *Caninæ*, and *Eucaninæ* divided into two or more subsections.

With a few exceptions, Dr. Keller's species appear to be good genetical species, but 7 of his subspecies prove to be equally good species. With regard to nomenclature, Dr. Keller in substituting *R. pendulina* L. for *R. alpina* L., *R. glauca* Pourr. for *R. rubrifolia* Vill., *R. eglanteria* L. for *R. rubiginosa* L., and *R. obtusifolia* Desv. for *R. tomentella* Lem., observes the strict rules of priority. He does not, however, substitute *R. Sherardii* Dav. 1813 for *R. omissa* Desegl. 1864 (misprinted "1894" on p. 245) although it is admitted as a synonym, nor does he substitute *R. cæsia* Sm. 1811 for *R. Afzeliana* Fries 1816, nor *glaucophylla* Winch 1816 for *vosagiaca* Desp. 1828. Dr. Keller still maintains the old specific name *R. villosa* L. which was specifically abandoned in the International Rules, and he makes his subspecies facultatively autonomous by repeating the generic initial before the subspecific name.

In citing *R. gallica* L. 1753, instead of *R. gallica* L. 1759, Dr. Keller overlooks Crépin's discovery that the original *gallica* of Linnæus of 1753 was a species of Caninæ and not the familiar plant that Keller describes: moreover, *R. gallica* L. 1759 is not the earliest name for the plant, since *R. rubra* Blackw. 1757 precedes it, but the oldest legitimate name for the genetical species is *R. centifolia* L. 1753, which happens to be the original name given by Theophrastus.

For several reasons it is desirable that the pentaploid species *R. tomentosa* Sm. should be removed from the tetraploid species of Vestitæ. The hexaploid species *R. Pouzinii* Tratt. should also be separated from the pentaploid *R. canina* L. and the hexaploid species *R. inodora* Fries (*sensu stricto*) from the pentaploid *R. agrestis* Savi.

Dr. Keller's 15 subspecies are not so satisfactory as his species. All are in the section Caninæ, and 7 are regional groups which work out as genetical species, while 2 are common to the whole area, and prove to be genetical varieties. It is now generally recognised that the multitudinous minor variants in *Rosa*, of which Dr. Keller describes no less than 2366, each with a set of key characters and a Latin diagnosis, consist almost exclusively of Mendelian segregations following generations of natural crossings of the results of gene mutations and chromosome transmutations within and without the species, leading to almost endless combinations of characters, some dominant and others recessive, some homozygous and others heterozygous. The classification of these minor variants is consequently a matter of extreme difficulty. Dr. Keller, in accordance with the Rules of Nomenclature, has made a classification of them into varieties and forms, and recently Christ, Wolley-Dod, and Heslop-Harrison have adopted a similar system. The chief difficulty is that each author has his own opinion whether the same segregate should stand as a variety or a form, and they do not always agree.

It is evident that a standard of classification on genetical lines is necessary for these minor variants of *Rosa*. Engler's idea that the term 'form' should be restricted to a fluctuating somatic modification and Du Rietz's suggestion that the term 'variety' should be confined to local homozygous biotypes (races) seem to be quite impracticable in *Rosa*, and it is hoped that the publication of this monograph will arouse interest among systematists generally so that a satisfactory classification of these minor variants in plants and animals may emerge.

In addition to copious references to authors, synonyms, and geographical distribution, the "Synopsis" contains an ingenious and extensive key to the species, which is made rather unwieldy by the inclusion of parallel varietal characters which are out of place in specific diagnoses. A full analysis of the local distribution of forms in Switzerland is

given, and statistical tables of leaflet numbers are shown under each species. A chapter on the relative fertility and sterility of species and natural hybrids shows the necessity for caution in estimating the percentage of functional pollen grains, and that the complications due to facultative apomixis should also be taken into account. Abstracts of 24 systems of classification of the European roses from 1813 until 1925 emphasise the taxonomic difficulties of the genus. In a chapter on the evolution of species, Dr. Keller accepts Täckholm's theory of the origin of the *Caninæ* by hybridisation in the Pleistocene period.

Forty excellent coloured plates are issued in a separate binding, which well and truly represent the species and hybrids illustrated. There is a useful and indispensable index, but the synonyms are apparently too numerous to be included. The publication of this important work enhances the reputation of all concerned in its production, and it will no doubt long remain the standard work on the roses of Central Europe. C. C. HURST.

## Morphology and Evolution

*Morphologische Gesetzmässigkeiten der Evolution.* Von Prof. Dr. A. N. Sewertzoff. Pp. xiv + 371. (Jena : Gustav Fischer, 1931.) 22 gold marks.

FOR a quarter of a century, Prof. Sewertzoff and his pupils have been working with the aim of obtaining general principles with the help of which to correlate the present state of knowledge concerning evolution. He came early to the conclusion that this object was most likely to be achieved by a study as detailed as possible of a particular group of animals, for which purpose he selected the vertebrates, paying particular attention to the hard parts so as to be able to make use of palæontology. His book, now under notice, is divided into two parts, of which the first deals with the evolution of the lower vertebrates : the second with the general principles derived from a consideration of such evolution.

In his survey of the history of the vertebrates, Sewertzoff adheres mainly to the generally accepted view. It must be noted, however, that he imagines the early craniates to have had three visceral clefts in front of the hyoid arch. This is one less than he formerly claimed, but it is still one too many, for the evidence from the somites, nerves, visceral arches and clefts, and hypophysis, all points to the premandibular somite (and, therefore, arch) as the original foremost of the whole series.

Sewertzoff departs from custom in contending that the sturgeons are derived more or less directly from selachian-like ancestors. Space is lacking for a detailed consideration of this point, and it must suffice to say that the evidence which Sewertzoff brings forward does not seem to be adequate to refute the view generally held by the palæontologists of Great Britain, to the effect that the sturgeons are degenerate descendants of the palæoniscoids.

There are a few errors in this part of the book : *Lepidosteus* does not have cosmoid scales ; the kidney tubules opening into the pronephric ducts in the early Protocraniata were certainly not nephridia, and the nephridia equally certainly did not open into the cœlom in the primitive Acrania, seeing that they are closed in *Amphioxus*. But these errors do not invalidate the general lines of Sewertzoff's scheme of vertebrate evolution, which is stimulating if not wholly acceptable. It may be mentioned in passing that while textbooks of morphology are not wanting, there is a need for works on the phylogeny of animals, on the lines of Sewertzoff's sketch.

Coming now to the second part of the book, Sewertzoff makes it clear that he is concerned not with the causes of evolution, but with the manner in which it has occurred, and with the morphological principles involved. He reveals himself as a staunch Darwinian and the whole stage of his thought is set in terms of adaptiveness of organs and of success or failure of organisms in the struggle for existence. He begins by distinguishing two main directions in evolution : the biologically progressive, leading to the production of large groups, rich in sub-groups and individuals, and expansion of range ; and the biologically regressive, leading to extinction.

In the biologically progressive direction, Sewertzoff recognises four types or modes. (1) Large changes of general adaptive significance, which raise the degree of organisation of the body and the intensity or energy of the life-processes. Examples of such 'aromorphoses' are the evolution of the brain, sense organs, and heart in the Protocraniata, and of the jaws, tail, and paired fins in the Gnathostomes ; the lungs, the neck, and feathers of higher forms. It may be noted that aromorphoses do not tie the organism down to any restricted mode of life. (2) Changes which definitely tie the organism to a definite more or less restricted mode of life, without increasing the degree of organisation or of energy output. These changes he calls 'idioadaptations', and holds them responsible for the divergence between rays and sharks, flat-fish and carps, snakes and lizards. Superficial changes of

form and colour also belong here, and a particular aspect of idioadaptation is specialisation. It is to be noted that periods of aromorphosis and idioadaptation may alternate in the history of a group, but the author knows of no case of a group which has undergone specialisation reverting to aromorphosis.

The third and fourth of Sewertzoff's modes are cænogenesis, or adaptive changes confined to early stages of development, and degradation or the acquisition of structures or their loss associated with sessile and parasitic modes of life. It would seem, however, that these categories could conveniently be included in the first two: degradation under idioadaptation, and cænogenesis under idioadaptation or aromorphosis according to the nature of each case.

After an inquiry into the principles which govern the alterations which organs undergo in evolution, Sewertzoff considers the relation between ontogeny and phylogeny. He rejects the Haeckelian view of the pressing back of adult ancestral stages into the young stages of the descendants, and agrees with the view which is constantly gaining favour, to the effect that "evolution is not the alteration of the characters of the ancestral adults, but a modification of the ontogenies of the descendants". As to the time in ontogeny when the evolutionary novelty may arise, Sewertzoff shows that it may be early on, or in the middle, or at the end of the period of morphogenesis, leading to what he calls 'archallaxis', 'deviation', and 'anaboly', respectively. In the latter case, evolution may proceed by the addition of new terminal stages of morphogenesis to the last stage of morphogenesis (not the adult stage) of the ancestor. In this case, the terminal stages of morphogenesis of the ancestors may be repeated, or 'recapitulated'.

The value of this part of Sewertzoff's book is all the greater from the fact that he has purposely made a number of new observations with which to illustrate his points. Such are, in brief, the views which Sewertzoff puts forward as his theory of phylembryogenesis. An interesting question now arises. Is evolution by aromorphosis more likely to occur as a result of the introduction of novelties at the early, middle, or late stages of ontogeny? Sewertzoff does not commit himself on this point.

As a result of a consideration of cases in which the time of appearance in ontogeny of certain evolutionary novelties may reasonably be surmised, it has recently been suggested that the chief characters of the large groups are more likely to have originated as novelties in early stages of development than the reverse. Large groups may also have characters which arose as late ontogenetic variations, but it is suggested that these are more likely to lead to the production of groups of small classificatory value. In this way it can be understood how the evolutionary capacity of large groups is greater than that of small ones, for, as a rule, the smaller the classificatory value of the group, the more specialised to a particular mode of life are its characters. Sewertzoff himself gives several examples which bear out these views, concluding that major novelties arise by archallaxis, while anaboly leads to the modification of something already present.

Prof. Sewertzoff's book is to be warmly recommended as a thought-provoking piece of work, and is all the more valuable because many of the original publications on the subject by himself and his pupils are somewhat inaccessible.

G. R. de Beer.

## Progress of Chemistry

*Chemistry at the Centenary (1931) Meeting of the British Association for the Advancement of Science.* Pp. xi + 272. (Cambridge: W. Heffer and Sons, Ltd., 1932.) 7*s.* 6*d.* net.

THE centenary meeting of the British Association, following on the celebrations of the centenary of Faraday's discovery of electromagnetic induction and preceding the Clerk Maxwell centenary at Cambridge, brought to London a number of eminent foreign visitors which was quite unique in the history of the Association, and is likely to remain unrivalled for many years to come. Although the visitors who came to England to pay honour to the work of Faraday and of Maxwell were primarily physicists, the boundaries between physics and chemistry have been so far obliterated that the officers of Section B (Chemistry) of the British Association were able to make full use of the opportunity which the occasion presented of providing a platform from which the leading workers in atomic physics could speak.

The work of the Chemistry Section included a remarkable presidential address by Sir Harold Hartley on "Michael Faraday and the Theory of Electrolytic Conduction", in which he disclosed the unexpected array of historical material and linked this up with the most modern views on the nature of strong electrolytes. The discussion which followed included contributions from Debye, Bjerrum, Brönsted, Fajans, Philip, Guggenheim, Butler, Scatchard, Lange, McBain, and Lowry. This discussion alone was therefore comparable in

interest with the Faraday Society's general discussion on "Strong Electrolytes" at Oxford in 1927, although it was limited to a single day.

The discussion on vitamins on the following day was in some respects even more remarkable, since the visitors who contributed to it must have come to England for this express purpose rather than for the associated physical celebrations. The discussion on vitamin A was introduced by Sir Frederick Gowland Hopkins, and was contributed to by Karrer, Euler, Morton, Heilbron, Richard Kuhn, Moore, and Drummond, while the contributors to the discussion on vitamin B included Jansen, Peters, Drummond, Callow, Windaus, Reerink and van Wijk, Heilbron and Simpson, the concluding review being contributed by Robinson.

A symposium on "The British Fuel Problem", with reviews by Sir David Milne-Watson, Sir John Cadman, and Mr. H. T. Tizard, provided a technical alternative to a discussion on the atomic weight of oxygen in Section A, and included contributions from Sir James Irvine and Prof. W. A. Bone.

The final discussion, on "The Structure of Simple Molecules", brought into the Chemistry Section many of the pioneers in atomic physics. The contributors to the discussion included Debye, Lennard-Jones, R. H. Fowler, Victor Henri, Heisenberg, Born, and W. L. Bragg.

In view of the unique character of the programme, it would have been a serious loss not to preserve a permanent record of the work done by the Section. The record provided by the secretaries in the present volume includes all the valuable material contributed to the four discussions. It has been issued in a well-printed volume, comparable in size with the official report of the London meeting of the British Association, and is issued at such a remarkably low price that it should merit a very wide circulation amongst those who are interested in the progress of chemistry in its various aspects.

## Short Reviews

*A Practical Handbook of Water Supply.* By Dr. Frank Dixey. Pp. xxviii + 571. (London: Thomas Murby and Co., 1931.) 21*s.* net.

FEW problems of immediate importance in the pioneer development of colonial territories are more urgent than the provision of an adequate water supply. Various geological surveys and irrigation departments give advice on particular schemes, but no book which would serve as a general guide has hitherto been available. Dr. Dixey has realised the necessity for such a book as a result of his experience in Nyasaland, and those who are called upon to provide water supplies in outlying regions owe him a deep debt of gratitude for the very practical and thoroughly competent treatise which he has been stimulated to write.

Although the conditions particularly kept in mind are those characteristic of Central and East Africa, the book will prove helpful to workers in other similar regions, and not only so, but also to students of water-supply problems in general, for the geological, engineering, and other aspects of the composite problems involved are all dealt with in ample detail. Methods of dam construction and of sinking wells and bore-holes to moderate depths are described, with the view of helping settlers and administrative officers who are likely to be inexperienced in such work. Less attention is paid to the technique of deep boring, which must of necessity be carried out by experts. The various means of safeguarding against contamination and of purifying unsatisfactory supplies are surveyed in the very important chapter on the quality of water. One of the most interesting chapters is that devoted to water-finding methods. The desirability of a geological report before costly schemes are undertaken is rightly stressed. "Reliance upon any other advice, such as that based on water-divining, may lead to serious waste of time and money." The book concludes with an invaluable summary of the water-supply conditions in South Africa, the Rhodesias, Nyasaland, Tanganyika, Kenya and Uganda, the last of these having been contributed by Mr. E. J. Wayland. There are several geological maps embodying information not otherwise easily accessible.

The book will undoubtedly be of very great assistance to those for whom it has been primarily prepared, and much of it will appeal to a far wider audience.

*Hydraulics for Engineers: including Turbines and Pumps and Unsteady Motion.* By Prof. R. W. Angus. Pp. xii + 304. (London: Sir Isaac Pitman and Sons, Ltd., 1931.) 12*s.* 6*d.* net.

IN view of the rapid development of the exploitation of hydro-electric power in Canada and the United States, the subject of hydraulics is of outstanding importance to engineers in North America. A new textbook on the subject by the professor of mechanical engineering in the University of Toronto naturally, therefore, arouses interest as to the treatment accorded to the problems which present themselves in connexion with turbine installations. Including centrifugal pumps, Prof. Angus devotes rather more than a third of his book to the consideration of this subject, and within this space gives an effective résumé of the conditions to be met and the calculations involved in design.

Among several examples of typical installations, Prof. Angus briefly describes the reaction turbines of the Conowingo plant on the Susquehanna River and the impulse turbines of the San Francisquito No. 1 plant of the city of Los Angeles. The former, which has a present aggregate capacity of 378,000 horse power, is among the largest in the world, and one of its units is of greater size than any other at present in existence, having a discharge nearly

three times that of the 70,000 horse power turbines at Niagara Falls. This unit, a section of which is illustrated, develops 54,000 horse power under 89 ft. head at a speed of 81·8 revolutions a minute. The Los Angeles runner, with a head of 870 ft., develops 32,200 horse power at 143 revolutions a minute, while another (also illustrated) at Big Creek, California, has a capacity of 56,000 horse power at 250 revolutions a minute, under a head of 2200 ft.

The first part of the book deals with the fundamental problems of flow of water in pipes and open channels, through orifices and over weirs, on lines which are fairly general, due prominence being given to the Francis formulæ for weirs and the Ganguillet-Kutter formula for open channels. The third and last part of the book is devoted to non-uniform flow. The type and diagrams are clear and distinct. Exercises are given, with numerical answers, and there is a serviceable index. B. C.

*Handbuch der Experimentalphysik.* Herausgegeben von W. Wien und F. Harms. Unter Mitarbeit von H. Lenz. Band 11, Teil 3: *Elektrische Beleuchtung*, von Dr. Helmuth Schering; *Schwachstromtechnik*, von Prof. Dr. K. Küpfmüller. Pp. xiii + 501. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1931.) 46 gold marks.

This section of the handbook is divided into two parts. The first deals with electric lighting and its measurement, and the second with the technics of weak currents, including telegraphy and telephony.

Prof. Schering discusses lighting mainly from the scientific point of view, but his results are immediately applicable in practice. Interesting diagrams are given of the energy emitted by substances at various temperatures and how this energy is divided up amongst the rays of different wave-lengths. For measuring mean spherical candle-power Russell's method is given. Apparently in Germany it is possible to buy polar paper divided up into the requisite angles, and this greatly shortens the time taken to make a measurement by this method. Useful data are given in connexion with the Hefner lamp, which has played such a great part in the history of photometry. A good discussion is given of projector lamps. The 'weak current' section of the volume is well done. It is clearly written, the diagrams can be understood at a glance, and it is not overburdened with mathematical equations. A description is given of cables suitable for long-distance transmission. The use of Pupin coils is described, and oscillograms are given to elucidate their action.

*Weeds in the Garden of Marriage.* By George Pitt-Rivers. Pp. xv + 86. (London: Noel Douglas, 1931.) 3*s.* 6*d.* net.

It perhaps might have been called more truly "Weeds in the Garden of Race Progress", for the very institution of marriage—as cultivated by Church and State—is one of the rankest weeds Mr. Pitt-Rivers finds. In his own words, his book is "a plea for a little more thinking", and it is backed by forcibly stated reasons for thinking as he thinks, and for seeing with him that a thoughtful application of the principles of eugenics to our economic and race problems is our only salvation; that, in fact, we are subject to compulsory restriction of reproduction, and eugenics only proposes to change the method of restriction to sterilisation rather than taxation, and shift its operation from the healthy to the feeble.

Mr. Pitt-Rivers is intensely in earnest, for, as Sir Arthur Keith points out in his introduction, he sees disaster stealing upon us, and if he reads the signs of the times aright, there is nothing that can save us. He sees the race, indolent, ignorant, and vain, using its power of reproduction to destroy itself; not only permitting, but even encouraging feebleness and disease to live by mating with intelligence and health, and to send forth new polluted streams, vitalised by that mating. Better, he says, incest and inbreeding than this steady undermining of intelligence and health. Incest gave us Cleopatra, and it would emphasise not only the good qualities of healthy stock but also the defects of the feeble and diseased, until the latter would perish of sheer inanition.

Make the world safe for intelligence, is Mr. Pitt-Rivers' cry, and all good things will be added unto you.

*Creep of Metals.* By H. J. Tapsell. Pp. xiv + 285. (London: Oxford University Press, 1931.) 30*s.* net.

For many years the maximum stress has been regarded by the engineer as the main criterion by which to estimate the strength of a material in service. It is now realised, however, that above a certain temperature the strength may not be truly disclosed by the ordinary tensile test, and a stress, which is often very much less than that which this test would suggest, may result in failure if sufficient time be allowed. The process which brings about fracture is a comparatively slow deformation known as 'creep'. Following on the pioneer work of Chevenard and Dickenson, a very large amount of information has been accumulated on this subject during the past ten years. It is, however, very widely dispersed through engineering and other scientific literature, and the author has performed a most useful service in bringing it together. No phase of the subject has been overlooked and a difficult task has been performed with marked success.

It is clear that as yet little or nothing is known about the ultimate physical explanation of the phenomenon. But the time has now come when it is possible for the author to devote the last chapter of his book to a consideration of the bearing of the facts on the design of structures to operate at those high temperatures at which such effects are most pronounced. In view of the present position of the knowledge of creep, no more than the author has been able to accomplish could possibly be expected, and a most valuable addition has been made to the literature dealing with what is too often the 'no man's land' between metallurgy and engineering. F. C. T.

## The British Association: Some Early Documents

MOST appropriately at the time of its centenary, the British Association came into possession of a collection of letters and other documents retained, and in part mounted in a book, by John Phillips, its first secretary. These were saved from destruction and generously presented to the Association by Prof. W. J. Sollas, after they had been unearthed in the department of geology at Oxford, of which Phillips in later life became the head.

By far the most important letter historically is the first—that which Brewster wrote to Phillips in February 1831, proposing the establishment of a 'British Association of Men of Science', and a first meeting in York. The Association possessed until now only a copy of this letter. A large proportion of the letters are acceptances or refusals of invitations to that first meeting: one finds among them such signatures as Whewell, Buckland, Airy, J. F. W. Herschel, Scoresby, Rigaud, Baden Powell. There are several letters from Robison, who interested himself closely in the details of the arrangements. One observes anxiety as to whether the unsettled state of the country would make it expedient to postpone the inauguration of the Association until 1832: strange that both the birth and the centenary should have fallen in evil days. We have other letters from Brewster besides the first, one of which indicates that he forecast York, as a geographical centre, not only for the first meeting but also for the subsequent headquarters of the Association. We have the essential portion of the letter from Harvey of Plymouth—unfortunately lacking the signature—from which Vernon Harcourt in his foundation speech borrowed, with acknowledgment, the comparison of the objects of the Association with Bacon's 'circuits of divers principal cities' in the "New Atlantis".

An outspoken letter from J. D. Forbes refers to one received by him from Whewell, who "in mentioning Dr. Brewster's attack upon Professors in their scientific character (which his best friends must allow to be unadvised and most unreasonable) . . . adds that even if other circumstances permitted he should certainly not think of going to York, to rally under Dr. Brewster's banners. Now this is truly too absurd. That Dr. B. originated it (*sic*) there can be no doubt however Mr. Murchison has endeavoured to confine its origin to London and the Geological Society (and I must say he treated his countrymen rather cavalierly on the occasion)—but to suppose that on that account the Doctor was to take any ostensible charge, so that even if he did a mere party feeling should keep men who ought to be above such things, from joining in a scheme intended for the general promotion of Science in Great Britain, is really vexatious. I believe I mentioned to you that Dr. B.'s nervousness in public is so great that even were he requested, he would be unable to act any conspicuous part at the Meeting. And it might nearly be considered the downfall of the Association, if the whole constellation of talent at Trinity were thus to be withheld from fostering so infantile a project. I think you might devise some means for correcting the most erroneous views of the Cantabs. . . ." Forbes' pen was not prone to restraint, and there is a letter from Brewster to Phillips, quoting with pain some comments by Forbes, in writing to a third party, which injudiciously reflected upon Brewster's candidature for the chair of natural philosophy at Edinburgh, to which Forbes himself was afterwards appointed.

Perhaps the most attractive 'human document' of the collection is the MS. report of a discussion on mineral veins, and other transactions, at the Cambridge meeting in 1833. The British Association has never been methodical in reporting its own discussions, and perhaps its reluctance, in earlier days at least, was not unwise, if this be a sample of a serious attempt at a report. Scientifically it is of little worth, save where John Phillips strikes out the reporter's version of his remarks and substitutes his own. The report starts, brightly, with the statement that "Mr. John Taylor read a paper on the state of our knowledge with regard to metallic veins, of which not much was audible in consequence of that low tone in which he read and the noise at the other end of the senate house". Sedgwick, as president, was in the chair, and proceeded to summarise the previous speaker's views "as far as he had understood him". Taylor, he said, had referred metallic veins to three causes—"that they were injected from above, or forced up from below by convulsions of nature, or else were what was called contemporaneous, that is made by causes in nature always in operation". Sedgwick remarked that for the results of this last process Whewell ("who had a great penchant for etymology and had larded our language with many words of his own invention") had proposed the phrase "veins of segregation"; whereupon Whewell, apparently at considerable length, said nothing in particular upon a topic which was scarcely his own, in justification of his new term, which seemed to find acceptance.

Buckland had previously considered Taylor's three causes, rejecting the first, admitting the second as possible, preferring the third. "He had however some fourth case which I have forgotten," says the reporter naïvely, "I think it was that of sublimation"; and a note is pencilled in Phillips' hand: "This was Dr. Buckland's favourite theory; by this process he supposed nearly all cases of difficulty could be solved". Not so others: Murchison expressed the fear that Buckland's "brilliant harangue might have silenced some gentlemen present who, he knew, held opinions varying from those which that learned gentleman had expressed". Sedgwick thought some of the distinguished foreigners present might have something to say, and that they were welcome to say it in French if they wished. A pleasant passage follows:

"*Mr. Murchison.* Mr. President, I am commissioned by the foreign gentlemen whom you have called upon to speak——

"*President.* No, no, not called upon: no one is called upon to speak—no one need speak unless they please.

"*Mr. Murchison.* Very well, Mr. President, then I am commissioned by the gentlemen whom you have not called upon to say that they are not at present prepared with arguments to refute Dr. Buckland's theories but probably may wish to do so at some future time."

Dr. Boase then stood forth, and began "in a very angry tone" by saying that he had "not been beaten down by Dr. Buckland's speech", and Sedgwick and Murchison had both to assure him that they had never intended to suggest this (and indeed it was sufficiently obvious from what remains to us of the speaker's diatribe). Phillips then took up Whewell's theory of segregation, and by way of supporting it, remarked rather caustically that "he would venture to trespass so far on the attention of the meeting as to state the facts distinctly". One faintly conceives Whewell's own sentiments on hearing this; but the meeting now appears to have concluded peacefully.

The proceedings at the general meeting on the following day seem, however, to have been even less harmonious. It opened, following a practice of the time, with reports of sectional transactions by appropriate representatives; and so far all was well. Then Peacock read a paper on the analysis of algebra, amid a buzz of conversation which Sedgwick vainly attempted to check: at last "the president requested that a constable should be sent up to stand by him"; actually, "a servant" was procured. Sedgwick by this time may have been feeling the strain of his office: he "observed that Professor Henslow had some proposal which he wished to make to the meeting and he had better speak for himself, as he considered that Professor Henslow knew his own intentions better than he, for he could not understand them at all". Poor Professor Henslow had nothing less innocent to propose than a botanical excursion. "He believed the neighbourhood of Cambridge furnished little matter interesting to the geologist, or no doubt Professor Sedgwick would have been happy to—— *Professor Sedgwick:* Talk of your own affairs if you please, Professor Henslow, and do not interfere with my business." The upshot was that the president, *ex cathedra*, said in effect that the botanists could do as they liked, but if the geologists wanted an excursion, he would rather be excused.

Certain further papers were given, including one by Rennie on hydraulics, "much too learned for common comprehension, and not well read". Finally, the president took the floor with a series of announcements, about "the ordinary", about a display of fireworks which "every member was invited to see and take with him a train of three ladies", about a recondite jest of Whewell's concerning waterworks in place of the fireworks; and at last "after several times calling the assemblage back to hear different announcements which he had forgotten, the meeting broke up for that day".

Such, we must suppose, is the earliest attempt to provide brighter reports of the meetings. One suspects that the "Mudfog Papers" may have had some basis in reality.

## Physical Laboratories and Social Service*

By Sir William Bragg, O.M., K.B.E., F.R.S.

In these days the services to be rendered by a physical laboratory become more definite than they were: not more stereotyped, because the possibilities and modes of their usefulness are increasing, but more clearly understood. With some curiosity I have read again an address which Lord Kelvin (then Sir William Thomson) gave at the opening of the physical and chemical laboratories at University College in Bangor in 1885. Thomson could then describe, as happenings of his own time, the beginnings of instruction in practical physics and chemistry and the construction of the necessary laboratories. Soon after he went to Glasgow, in 1846, he was in need of help with some electrical measurements and invited the aid of students, which was willingly given. Others heard that some of their fellows had got experimental work to do, and begged to be allowed to join in. This was the beginning of practical work for the students in his laboratories. Thomson recalled, with great zest, that three-quarters of his helpers were theological students, and that he had to explain to an amazed outsider that they seemed to be happy in their work and were getting on very well. At that time, of course, experimental science had already an accepted place, but there is a quaint evidence of a certain antagonism to it when he carefully explains that to measure the forms and properties of crystals is not to put them to an ignoble use.

At that time, also, the Cavendish Laboratory at Cambridge had got well under way; there were laboratories in the London colleges and elsewhere. But the number was small in comparison with that of to-day, when so many universities, colleges, schools, industrial firms, and other bodies have built and equipped laboratories, many of them magnificent in their equipments and their spaces. The nation itself has felt the need, and in 1899 founded the National Physical Laboratory at Teddington, where, also, a National Chemical Laboratory has now been working for the last few years. The research associations working in connexion with the Department of Scientific and Industrial Research have all their separate laboratories where physical and other research is carried on.

There has, in fact, been a great change since Thomson made his Bangor speech, in the general estimate of what may and ought to be expected from the physical laboratory. People are undoubtedly more interested in the growth of natural

* From an address delivered at the opening of the new Physics Building of the University of Leeds on Feb. 18.

knowledge, and more aware of what it means to them. The manufacturer has discovered the possible, and often immediate, advantage of research; the politician observes that scientific discovery is a world force; the teacher and the thinker find that the unfolding of Nature's laws alters the lines on which they move, and many people of every kind ponder over what this continual advance in knowledge may imply.

Moreover, John Citizen is interested in yet another way. There was once a time when private liberality alone founded institutions of learning and provided for their maintenance. Universities, colleges, and schools still owe much to the generosity of their friends. But such institutions are also, in these democratic days, supported directly by the citizen by way of government grants, county grants, municipal grants, and by more widely spread contributions from individuals. Industrial laboratories and State laboratories, of course, are directly provided for by funds which are expected to be repaid in the form of contributions to the welfare of industries and of the community in general. John Citizen has not only become interested as a spectator, in the advance of knowledge by experiment: he has also begun to see its advantage to himself, and is willing to pay for it.

Physics might be thought to be one of the last of the sciences to feel this change of attitude, because it is one of the most fundamental, further away than the others from direct contact with everyday life. Much of modern physics has, of course, an appearance of remoteness. That is not only due to the nature of the subject, but also because various applications of physics have led to hiving-off processes. As soon as a branch of physics becomes useful, it ceases to be physics and begins a new life under another name, such as the various forms of engineering science, or meteorology, or cryogenic research. But there are few things more fascinating in scientific work than the unexpected application of some discovery, made in the progress of a research which seems to be out of touch with everyday things: it may take the form of an illumination of some common event, or a solution of a vexed question, or a welcome aid in some enterprise. Contact is continually being made between the abstruse and the obvious: we should scarcely expect otherwise if we are convinced of an all-embracing unity.

Thus a physical laboratory takes its recognised place of service to the community. What can it do now? How can it extend its service in the future?

First, of course, it exists for the instruction of the student. Many professions for which men and women are trained depend to a greater or lesser extent upon physical laws, which must be grasped and understood. Teaching by experiment can be made an instrument for most valuable training in accuracy, judgment, and the regard for unbiased opinion. Moreover, these young people go out into the world as exponents of ideas and principles which they have learnt to believe in. The great and useful influence which may proceed from a laboratory cannot, in general, be exerted directly: it has to be disseminated through many channels. In the laboratory it is possible to teach what science is, and what it implies: lessons which are far from being learnt by the world at large. The British Broadcasting Corporation, in its useful, praiseworthy way of attacking the great questions of the day, has recently employed eminent thinkers and workers to speak on "Science and Civilisation". These discourses have been, it seems to me, of great benefit to the cause of science, and not least those which at first sight seem to be antagonistic: for their 'acid' has bitten, not into science itself, but into false conceptions of it, and has left the nobler metal clean and untouched. There are two notable errors which discussions such as these help to remove. One is to mistake mechanisation for science, and to ascribe certain evils to science which come from a wrong use of the machine—which are in truth, as Sir Oliver Lodge says, a blot, not on science, but on civilisation. Splendid truths can be put to evil purposes. The other of the errors to which I would refer is the use of scientific terms, conceptions, and facts in regions where they have no place. I do not mean only arguments about ethers, vibrations, influences, and the like, which few people take seriously; but there is a curious liking for risky extrapolation; for discussions of questions to which experimental science is not yet ready, possibly never will be ready, to give an answer; for argument by analogy, which is dangerous.

A laboratory exists also for the increase of natural knowledge by experiment: and none more obviously so than the laboratory of a university. Of necessity, the most fundamental and valuable research must be done—not as being useless, as some exaggerations would have it—but without regard to the nature, or even the possibility of its use: which is obvious enough. I need not elaborate this vital point: it is well understood.

Of recent years the encouragement of industrial research has led to the establishment of a number of laboratories attached to various industries, and dealing mainly with the physical and chemical problems that industry encounters. These are supplied with men mainly trained in university laboratories. The Department of Scientific and Industrial Research makes a number of grants each year to men working in university laboratories in order that they may be enabled to train themselves for industrial research posts. It is for the university laboratory to encourage and help those who avail themselves of these grants. The university laboratory should be in touch with the surrounding research associations, thus keeping contact between pure science and its special adaptations.

It is possible that there is yet another way in which the laboratory may be of service. I mention it rather as a provocative suggestion than as an actual recommendation. Is it not possible to see more of John Citizen himself in the laboratory? Of late years the science museum has advanced in popularity and usefulness by leaps and bounds. It is far more up-to-date in its exhibits, far more interesting in its displays. The well-organised Science Museum in South Kensington is visited by

far more than a million people a year. A huge museum is in course of erection in Philadelphia. The great museum in Munich is famous. It is, by the way, interesting that this pioneering institution should have been founded in the city where Count Rumford served the State of Bavaria so notably. For it was he who conceived the idea of the science museum and wrote elaborately on its objects and its management. This was a hundred and thirty years ago : and it could not be improved upon now. The Royal Institution was founded in the attempt to give form to his ideas. It failed to do so because the times were not ripe ; but that is no longer the case. The Faraday Exhibition of last September drew fifty thousand visitors in the ten days of its activity. I had occasion recently to visit a smaller but similar exhibition arranged in the new laboratories at Exeter ; five thousand people visited it in two or three days. The public has not only a newly wakened interest in science, but also is delighted to see actual demonstrations. This is all the better because so much of the interest has been excited by written description or by talks over the ether, and the visible example is much needed as a corrective.

Such exhibitions are of proved value, and may be extremely useful under the conditions of to-day. If any effort were made to follow examples set elsewhere, to demonstrate visually to John Citizen the slow unfolding of Nature's laws by patient research, the discovery of unsuspected beauties of order and adaptation, the origin of new conceptions of the universe, and, not least, the skilful handling of new knowledge for the service and delight of man, then the university laboratories would naturally be looked to for help. To them it would fall, as it fell to the Royal Institution, to illustrate particularly the development of scientific ideas and methods.

We cannot ask that everyone shall be trained to understand and follow the advance of scientific knowledge. All that can be worked for—and it is far from our present attainment—is that there shall be an understanding of what science is, of what it can do, and of what it cannot do. Even this cannot be expected from the public as a whole : but it is urgently necessary in these days that a sufficient number shall be so informed, and especially those whose collective opinions and wishes determine the general courses of action.

## Clouds High in the Stratosphere

By Prof. S. Chapman, F.R.S.

THREE years ago, Prof. C. Størmer, of Oslo, made a preliminary announcement in Nature of photographic observations by himself and his assistants upon the height and colour-distribution of some clouds at a remarkably great height in the atmosphere nearly over Oslo.[1] He has now issued a detailed account of this work,[2] and also of some hitherto unpublished visual observations on similar clouds, made by him on Jan. 1 and Jan. 15, 1890. The memoir is very fully illustrated by 140 diagrams and eleven beautiful photographs, three of which are reproduced herewith.

The clouds were of the type termed in English iridescent ; in German, the language in which Prof. Størmer's memoir is written, they are called *Perlmutterwolken* (mother-of-pearl clouds). The simile appears to be an apt one for the more luminous parts of the clouds, which present one of the most beautiful spectacles afforded by the sky. The colours and colour changes observed in these clouds are stated to be " essentially different " from the ordinary iridescence often seen at the edges of thin clouds near the sun. They are also very different from the bluish whiteness of the luminous night clouds, at about 80 km. height according to Jesse, which Størmer states have often been seen by him. Very detailed descriptions are given as to the changing colour distribution of the clouds, especially for those of January 1890 ; the colours are mainly arranged in bands following the outlines of the clouds, and these bands, and the outlines, in some cases change rapidly, so that before a sketch of them is completed the earlier part of the sketch no longer represents the form of that section of the cloud.

Apart from their extreme beauty, the clouds are distinguished for their great height ; this was suspected by the late Prof. H. Mohn, who specially studied these clouds, but it was first definitely confirmed by Prof. Størmer in 1927, who was able, on Dec. 30, 1926, to take two pairs of simultaneous photographs of such clouds from his auroral stations at Oslo and Oskarsborg. The height found was between 26 km. and 30 km. The new photographic material for the clouds of Jan. 13, 1929, is much more ample, the number of pairs of photographs exceeding ninety. The heights then found lie between 23 km. and 26 km. The existence of clouds at this high level had never previously been established. Ordinary clouds are almost entirely confined to the troposphere, that is, below about 10 km. These mother-of-pearl clouds are high up in the stratosphere.

Yet another peculiarity of these clouds is their rarity ; Prof. Størmer saw them in 1890, but from 1892 until the end of 1926, though carefully watching for them, he failed to find any. In 1929 he again saw them. The conditions under which they were seen were similar in the three cases, and agreed with those described by Mohn, as associated with nearly all his observations of the clouds. They occur when there is a deep barometric depression near Oslo, and usually to the north ; owing to the distribution of the mountains in the adjacent region, warm dry winds (Föhn) then often blow down the southerly and easterly slopes towards Oslo, and produce high temperatures, and a clear sky, over a part of the cyclonic area which is usually overclouded. Hence Størmer suggests that the high clouds may in fact be common features in the stratosphere over the ascending part of cyclones, but usually invisible. If this

FIG. 1.—Iridescent clouds to the west-north-west, after sunset on Jan. 13, 1929.

FIG. 2.—Iridescent clouds to the west-south-west, on Jan. 13, 1929.

suggestion could be tested by aeroplane observations above the clouds during cyclones (though this may offer great difficulty) it would be of great interest.

Visual observations of the clouds seen in December 1926 indicated the very high velocity of 75 metres a second (170 miles an hour). Those of January 1929 were nearly stationary, though near the ground there was a strong north-westerly wind; "the mother-of-pearl clouds lay over Ostland [a district near Oslo] for a time longer than that needed by the lower air to travel from southern Norway to Germany". Those of January 1890 seemed to be nearly stationary as a whole, a second, during the $1\frac{1}{4}$ hours of duration. If this be interpreted as their steady rate of fall subject only to gravity and the resistance of stationary air, it enables the size of the cloud particles to be estimated roughly, assuming that they have the density of water and are spherical. Applying Stokes's formula, the result is 0·005 cm. radius, but this value is near the upper limit for which, in these circumstances, Stokes's formula is applicable. The radius of ordinary cloud particles is about 0·001 cm. It is, of course, uncertain whether the substance forming the mother-of-pearl clouds is water, though it is difficult to see what else it could be. Iridescence is currently interpreted as

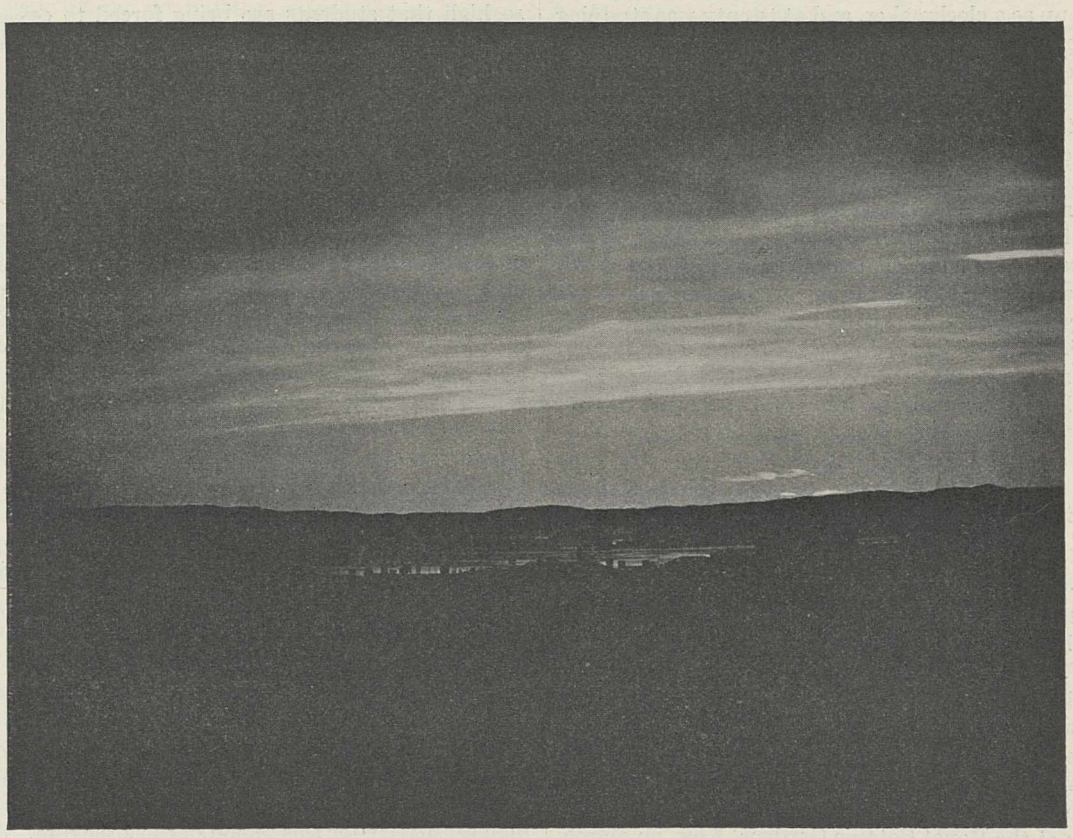

Fig. 3.—Iridescent clouds to the south-west, on Jan. 13, 1929.

but, like those of 1929 (though in a higher degree), they showed rapid internal motion, constantly breaking up or changing their shape. This is of interest as tending to confirm the view that convection or eddying motion does not cease at the top of the troposphere, but may extend far up into the stratosphere, at least to a sufficient degree to maintain a uniform mixture of the permanent constituents of the air up to a considerable height. Hitherto the most direct support for this idea has been the distorted meteor trails sometimes observed, generally at greater heights than 30 km. Prof. Størmer's observations on these high clouds of 1890 seem to afford valuable independent confirmation of this view.

The photographs of one small cloud, of January 1929, indicate a slow velocity of descent, of 30 cm. indicating the presence of supercooled waterdrops.

The physical implications of the presence of these clouds at their considerable height in the stratosphere are, and for some time may remain, obscure; but possibly they will play a significant part, along with such other remarkable facts as those of the ozone relations with surface weather, in unravelling the mysterious and important problem of the origin of cyclones. However this may prove, Prof. Størmer is to be congratulated on this new achievement in precise upper atmospheric investigation, an interesting and important by-product of the organisation he has built up for the study of the aurora borealis.

[1] Nature, **123**, 260, Feb. 16, 1929.
[2] *Geofysiske Publikasjoner*, vol. 9, No. 4, Oslo, 1932; 27 pp. and 16 plates; 7.00 kr.

## News and Views

### Bicentenary of David Rittenhouse

ON April 8 occurs the bicentenary of the birth of David Rittenhouse, the American astronomer, who has been described as " a true product of American genius and toil, and the highest embodiment of the pioneer spirit in science during the colonial period". The eldest son and the third child in the family of a farmer of Norriton, about twenty miles from Philadelphia, as a boy he began work on the land, but the gift of some tools and mathematical books stimulated his interest in mechanics and science. While still a youth he set up as a clockmaker, and at twenty was studying Newton's "Principia". Though in after years he devoted much time to mathematics and physics, his first important work was in astronomy. He made the first transit instrument and the first orrery constructed in America, in 1768 began the erection of an observatory at Norriton, and the following year took a prominent part in observing the transit of Venus. One of the earliest members of the American Philosophical Society, he contributed nineteen papers to its *Transactions*, in 1775 he delivered an oration on the history of astronomy, and, on Franklin's death in 1790, was chosen president. From 1777 until 1789 he was treasurer of the State of Pennsylvania, and from 1792 until 1795 master of the Mint of the United States. He received honorary degrees from Harvard, Princeton, and Pennsylvania Colleges, and in 1795 was elected a fellow of the Royal Society. His death took place in Philadelphia on June 26, 1796, and he was buried in the Presbyterian churchyard in that city.

### Dr. N. E. Brown

THE University of the Witwatersrand, Johannesburg, has conferred the honorary degree of D.Sc. on Mr. N. E. Brown, formerly assistant in the Royal Botanic Gardens, Kew, in recognition of his work on the South African flora. At the request of the Moss professor of botany in the University, and to mark the conferment of the degree, Sir Arthur Hill formally presented Dr. Brown to his old colleagues in the Herbarium of the Royal Botanic Gardens, Kew, on March 19. In the course of a short address, Sir Arthur said: " Dr. Brown was on our staff for forty-one years, from 1873 until 1914. He was elected an associate of the Linnean Society in 1879, and in 1921 he received the Senior Captain Scott Medal for scientific research in South Africa from the South African Biological Society. I need not detail his many contributions to South African botany, as they are so well known to all botanists, but it is interesting to record that the following eminent South African botanists warmly supported the proposal that Dr. Brown should be honoured by South Africa: Gen. the Right. Hon. J. C. Smuts, Dr. I. B. Pole Evans, Prof. J. W. Bews, Prof. R. S. Adamson, Prof. R. H. Compton, and Dr. John Muir."

### Taxation of Imported Books in Australia

As recorded in NATURE of Feb. 20, p. 271, a deputation representative of national libraries, universities, professional institutions in Australia and the Council for Scientific and Industrial Research waited on the new Prime Minister, Mr. Lyons, early in February and pleaded for remission of the emergency taxation on imported books imposed by the late Labour Government. The revenue from this source in the current financial year ending on June 30 is estimated at about £75,000 from primage tax and £55,000 from sales tax. It was urged that the continuation of these taxes would result in a far greater loss in efficiency to the whole community than a loss of £130,000 would represent to the Government. Book prices are now so high that students are being forced to cease purchasing technical works and to rely more on libraries; but, unfortunately, the libraries are failing them. That in Sydney, for example, was obliged recently to cease its subscriptions to no less that 100 journals, and in the near future it is feared that a further 150 will have to be sacrificed. Other striking examples of the unhappy results of this taxation were quoted. Mr. Lyons, in reply, agreed with all the main contentions of the deputation, and offered slight relief in cases of exchange publications and certain historical materials for libraries. For the rest, he frankly pointed to the disquieting financial position of the Commonwealth and asserted that attainment of budgetary equilibrium is the only hope for universities, scientific societies, and the whole country. The book tax revenue must remain for the present. Sheer necessity is driving the Government to this unfortunate device, and to others also, which admittedly and inevitably will to some extent undermine the efficiency of the nation. Such a reply, while quite understandable, leaves a serious problem to be faced by educational and scientific organisations in Australia.

### New Emulsion Sensitive to the Infra-red

FOR some time past, photographic materials sensitive to radiation between 7000 A. and 9000 A. have been available. The sensitivity of these plates has, however, not been high. The Ilford Company has now produced a plate which possesses a comparatively high sensitivity for this region of the spectrum. With a subject illuminated by two 1500-watt gas-filled lamps at a distance of about eight feet and screened by filters cutting off radiation of shorter wave-length than 7000 A., the exposure is about half a second with the lens working at *f*. 4. Such photographs, taken in the dark, serve as an excellent demonstration of the existence of invisible radiation; the public, already accustomed to the idea of ultra-violet rays, thus becomes familiar with the infra-red. The practical use of these plates is, however, considerably greater than that of demonstrating the actinic power of the infra-red: in astronomical and geographical recording, their power to respond to the unscattered radiation coming through mist and haze from very distant objects makes them particularly valuable.

### The Sherman Hoyt Cactus House, Kew Gardens

THE outstanding feature of the Royal Horticultural Society's Show at Chelsea in May 1929 was the

exhibit of cacti and other succulent plants which was shown by Mrs. A. Sherman Hoyt, of Pasadena, California. The collection of living plants was arranged against a painted scene of the Mohave Desert, and the whole exhibit was a presentation of the desert flora of Southern California. At the close of the Show, Mrs. Sherman Hoyt very generously presented the collection of living plants to Kew, together with the painted desert scene and the rock and sand which she had brought over from California. Since it was impossible to make an adequate display of her exhibit or to make use of the very beautiful painting in any of the houses at Kew, Mrs. Sherman Hoyt most generously offered to build a special house for the display of her plants with the background. In the house, now completed and planted, the desert scene occupies the semi-circular wall of the apse, and in the foreground is a representation of the desert in conformity with the painted background. The stone which has been used for building up the foreground is old red sandstone from Dunster, Somerset, and matches remarkably closely both in colour and structure the Californian rocks shown in the picture. Cacti and other succulent plants have been placed among the rocks in positions as near as possible to those in which they are found in their native home, and the whole effect makes a remarkably striking picture, since the rocky foreground blends so naturally with the painted desert scene behind that it is by no means easy to detect any break between the actual living plants and those shown in the background. The house was opened to the public on March 24.

### India and Babylonia

The discoveries at Tell Asmar (Eshnunnu or Ashnunnak), announced by Dr. H. Frankfort in his letter to the *Times* of March 26, constitute an addition of no little importance to the evidence linking up the early civilisations of Mesopotamia and the Indus valley, especially if his conjectural relation of the new finds to the culture of Mohenjo Daro should be confirmed by subsequent investigation. The excavations of the Oriental Institute of Chicago on the site of private houses of the age of the Dynasty of Akkad (*c.* 2550 B.C.) on the northern outskirts of the Tell have brought to light two seals, of which the character points unquestionably to an Indian origin. One, a cylinder seal, shows a design of a procession of animals, elephants and rhinoceros with crocodiles, which in subject and convention is both alien to Mesopotamia and referable to the Indus civilisation; while the second is of more common Indian form, a square stamp seal with a pierced knob on the back, and bearing a design of concentric squares which does not appear elsewhere in Mesopotamia, but occurs on similar seals at Mohenjo Daro. Further evidence pointing in the same direction has been found in the form of etched carnelian beads resembling Indian specimens, kidney-shaped inlays of bone identical in shape with some in shell from Mohenjo Daro, and two sherds of pottery showing a decoration with knobs, unknown in Mesopotamia, but also occurring at Mohenjo Daro. Certain distinctive features in the seals, however, lead Dr. Frankfort to think that either they belong to a slightly earlier or later phase of Indian civilisation than that at Mohenjo Daro or they may have come from another site within the same cultural area, the latter alternative being the more probable.

### Bird-ringing in Great Britain

The banding or ringing of birds is now accepted as the established technique for elucidating migratory and other movements, and Mr. H. F. Witherby and the *British Birds* scheme are to be congratulated upon the success with which they have kept the system alive and increasingly flourishing in the British Isles. During 1931, more British birds than ever were marked with identification rings, 29,554, and this brings the grand total since the beginning of the scheme in 1909 to 316,955 (*British Birds*, March 1932, p. 286). Recoveries vary greatly amongst the different species: the highest percentages are shared by two birds of prey, the peregrine falcon (23·3 per cent) and the merlin (21·8 per cent), and these figures suggest the intensity of destruction which overtakes such birds at the hands of game-preservers, for even the innocent kestrel is represented by 49 returns out of 494 ringed. At the other end of the scale stands the blackcap, the 517 ringed individuals of which gave not a single return, and for all the warblers and even many of the finches the recoveries are very meagre. Of 496 nightingales only 2 have been handled again, and of 507 arctic terns only one. It is obvious that a great deal of labour goes unrewarded in ringing birds; 22,943 swallows have yielded only 163 (0·7 per cent) returns, but the returns have brought out new facts regarding the range of the southward migration and the return of the birds to the locality of their birth. More curious still, of 37,225 song-thrushes, only 481 or 1·4 per cent have been found again.

### The Nature of Carpels

In a preliminary notice (*Bull. Classe des Sci. (Acad. Roy. de Belgique)* 5e Série, tome 17, 1931), Grégoire has criticised the view of the foliar nature of carpels, and in a fuller treatise he proposes also to extend the argument to the comparison of stamens with leaves, and, in fact, of the flower with a vegetative bud. His criticism is based on ontogeny; he points out that when carpels are formed, they do not appear as lateral structures on the floral axis, and the apex of the latter can never be recognised as still persistent in the centre of the flower. Further, he considers that the margins of the carpellary upgrowths do not meet and fuse marginally as is usually supposed, but are merely the appearances due to the upward extensions of a split in the tissues of the lower part, as this expands to form the cavity of the ovary. Most botanists agree, however, that the comparative morphology of vegetative and reproductive shoots supports the general view of the homology of vegetative bud and flower, but the changed type of growth has so altered the floral parts that, the nearer one passes towards the centre of the flower, the more difficult does it become to press detailed comparisons.

### Cultivation of Bulbs

DURING recent years, bulbs have become a field crop of considerable importance, especially in the Scilly Isles, Cornwall, and Lincolnshire, and growers, or intending growers, will welcome the illustrated bulletin No. 44, entitled "Narcissi Culture", recently issued by the Ministry of Agriculture (H.M. Stationery Office, 9*d*.). Although bulbs grow well on a number of soils, good drainage and cultivation are essential, but the direct application of fresh manure should be avoided. Potatoes which have been adequately manured leave the soil in excellent condition for bulbs. Among some of the more important questions upon which advice is given are those relating to grading, lifting, storage, and planting. Eelworm has become a serious menace to the bulb-grower, and sterilisation by means of hot water (three hours' immersion at 110° F.) is strongly advocated, the treatment being given when the bulbs are in as dormant a condition as possible, or injury may result. As regards flowers, while good grading, bunching, and packing are essential, the importance of making the flowers look attractive by means of details such as packing-paper should not be overlooked. Although this trade in narcissus flowers has increased so enormously, the allied bulb-growing industry could become one of even greater financial importance, for the sum spent annually on imported bulbs amounts to nearly £1,500,000.

### Manures and Manuring

IT is recognised that owing to the variation in local conditions, it is impossible to give a complete guide to manuring on every farm. Still, the information supplied in *Bulletin* No. 36, entitled "Manures and Manuring", which has recently been issued by the Ministry of Agriculture to replace the sectional volume of *Leaflets* No. 8 on the same subject, the text having been considerably revised by Mr. H. V. Garner (H.M. Stationery Office, price 1*s*. 3*d*. net), should be of the utmost value to farmers, if they are to derive the fullest benefit from the money spent on fertilisers. The *Bulletin* is divided into three parts, the first of which deals with organic manures. In spite of the recent great development in artificial fertilisers, farmyard manure is still the stand-by of arable farmers, but although it is by far the most important type of organic manure, the value of other materials such as liquid manure, town refuse, poultry manure, and seaweed is evidently considerable. Part ii. is devoted to artificial fertilisers. The various types of nitrogenous, phosphatic, and potash manures now on the market are described, while a further section deals with the use of compound manures. The third part supplies useful information with regard to the purchase and use of artificial fertilisers, and enables the farmer to determine the comparative value and costs of nitrogen, phosphoric acid, and potash in the different forms without difficulty. Some suggestions are made, on quite general lines, as to the treatment of farm crops, and a further section is devoted to a discussion of soil analysis and its bearing on cropping and manuring.

### Improvements in Epidiascopes

RECENT developments in the design of instruments for the projection of opaque objects have been directed towards increasing the intensity of light directed on the object, improving the quality of the projection lens, and simplifying the mechanical construction in order to ensure lightness, durability, and ease of manipulation. An active part in the development and perfecting of such instruments has been taken by Messrs. Newton and Co. of 72 Wigmore Street, London, W.1. Since the production of their first episcope in 1916, the efficiency and convenience of succeeding models have increased with each stage of development. The high efficiency of their latest types is due largely to the use of special diffusion reflectors. The illuminant is a single 500-watt gas-filled lamp which is so placed that four of these reflectors can be used to concentrate the light on the object and give a uniform illumination over the whole field, an area 6 in. × 6 in. This arrangement, combined with a large aperture projection lens, provides an illumination on the screen equal to that obtained from earlier instruments employing two lamps. As only one lamp is used and the lamp-house well ventilated, the objects are not exposed to any great heat. When it is necessary to keep them at room temperature a ventilating fan can easily be fitted. The silver-surfaced reversing mirror is mounted outside the lamp-house and, consequently, is not subjected to heating from the lamp. The construction of the body, which is of cast aluminium, is such as to ensure lightness and durability; and the design of the instrument renders its operation extremely simple. Precise and easy adjustments are provided for all necessary movements. Instruments of different sizes, embodying these improvements, are available with working distances ranging from 16 ft. to 40 ft.

### Electrical Conveyors in Mines

IT is generally admitted that the only real way to increase the prosperity of a coal mine is to increase the output per head of the workers employed. Of recent years great improvements have been made in the methods of the removal of the coal broken at the working face by mechanical conveyors actuated by electric motors. The Metropolitan-Vickers Electrical Company has specialised in the production of motors and control gear for this purpose. In the December issue of the firm's *Gazette*, an account is given of the many rigorous conditions these motors have to satisfy and the various types of conveyor used in practice. In the belt conveyor the coal is carried on a moving continuous belt. In the shaker conveyor it is conveyed by an oscillating trough, which moves slowly in one direction but has a comparatively quick return. The coal is thus carried forward in the desired direction by a series of jerks. In the scraper conveyor the coal is conveyed by a continuous scraper working in a fixed trough. For each type of conveyor the demands on the electrical motor are different and so also are the arrangements of the electrical control equipment. Graphs are given, showing how the loads on these types

of conveyor vary with the time. In the motors ordinarily used, causes of failure arise from the whipping of the shaft and from the ingress of stone dust at the bearings. In the motors described, the roller-bearing at the driving end and the ball-bearing at the opposite end are both constructed in dust-proof 'housings'. The diameter of the shaft of a Metropolitan-Vickers new 15-h.p. conveyor motor is 2·5 in. and the rotating part is practically indestructible. The progress made in mechanical haulage will greatly diminish the use of animals underground for haulage purposes.

### British High-Speed Aircraft

THE Aeronautical Research Committee has recently issued a résumé of the original scientific work done by various authorities in Great Britain upon the development of racing seaplanes, which has led finally to the winning outright of the Schneider Trophy and the breaking of the world's speed record during September 1931 (*Reports and Memoranda*, No. 1300. "Collected Reports on British High Speed Aircraft for the 1927 Schneider Trophy Contest", by W. L. Cowley. London: H.M. Stationery Office). This is a departure from the normal procedure of issuing information in disconnected reports and memoranda as it becomes available, which has the advantage that it becomes virtually a textbook upon its subject and saves the labour necessary in hunting up such information when issued in separate pamphlets. On the other hand, if it is necessary to wait for more than four years for the collection and collation of such information, the advantage of its more convenient method of issue is largely outweighed by the obsolescence of its material. The subject matter is divided into separate headings of research, specifications, design and construction, inspection and test, and operational. It deals in great detail with three machines that are widely different in characteristics regarded from the point of view of high speed flight. The monoplane versus biplane, and the air-cooled versus water-cooled engine controversy is thoroughly fought out with representative machines of each class. The most significant thing about the report is the agreement between scientific prediction and actual results, and the ability of scientific investigation to explain apparent phenomena arising during practical use of the aircraft.

### Nickel in Marine Engineering

THE January issue of the *Transactions of the Institute of Marine Engineers* contains, as usual, a selection of important articles from the technical press, and a report of a paper on "Nickel and Nickel Alloys in Marine Engineering", read to the Institute by Mr. J. McNeil on Dec. 8. Of all the many uses to which nickel has been put aboard ship, none has proved more valuable than when alloyed with copper for condenser tubes. For a very long period, the deterioration of brass condenser tubes, with its accompanying trouble through leakage of sea water, has been a very serious problem, especially in ships fitted with water-tube boilers, but it appears to have been solved at last by the use of an alloy of 70 per cent copper and 30 per cent nickel for the tubes. Alloyed with both ferrous or non-ferrous metals, nickel is used for steam turbine blades and nozzles, high-pressure steam valves and fittings, propellers, pistons and liners of Diesel engines, reduction gear wheels, and even crankshafts. Recently a process has been evolved in which nickel can be deposited in thick layers and thus worn parts built up. There is remarkable adhesion between steel and deposited nickel, and the resistance to shear of a thick ring of nickel deposited on steel is stated to be practically that of the metal itself.

### Arctic Exploration

MUCH activity in polar exploration during the last year, particularly in Greenland and Northern Land and adjacent islands, is noted in the *Polar Record* for January. When Nansen crossed Greenland in 1888, the journey was considered to be difficult and adventurous. Since that date several other crossings have been made, but no period has been so fruitful in the exploration of the ice sheet as 1930 and 1931. During that time, two observatories have been instituted and used for longer or shorter periods on the ice, including the German station of the Wegener expedition in the centre; three new crossings of the ice-sheet have been made, including one across the greatest width; and for the first time, echo measurements of the thickness of the ice have been taken. It is also noted that Soviet explorers from the station on the Kamenev Islands to the west of Northern Land, in long sledge journeys, have filled in the western coasts of that land and determined its northern extremity in lat. 83° 16′ N., long. 95° 37′ E., thus finishing the last piece of pioneer work that the arctic regions offered. Details of these and various other polar explorations are given in the journal.

### The Malabar District of India

A SERIES of articles on the Malabar district of India is published in an enlarged number of the *Journal of the Madras Geographical Association* (Oct. 1931–Jan. 1932). These papers were read at a conference of the Association held at Palghat in May 1931. They cover the geology, meteorology, botany, and agriculture of the district, and are illustrated by various maps. Following these there are other papers dealing with modern and ancient trade, trade routes, and urban centres. A particularly interesting paper treats of Roman trade centres on the Malabar coast. There are also notes on the place names. The volume is a useful contribution to the study of India, and is chiefly the work of Indian teachers.

### Tours in the U.S.S.R.

IN 1931 the Society for Cultural Relations arranged two conducted tours to demonstrate present activities in science and medicine in the U.S.S.R. Similar tours, each lasting about a month, are being organised this year between July 15 and Sept. 15. It is hoped to arrange parties for physicists, biologists, medical men, and others, each party being limited to about twenty persons. Travelling arrangements will be made by Intourist, Ltd., Bush House, Aldwych, W.C.2, and

competent guides and interpreters will be provided by " Voks ", the Soviet organisation for cultural relations with foreign countries. Full particulars can be obtained from the Society for Cultural Relations, 1 Montague Street, London, W.C.1.

### Royal Institute of Public Health

THE annual Congress of the Royal Institute of Public Health will be held in Belfast on May 10–15, under the presidency of the Marquess of Londonderry. The Congress will be divided into the following Sections: I., State Medicine and Municipal Hygiene; II., Industrial Hygiene; III., Women and Children and the Public Health; IV., Tuberculosis; V., Pathology, Bacteriology, and Biochemistry. The inaugural meeting will be held in the Great Hall of Queen's University, at 11 A.M. on May 10, when the presidential address will be delivered. Several general excursions have been arranged, besides sectional visits to hospitals, sanatoria, etc., and certain institutions, centres, and works will be open for inspection. Further information can be obtained on application to the Secretary, Royal Institute of Public Health, 37 Russell Square, London, W.C.1.

### Anti-Malarial Measures

SIR MALCOLM WATSON stated at a meeting held in January of the Industrial Anti-Malarial Advisory Committee of the Ross Institute for Tropical Diseases that while Paris green has a place in malaria control, it is not a substitute for oiling surface waters that breed mosquitoes, for the female can safely lay its eggs in water treated with Paris green, but is killed by water that has been oiled. The nature of the crude oil forming the basis of anti-malarial oiling mixtures has an important bearing on efficiency, and Dr. Ramsay, in association with the Burma Shell Group, has completed researches upon the oils best suited for such mixtures.

### Joint Archæological Expedition to Antioch

ARRANGEMENTS have been made, we learn from Science Service, Washington, D.C., between Princeton University, New Jersey, and the Musée National of France, the Baltimore Museum of Art, and the Worcester Art Museum, for a joint expedition of excavation at Antioch. A five-year programme of excavation has been arranged. Prof. George W. Elderkin, of Princeton, is leaving immediately for Antioch to initiate the work. It is expected that it will be possible to excavate this ancient city without any disturbance of existing buildings.

### Announcements

WE much regret to announce the death, on March 26, at the age of seventy-seven years, of the Right Hon. Sir Horace Plunkett, K.C.V.O., F.R.S., first vice-president of the Department of Agriculture and Technical Instruction for Ireland and a pioneer in the organisation and development of Irish agriculture.

AT the March meeting of the Council of the Institute of Actuaries, Mr. W. Palin Elderton was elected president to succeed Mr. H. M. Trouncer, whose term of office expires in June.

MR. ALDOUS HUXLEY will deliver the Huxley Memorial Lecture at the Imperial College of Science and Technology, South Kensington, London, S.W.7, on May 4, at 5.30 P.M. The subject of the lecture will be " Huxley as a Literary Man ".

AT the annual business meeting of the Royal Philosophical Society of Glasgow, held on March 23, the following officers were elected: *Vice-President*, Dr. Henry L. G. Leask; *Hon. Librarian*, Dr. James Knight; *Hon. Treasurer*, Sir John Mann; *Secretary*, Mr. John A. Buyers; *Members of Council*, Mr. John P. Heslin, Miss M. A. Hannan Watson, and Mr. George B. Wishart.

LORD WAKEFIELD has given a sum of £25,000, spread over seven years, as a contribution to the Imperial Institute. The Institute is financed by annual grants from the Treasury, the Dominions, India, and the Colonies, and was faced with the prospect of curtailment of its activities, owing to temporary reduction of some of its supporting grants. It is hoped that Lord Wakefield's gift will enable the Imperial Institute to tide over the period of difficulty.

A COURSE of three public lectures on "The Rôle of Statistical Method in Industrial Standardisation" will be given by Dr. W. A. Shewhart at University College, Gower Street, London, W.C.1, on May 3, 5, and 6, at 5.30 P.M. Dr. Shewhart is a member of the technical staff of the Bell Telephone Laboratories, New York, and in these lectures an attempt will be made to outline the present status of the applications of modern statistics. A syllabus of the lectures may be obtained on application to the Academic Registrar, University of London, South Kensington, London, S.W.7.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A public librarian under the Colwyn Bay Urban District Council—The Clerk to the Urban District Council, Council Offices, Colwyn Bay (April 14). An assistant curator in the Royal Botanic Gardens, Kew, in charge of the Decorative Department—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (April 15). A mathematical master at the Royal Naval College, Dartmouth—The Headmaster, Royal Naval College, Dartmouth (April 18). A professor of philosophy at Armstrong College—The Registrar, Armstrong College, Newcastle-upon-Tyne (April 20). An assistant in the Natural History Department of the University of Aberdeen—The Secretary, University, Aberdeen (April 20). A reader in chemical engineering at the Imperial College (Royal College of Science)—The Academic Registrar, University of London, South Kensington, S.W.7 (April 22). A professor of zoology at Armstrong College and director of the Dove Marine Laboratory—The Registrar, Armstrong College, Newcastle-upon-Tyne (April 23). A whole-time radiologist at the Johannesburg Hospital—The Superintendent, Johannesburg Hospital, Johannesburg, South Africa (May 25). A male laboratory assistant at the Government Experimental Station, Porton—The Commandant, Experimental Station, Porton, near Salisbury.

## 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.*]

### Atoms and Molecules as Fitzgerald Oscillators

ACCORDING to the theory of the Raman effect, the depolarisation $\rho$ of the Raman lines in gases and liquids should, when observed at right angles to the natural incident light, never exceed the value $\rho = 6/7$. Whilst values of $\rho \geq 1$, which have frequently been observed, could be ascribed to observational errors, a value of $\rho = 2$, which has been estimated by Bhagavantam [1] for one line of liquid sulphur trioxide, called for a further investigation. I have carried out this work,[2] using polarised incident light with the electric vector perpendicular to the plane through the light source, scattering object and observer. Denoting by $\sigma$ the depolarisation for this mode of observation, there exists between $\sigma$ and $\rho$ the relation

$$\sigma = \frac{\rho}{2 - \rho}.$$

It is clear, that, whilst the theoretical limit for $\sigma$ is 3/4, one should get $\sigma = \infty$ in the case cited by Bhagavantam. This was clearly disproved by the experiment, which gave a value of $\sigma$ not exceeding unity.

Sir C. V. Raman has lately made [3] the very original suggestion that the observed values of $\rho > 6/7$ might be explained theoretically by assuming that the scattering molecules behave as magnetic dipoles. If this be the case, it is the magnetic vector in the incident light which gives rise to the Raman line; consequently the above-mentioned experiment must be repeated with the incident light polarised at right angles to that used formerly. For $\sigma$ one now has $\infty \geq \sigma \geq 4/3$, for $\rho \infty \geq \rho \geq 7/6$, the relation between $\sigma$ and $\rho$ remaining unchanged. As Sir C. V. Raman mentioned in his letter that some new measurements of Venkateswaran had revealed that this phenomenon of "anomalous polarisation" could be best observed with thiophene, I repeated the experiment with this substance. The result was entirely negative; all Raman lines showing complete depolarisation, as was to be expected with an electric dipole radiation.

Sir C. V. Raman, to whom I communicated the result of this investigation, has answered by a letter, the relevant part of which is here published with his authorisation:

"Observations of depolarisation in excess of the 6/7th permissible with incident natural light for an anisotropic electric dipole had been reported by several observers since 1928. The list includes Prof. Cabannes, Carrelli-Pringsheim-Rosen, Bhagavantam, West and Farnsworth, Parthasarathy, Venkateswaran, and others. I was impressed by this array of names, and hence was led to put forward the suggestion that a molecule may possibly scatter light also as a magnetic dipole or else as an electric quadrupole. Regarded purely as a theoretical proposition, I believe the idea to be sound. Spectroscopists have already shown that electric quadrupole radiation from atoms may be observed, and it seems not unlikely that several unexplained puzzles concerning the scattering of light may find an analogous solution.

"The remark in my note in NATURE of Nov. 7, 1931, reporting experimental confirmation of the idea by Venkateswaran was, however, premature. Subsequent experiments by Venkateswaran himself gave highly discrepant and puzzling results. The source of error appeared to be in the use of photographic photometry, which in the case of very faint lines is liable, if sufficient care be not taken, to give misleading results. Bhagavantam has examined the matter systematically, and his conclusion is that all earlier reports of depolarisation of scattered light exceeding 6/7 for incident natural light are to be regarded as spurious and unjustified. No genuine exception to the 6/7th rule has so far been established.

"As you are well aware, it follows from the electric dipole theory that when incident horizontally polarised light is used, all the scattered radiations must be completely depolarised. Your spectrograms with thiophene show this unmistakably to be the case, and hence must be regarded as disproving the existence of anomalous polarisation—at least in this particular case. I, however, still cherish the hope that quadrupole radiation from molecules may be detectable in specially favourable cases, and experiments with this object are being carried on here."

R. BÄR.

Physikalisches Institut der Universität,
Zürich, Feb. 17.

[1] *Ind. J. Phys.*, **5**, 59; 1930.
[2] *Helv. Phys. Act.*, **4**, 130; 1931.
[3] NATURE, **128**, 795, Nov. 7, 1931.

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### Rapid Estimation of Water-Content in Undisturbed Soil and in Bales of Cotton

AN instantaneous method for estimating the moisture content of soil, at any particular spot below the surface of the ground, even approximately, should be very useful in plant physiology, irrigation, and in soil science generally. The high dielectric constant of water suggested to me that the variations in capacity of a 'leaky' condenser permanently buried in the soil should serve this purpose.

Alternating current from a valve oscillator is convenient to use for the purpose, but a capacity-bridge (such as is marketed by Messrs. Heilan, of Frankfort) is impracticable, on account of power-losses to earth from the buried condenser. Resonance methods evade this earth effect (the circuit being symmetrical), and I have now worked out on this basis a technique which seems very satisfactory.

The buried condensers are conveniently made from glass web-tubing filled with mercury to give any desired capacity. Such double tubes can easily be made also in capillary form, and are then very sensitive: for example, a tube of 1½ mm. width externally has a capacity per centimetre of 1·5 $\mu\mu$F. in air, which rises to a 'capacity' of 6 $\mu\mu$F. per centimetre in water; with tubes of this size it is possible to examine localised details, such as the function of single roots.

The readings are but slightly affected by any variations of electrolytes above the level of minimum conductivity likely to be found in any soil. The 'capacity' indicated is predominately that of a zone only a millimetre or so in thickness around the tube, so that intimate contact with the soil is necessary; this is not a difficulty when the condenser is permanently buried in deep soil which never becomes air-dry; for other situations an artificial 'soil' of plaster can be cast round the tube, at the cost of making its responses sluggish.

The method can be used, with caution, for determining the concentration of mixtures of liquids which have different dielectric constants, such as alcohol and water: the web-tube is immersed in the liquid, and its gain in capacity subtracted from the variable condenser in parallel, until resonance is indicated by the grid-circuit galvanometer, which can all be done in a few seconds.

A further possible application is to 'works control'

of the moisture content of cotton bales as they issue from the power presses at Alexandria ready for export. At this moment their moisture-content is fairly homogenous, their weight and volume are known, and the nine iron hoops securing the bale are of standardised dimensions and spacing. These hoops can thus be treated as condenser plates, which provide about 300 $\mu\mu$F. total capacity on a bale weighing one-third of a ton and containing 8 per cent of moisture. About half of this is residual, the remainder being equally divided between the inter-hoop capacity in air, the effect of dry cellulose, and of the water therein. From this point additional moisture increases the readings rapidly (accompanied by blunting of the resonance curve due to conductivity), and the 'capacity' rises from about 300 at 8 per cent to 400 or more at 11 per cent. It should thus be possible to be sure that every bale lies between the limits of 8 per cent and 9 per cent permitted under the international agreement, and to effect this observation in about ten seconds only, which is even faster than the presses can produce the bales. The apparatus required is no bigger than an attaché-case.

In learning the technique necessary for effective use of these unconventional 'leaky' condensers, I have been helped very much by Mr. G. F. Briggs of Cambridge, by Mr. Moss of the Cambridge Instrument Co., Ltd., Mr. J. H. Cole of the Egyptian Survey, by my chemist colleagues here, Dr. W. H. Williamson and Mr. D. Gracie, and by my son.

The first account and demonstration of the method was given before the Cairo Scientific Society on Feb. 28.

W. LAWRENCE BALLS.
Ministry of Agriculture,
Botanical and Plant Breeding Section,
El Gîza, Feb. 1.

## Behaviour of Bielschowsky-stained Neurofibrillæ between Crossed Nicols

ARTIFICIAL cultivation of tissues *in vitro* has little affected the field of investigation in organic neurology. The older histological methods are still irreplaceable, and of special value is that of Bielschowsky, which renders distinguishable the minute neurofibrillæ at all stages of development save possibly the earliest at which nervous conducting structures are present. Bielschowsky's method involves the staining of the fibrillæ probably with a complex compound of silver formed through the interaction of certain of its salts in solution with the chemical constituents left in the nerve after treatment with a series of 'fixative' reagents. At least, that is a possible explanation of the visible results viewed through the microscope. The colour of the fibrillæ varies from a dark to a very dark brown or black, and unfortunately non-nervous structures are also coloured a lighter brown or yellow, so that the actual identification of the fibrillæ is in practice inferred from their visible form and connexions as well as from their appearance more or less sharply contrasted with their immediate surroundings.

Any device which increases this natural contrast would be a technical gain facilitating *detection* of the minuter fibrillæ affected by the Bielschowsky reaction.

It is therefore of interest that in sections stained by Bielschowsky's method the neurofibrillæ are very distinctly visible in the 45° position relatively to the crossed nicol planes. Even the smallest filaments of the marginal layer of the embryonic central nervous system are revealed with great brilliance. Figs. 1 and 2 reproduce the features of untouched photomicrographs of a lumbar nerve and *ramus communicans* in a 24 mm. human embryo (Zeiss 4 mm. apochromatic objective, substage polariser, and eyepiece analyser; Wratter 'A' filter, and panchromatic plates. For convenience, the polariser instead of the analyser was rotated; hence the faint cross lines in Fig. 1 appear in an unconventional position. The actual planes of the nicols are indicated by white lines).

A few brief comments on this result may be of interest.

(1) The neurofibrillæ are more specifically distinguished in Fig. 2 than in Fig. 1; that is, when viewed between crossed nicols.

(2) Maximum illumination of the images occurs in four positions at right angles and there are correspondingly four 'positions of extinction' (crossed nicols).

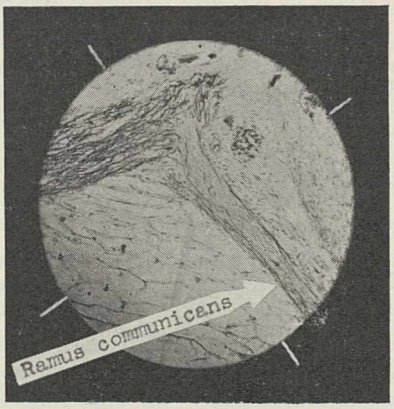


FIG. 1.—Lumbar nerve and *ramus communicans* of a 24 mm. human embryo. Nicols uncrossed. ×150.

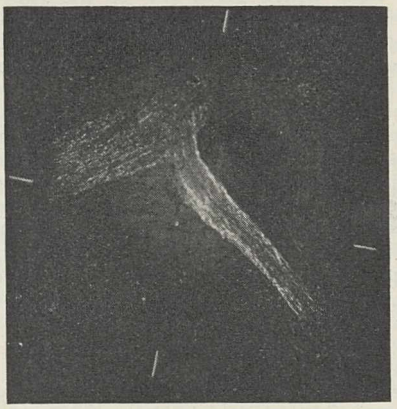

FIG. 2.—Same preparation as Fig. 1, with nicols crossed. ×150.

The exhibition of this phenomenon is regarded by petrologists as a demonstration of the presence of a crystalline substance. Prof. H. H. Read tells me that the question of an alternative inference does not arise when minerals are under consideration. Nevertheless, caution is necessary in dealing with animal matter. A liquid could scarcely have survived the process of preparation, and although elsewhere I have described the production of faint images by 'casts' of celloidin hardened in contact with striped muscle, such a surface phenomenon does not appear to be involved here.

(3) The apparent absence of continuity in the lines of Fig. 2 (particularly in the larger nerve) is direct evidence of the 'extinction' phenomenon, since it is due to irregularities in the course of the fibrillæ. When the object is rotated, the images appear to flow along the fibrillæ. The anisotropic substance is

therefore evenly distributed, and the optical axes of the particles have a common or parallel direction relatively to the axis of each fibril.

(4) Since the images with crossed nicols are single narrow bands, uniformly illuminated, it seems that the Bielschowsky method is not an 'incrustation method'. The word 'impregnation', too, is ambiguous.

(5) The reaction depends upon the specific constitution of the nerve, physical or chemical, so far as a section of animal tissue is concerned, since the optical properties are not displayed by non-nervous stained structures present, for example, the nuclei of erythrocytes, surface deposits, or mesodermal trabeculæ, although this generalisation is subject to qualification (see 10 below).

(6) Living nerve is anisotropic.

(7) Arising from (6), the arrangement of the anisotropic substance in Bielschowsky preparations may be due to the constitution of the nerve itself, or it may be due to the formation, in combination with the nerve, of an anisotropic substance, or it may be due to tension in the neurofibril.

(8) Section of other embryonic material at a comparable stage stained with hæmatoxylin and eosin, Mallory's *säure fuchsin*, etc., and Haidenhain's hæmatoxylin do not exhibit the phenomenon. Preparations of adult mammalian tissues stained intra-vitally with methylene blue show it, but only for very short stretches of the nerve where, apparently, it is not well stained. This observation is at present confined to myelinated fibres, and the anisotropic parts appear to be localised near the nodes of Ranvier. Weigert preparations of the adult human central nervous system give a negative reaction for the nerves but a positive reaction for the adventitia of blood-vessels.

(9) Striated muscle stained by Bielschowsky's method exhibits a 'sheen' when viewed between crossed nicols. I have not been able to determine whether the source of this 'sheen' is localised in the anisotropic discs as it is in unstained fibres.

(10) In some preparations of a primitive vertebrate, the phenomenon is exhibited by certain elements in relation to the trabeculæ of the notochord. This limitation upon (5) is itself interesting and will be the subject of further observation, for nerves have been recorded as entering the notochord.[1] Further, Bielschowsky material from the *same* subject as the Weigert material mentioned in (8) gives a strongly positive reaction for nerves and a *weakly positive* reaction for the adventitia. The peculiarities of the connective tissue in material from adults may thus limit the usefulness of these observations to young tissues, but this is uncertain. Tudor Jones.

The University of Liverpool,
Jan. 28.

[1] Julia Platt, *Anatomischer Anzeiger*, **7**, S282; 1892.

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### Nature of the Ionic Conductivity of Glass

It has been found experimentally,[1] that the equivalent conductivity of glasses of the system $B_2O_3 + Na_2O$ increases very sharply (a million-fold) with the concentration of sodium in the glass. This increase begins at a definite concentration, about 3-5 per cent $Na_2O$. In order to elucidate the nature of these facts, the velocity of solution of the glasses was measured. These experiments have shown that with this system the curve of the rate of solution has a maximum and, further, a sharp fall in a certain region of concentration of $Na_2O$ corresponding to the very beginning of the increase of equivalent conductivity (Fig. 1). Analysis of the quantitative data of the rate of solution indicates that orientation of polar molecules of borates of sodium in this region occurs.[2] According to Tamman's well-known data, there exist in the $B_2O_3$ glass certain positions unoccupied by molecules (free positions).[3] It is easy to conclude that in the region of the increase of the equivalent conductivity, the increase of orientation of the molecules leads to their more compact packing, and this, in its turn, leads to the disappearance of free positions (positions unoccupied by molecules). In the region of small concentrations of $Na_2O$, the molecules of the borates of sodium are separated from each other and practically do not interact. Elementary considerations, which we here omit, make it possible to assume that the layers of the $B_2O_3$ molecules disappear among the polar molecules of the borates of sodium just in the region where equivalent conductivity begins to increase. It is therefore natural to expect the

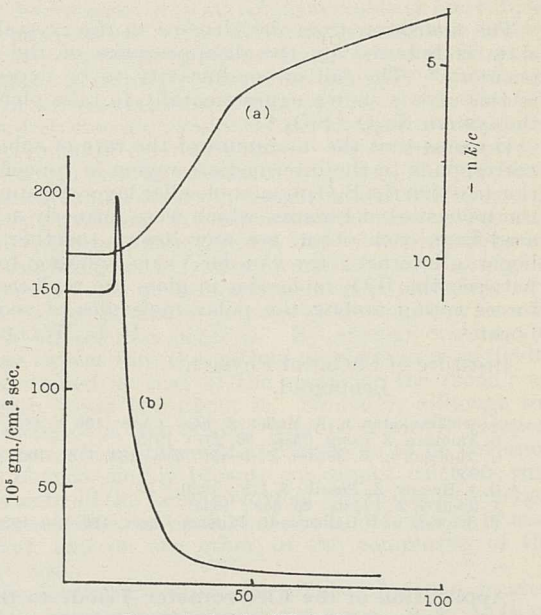


Fig. 1.—*a*: Equivalent conductivity at 250° C. of a borax glass; *b*: velocity of solution at 100° C.

appearance in this region of a tendency to orientation among the molecules of borates, and at the same time a decrease of the energy of their dissociation ($Na_2B_8O_{13} \rightleftarrows Na^{\cdot} + NaB_8O'_{13}$ . . .) as a result of their interaction. Owing to this, we obtain a great increase of conductivity, caused, as we know, by the sodium ions.

From what has been said, a subdivision follows of glasses:

(*a*) Glasses with low sodium content. Owing to free (unused) positions, all dissociated ions have translational motion. The dissociation energy of borates does not depend on the concentration of sodium, owing to the absence of interaction between the polar molecules of borates separated from each other by the $B_2O_3$ molecules. These conclusions agree with the experimental fact that the concentration of sodium does not influence the equivalent conductivity.[1]

(*b*) Glasses with high sodium content. Owing to the gradual disappearance of free positions, the chain-like displacement[4] of the ions of sodium increases; consequently, the effective velocity of the translational motion of the ions decreases. Experimentally it is manifested in the considerable decrease of

the value $B - \ln c$ in the expression of the logarithm of equivalent conductivity:

$$\ln \frac{k}{c} = -\frac{A}{T} + (B - \ln c)$$

(in which $T$ is temperature, $c$ sodium concentration, $A$ and $B$ constants). Nevertheless, the equivalent conductivity of glass greatly increases owing to the decrease of energy of dissociation of borates as a result of the interaction of their molecules. Experimentally it is shown in the fall of the coefficient $A \cong \frac{E}{4}$.[1,5]

It is found that the dissociation energy $E$ falls with the increase of molecular concentration of the polar molecules of borates $m$ (per cm.$^3$ of glass) according to the equation:

$$E = \frac{3{\cdot}6}{\sqrt{m}} \text{ cal.}$$

The transition from the vitreous to the crystalline state is followed by the disappearance of the free positions.[3] The fall of conductivity to be expected in this case is shown experimentally to take place in the system $Na_2O + SiO_2$.[6]

It seems that the maximum of the rate of solution corresponds to the intermediate region of concentration in which the $B_2O_3$ monomolecular layers disappear; the molecules of borates, which were formerly separated from each other, are now drawn together and begin to interact; the van der Vaals' cohesion forces between the $B_2O_3$ molecules in glass are replaced by forces acting among the polar molecules of sodium borates.

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[1] S. Schtschukarew u. R. Müller, *Z. phys. Chem.*, **150** A, 439; 1930.
[2] G. Tamman, *Z. anorg. Chem.*, **90**, 297; 1915.
[3] G. Tamman u. E. Jenkel, *Z. anorg. Chem.*, **184**, 716; 1929: **186**, 171; 1930.
[4] G. v. Hevesy, *Z. Physik.*, **2**, 178; 1920.
[5] J. Frenkel, *Z. Physik.*, **35**, 652; 1924.
[6] R. Schwarz u. J. Halberstadt, *Z. anorg. Chem.*, **199**, 33; 1931.

## Application of the Electrometer Triode to the Measurement of High Resistance

IN some experiments made by us on the application of the electrometer triode to the measurement of the ionisation produced by radioactive substance and X-rays, alcohol xylol resistances of the order $10^3$-$10^6$ megohms have been employed. A method of measuring such resistances has been devised, in which use is made of the very high grid-filament resistance of the triode. The arrangement is indicated in Fig. 1. $R_1$ is a known resistance, $R_2$ is the resistance to be determined. With the potentiometer short-circuited and the key $K$ open, the normal anode current is first balanced by variation of the resistance $Z$ in the short-circuit $GZ$, so that the galvanometer indicates zero. The key $K$ is now closed, and the current in the circuit $ER_1R_2$ alters the voltage of the grid by an amount equal to the voltage drop across $R_1$. The anode current is thereby altered, and the galvanometer is deflected. The grid is now restored to its original potential, by applying to it a potential by means of the potentiometer $P$, the reading of the potentiometer $e$ being a measure of the voltage across $R_1$. Obviously then

$$R_2 = R_1(E - e)/e.$$

Resistances up to $10^6$ megohms have been measured in this manner, the procedure being to construct a series of alcohol-xylol resistances of the order $10^2$, $10^3$, $10^4$, and $10^5$ megohms. The lowest of these is first compared with a standard resistance of 10 megohms. This is then used as a standard to measure the $10^3$ megohms, the process being repeated for the higher resistance.

$E$ is usually a two-volt battery, and for accuracy the ratio of $R_2 : R_1$ should not be much less than 10 : 1. The valve employed in these measurements is supplied by Philips Lamps, Ltd., and its chief characteristic, which makes it so suitable for such measurements, is that the grid current, when the grid bias is

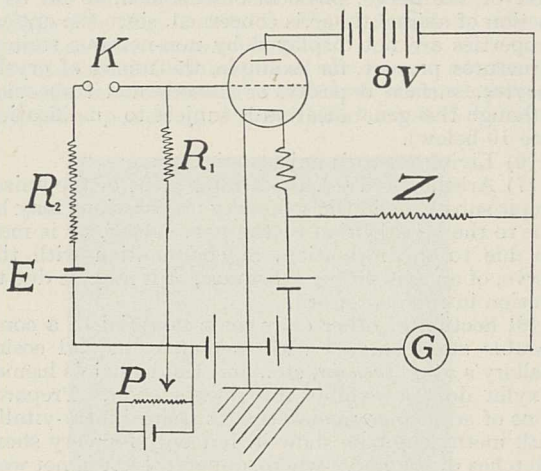


FIG. 1.

– 2 volts, is less than $10^{-14}$ amp. The method cannot be employed for resistances above $10^7$ megohm, as resistances of a higher order are comparable with the grid filament resistance of the valve.

The potentiometer employed is by the Cambridge Instrument Co., Ltd., and a comparatively insensitive galvanometer (1 division per microamp.) is sufficient.

Further details of the method will be published later, in connexion with the work on ionisation measurements which are in progress.

J. A. C. TEEGAN.
NANCY HAYES.

University College,
Cork, Feb. 4.

## The Revival of Scholasticism

I. IT is difficult to see just what is the meaning attached to 'direct contact' in the statement that "we have no means of getting into direct contact with them [physical objects]" ("The Decline of Determinism", NATURE, Feb. 13, p. 235). For, the fact that the sense-organs merely reflect objects is not a modern discovery: it was the basis of Francis Bacon's inductive philosophy. "Our method is continually to dwell among things soberly; without abstracting or setting the understanding farther from them *than makes their images meet.*" "For however men may amuse themselves, and admire or almost adore the mind; it is certain that, like an irregular glass, *it alters the rays of things.* . . ." "The capital precept for the whole conduct is this, that the *eye of the mind* be never taken off from things themselves; but *receive their images* truly as they are." "The mind is like a glass, capable of the image of the universe . . . as the eye to receive the light." (Preliminaries, "De Augmentis Scientiarum".)

In the "Anugītā Upanishad", one of the earliest known philosophical writings, it is repeatedly stated that the senses are conscious only of the *qualities* of 'objects', which are themselves merely appearances—*Māyā*; in effect, merely condensations or accumula-

tions of energy. Any 'contact' with these accumulations can be, of course, but our consciousness of an electromagnetic 'contact' or interaction. This 'sensation' of an 'image', a 'sound', etc., is immediate. Inferences are subsequent and are formed by another aspect of consciousness—the *rational mind*, an extreme development of the function which operates in the higher animals *immediately* as *instinctive inferences*. 'Time' is, therefore, a synonym for deliberation and ratiocination about appearances. It deludes speculative thinkers, who, as Bacon pointed out, confuse metaphysics with physics, 'final causes' with 'physical motions'. They expect to find the principle of cause in the chimeras of the mind.

II. The *inferences* with which the external world is said to be populated (p. 236) are the progeny of human reasoning, which erroneously presumes that 'time' is predicative and causal: they are not born of judgment by induction, whereby "we both find and judge by the same operation of the mind, almost in the same manner as by the sense"; that is, when the understanding reflects the inner 'forms' of things. Bacon should be re-read in the light of our modern knowledge of electromagnetic induction. 'Cause' is in the nature of things, not in 'time' or in ratiocination. Things are so, and could not be otherwise, given a certain *combination* of 'relations' and 'motions'. That which is given is isolation or tension, which is independent of 'time'. Experimental science has been built up on a progressive knowledge of the principle of isolation; and this has been obtained by the inductive use of the mind, in Bacon's sense: "A true and legitimate union between the experimental and rational faculty, the undue separation thereof has caused the greatest disturbances in the family of mankind"—theological disputes and religious persecutions.

III. It is surely not correct to state (p. 233) that 'determinism' has been the attitude of science for more than two hundred years. The word itself shows its scholastic origin. Its crude connotation was foisted on science in the nineteenth century—*not by experimental workers*. Father Félix, the famous preacher at Notre Dame de Paris in the 'fifties, foresaw the inevitable reaction from 'determinism' and 'predicted' that mystery would be the fatality of science. To-day the clerical party in the popular press are boasting that "science has lost its old arrogance", that its labours have been in vain, and that man must resign himself to uncertainty with regard to knowledge. 'Determinism' and 'indeterminism' are alike speculative inferences of Neo-scholasticism, which is flourishing to-day in England and on the Continent because inductive philosophy has provided it with a vast amount of data on which to speculate. There is a point in the cycle of every civilisation when sophistical thinking balks the work of experimental science, and the civilisation thereafter declines.

IV. The labours of the great experimenters demonstrate that, as a creative thinker, man is superior to physical Nature. He can insulate his mind, shut out the rays reflected by the appearance of things, stop the activity of the 'natural reason' temporarily, and so induce an energy in the brain, of an order different from the energies of physical propagation and reproduction, which effects transformations, whether indirectly in the laboratory or directly in the physiological 'habits' of his own organism (p. 240), and alters tendencies to normal or natural reactions. Man creates civilisations and their arts, reshapes his environments, and can remould his thoughts, if he will. Has a brain of this generative power been found elsewhere in Nature? Hence, it seems "incredible what a number of idols have been introduced into philosophy by the reduction of natural operations to a correspondence with human actions; that is, by imagining Nature acts as man does: which is not much better than the heresy of the anthropomorphites that sprung up in the cells and solitudes of ignorant monks" ("De Aug. Scient.", XIV.).

W. W. L.

### Determinism

In discussions which have taken place recently in the columns of Nature, and elsewhere, on the subject of determinism, various aspects of the problem are omitted which appear to me to be important. In the first place, both determinism and indeterminism are subjective phenomena, dependent on mind, and subject to its limitations, including fallibility. Secondly, they are eternally associated in mind, and become meaningless in isolation. A universe ruled entirely by determinism is to me as unthinkable as one subject to pure chance. The difficulty is with our human minds to attempt to adjust ourselves to a world which appears to be partly determined and partly fortuitous.

In the inorganic, and microscopic, world, scientific research steadily eliminates the element of chance, as experimental error diminishes. Astronomical phenomena can now be calculated with very fine precision, and earthquakes are no longer considered to be entirely capricious. It matters little whether uncertainty still reigns in atomic physics, since even the realisation of this has been arrived at by methods which, in being scientific, rest on an implicit faith in causality. All we can say is that at present we do not *know* exactly how an electron behaves. By analogy we may at least expect that the path of an electron is as rigidly determined as that of the earth, or the moon; we merely know less about it. Similarly, although the shaking of a box of dice may be a purely physical process, the results will appear to us to be governed by chance, simply because we cannot calculate and measure all the forces involved. Here chance emerges on one side as a measure of the limitations of human mind, and on the other, of the complexity of the universe.

In the organic world the problem becomes greater, while remaining essentially the same. A living thing has a biological urge which we recognise as purpose, and which determines how it will behave. This presupposes a universe sufficiently reliable to admit of adaptations, for adaptation in itself implies necessity, but since it can never be perfect, a margin is left over for chance, and for evolution; while within one generation chance determines food supply, survival, reproduction, and dispersal. In absolutely identical situations we may well expect identical twins to react in exactly the same way, but identical twins are comparatively rare, and identical situations, in our knowledge, are rarer still. There is therefore scope for free will, in so far as on one side the universe is apparently governed by necessity, and on the other is capricious enough for individual decisions to be made.

In naïve experience we human beings are conscious of both determinism and chance. To us the slavery of the ant appears repulsive, and while we try to eliminate the element of chance from economic life, the logical outcome of our efforts would terrify us. Some equilibrium between determinism and chance appears to be an essential condition for a healthy life. Such an equilibrium lies at the root of many human activities, as in conventions, fashions, morals, adventure, and romance. It supplies a basis for the assessment of character. It runs as a thread through all art, which on one side is limited by reality and style, and on the other admits of individual imaginative

treatment. It appears in betting, and it is the basis of all games. The degree of capriciousness which can be tolerated varies for each individual, but it never vanishes.

R. WEATHERALL.

Eton College, Windsor,
March 7.

### Physiological Specialisation of *Hemileia vastatrix* B. and Br.

IN the course of some recent work on the behaviour of a number of hybrids and selections of *Coffea arabica* Linn., collected at the Mysore Government Coffee Experiment Station, towards infection by *Hemileia vastatrix* B. and Br., indications of the existence of physiological specialisation in this rust fungus have been obtained.

It had previously been found possible to carry out inoculation experiments on detached leaves in the laboratory, and to keep such leaves healthy for at least six weeks. The method was applied to testing a number of resistant and partly resistant selections. Among these, one selection, *S.* 5/30, was found to be completely resistant to spore collections made from the Coorg variety of *Coffea arabica*, though it showed

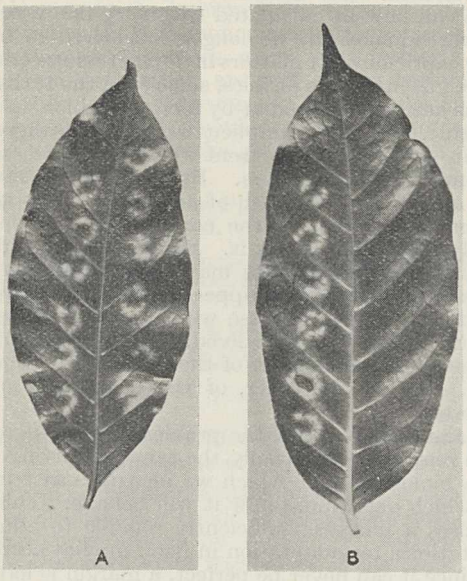


FIG. 1.

itself to be somewhat susceptible to the rust in the field.

Tests were then made with collections of spores from the Coorg variety and from the selection itself. Four leaves from a susceptible Coorg tree and four from the selection *S.* 5/30 were inoculated on the right-hand side of the midrib with a Coorg spore collection and on the left-hand side with an *S.* 5/30 spore collection. Six areas on each half-leaf were infected by dusting the spores on the surface of drops of sterile distilled water. The results were as follows:

Coorg Leaves (Fig. 1, *A*).

Right-hand side: Coorg spore collection, 21/24 successful inoculations.
Left-hand side: *S.* 5/30 spore collection, 17/24 successful inoculations.

*S.* 5/30 Leaves (Fig. 1, *B*).

Right-hand side: Coorg spore collection, 0/24 successful inoculations.
Left-hand side: *S.* 5/30 spore collection, 23/24 successful inoculations.

Identical results have been obtained in a number of similar experiments. There are indications of very minute chlorotic flecks in the case of Coorg spore infections on *S.* 5/30 leaves, and the histology of these flecks is shortly to be investigated. The infections caused by the two spore collections on the Coorg leaves and the *S.* 5/30 spore collection on the *S.* 5/30 leaves are morphologically indistinguishable.

Up to date, only one plant exhibiting this difference in behaviour to different spore collections has been found. Work is in progress involving the study of plants of the same origin as *S.* 5/30 and other plants showing variations in behaviour to *Hemileia vastatrix*. A full account will be published when results are available.

I am indebted to Mr. M. J. Narasimhan, mycologist, Department of Agriculture, Mysore State, for the photographs of infected leaves.

W. WILSON MAYNE.

Mysore Government
Coffee Experiment Station,
Balehonnur, Kadur District,
Mysore State,
Jan. 20.

### Microscopic Measurements

IN elementary biological classes the measurement of microscopic objects is useful for training in accurate observation and for the intelligent use of the various parts of the microscope. In this connexion it may be pointed out that the estimation of the vertical distance between objects in microscopic preparations helps greatly in the realisation of solid forms and of the information which may be obtained from superimposed optical sections. The estimation can be made very simply by the use of a microslip carrying on one side a short line of transparent red, and on the other a similar line of green, glass ink. The lines cross each other and form an 'X' when one looks vertically through the slip. From the thickness of the slide at X, ascertained with a coverglass-micrometer, and the number of revolutions of the milled head of the fine adjustment of the microscope, which are required to pass from the level of the focus of the red to that of the green line, the pitch of the screw and the value of the movements of the fine adjustment are obtained.

Despite errors due to accommodation and refraction the use of the fine adjustment calibrated in this way is very advantageous, and, when combined with micrometric observations in a horizontal plane, conveys a sense of solidity which can scarcely be obtained so simply by any other method. By way of example, the vertical diameter of a filament of *Spirogyra porticalis* was estimated by this method as 0·021 mm., while its horizontal diameter, found by the 'ghost micrometer', was 0·0198 mm.

HENRY H. DIXON.

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Dublin.

### Catalysis in an Inert Solvent

As Dr. Traill is now in Australia, I may direct attention to the fact that calculations of a similar character to those given by Dr. Moelwyn-Hughes in NATURE of Feb. 27, p. 316, had already been made by him. These were published in the February number of the *Philosophical Magazine* under the title "Kinetics of a Catalysed Isomeric Change in Solution", whilst Dr. Moelwyn-Hughes's letter was in the press.

T. M. LOWRY.

Laboratory of Physical Chemistry,
Cambridge, Feb. 27.

## Research Items

**Troy.**—Archæological and geographical problems relating to the site of Troy and its identification with Hissarlik are discussed by Miss Winifred Lamb in *Antiquity* for March in the light of her excavations at Thermi in the Island of Lesbos. Doubts, which had long been dormant, have been raised recently by the contention that there was no room for the Achæan camp and the actions described in the Iliad on the land between Hissarlik and the Hellespont. A number of treatises have maintained in consequence that Hissarlik is not Troy, and that Troy was not situated on the Hellespont. An alternative site at Besika on the west coast has been suggested, but is untenable; while the view that Hissarlik was a burial ground of the Achæans is not in accordance with archæological fact. If another Troy is to be found, it must be by excavation of some of the still unexplored mounds of the Troad. At present the position of Hissarlik can be tested only by comparison with other settlements of the same culture. The excavations at Thermi for the first time have afforded architectural material which can be placed side by side with that of Troy. Five towns, one above another, have been uncovered, giving the whole plan of the upper town with about three-quarters of each of the others. The period after Troy I. when Hissarlik was deserted was for Thermi III. a period of growth and activity; and Thermi also reflects the prosperity in Anatolia which was heralded by the foundation of Troy II. on an unprecedented scale. Before the fall of Troy II., destroyed possibly by the Hittite, the Thermiotes seem to have anticipated danger, for they abandoned the site.

**Thorn-lined Traps.**—An interesting question of distribution is raised by Mr. Henry Balfour in *Man* for February in describing certain thorn-lined traps now in the Pitt-Rivers Museum, Oxford. A note on specimens of these traps which appeared in *Man* in 1925 has elicited information of examples from different areas and in use by various peoples, showing practically a continuous dispersal range from the area north of the Brahmaputra to Melanesia. The traps are clearly closely related to one another and have a common origin. An example is now known from a new and unexpected locality. It was collected by Dr. E. Evans-Pritchard among the Azande of the Welle District in eastern Sudan. This trap is a long narrow tube of open basket-work, consisting of eight strips of split cane fastened together at one end and running in a nearly parallel, but slightly diverging, series to the full length of the trap. The strips are woven to form a rigid, slightly tapering basket in which three thorn-bearing twigs are fastened, so that a small animal, such as a rat, is afforded easy ingress, but cannot back out. It resembles very closely a type found among the Konyak Nagas, which is also used for catching rats. The occurrence of this type of trap after so wide a gap in distribution raises an interesting question as to whether it is to be referred to a common prototype or is to be regarded as a case of independent origin. A tubular form of trap, but differing in action, is widely dispersed in tropical Africa.

**Growth of Wool in Australian Merino Sheep.**—By the periodic measurement of the mean length of adjacent locks or staples at fixed points on the shoulders of the merino sheep, K. M. Fraser has investigated the growth of the fleece of merinos grazed on 'natural' pastures throughout the year (*J. Coun. Sci. Indust. Res.*, Australia, **4**, 204; 1931). It is to be noted that the elongation of the staple does not necessarily correspond to the average rate of growth of all the fibres in the staple, but it is on staple form that breeder, buyer, and wool expert base their judgments. Fraser found that the body-weight of the sheep themselves showed very considerable fluctuations, associated with the alternation of periods of drought and heavy rainfall during the year and consequent shortage and luxuriance of pasture. But in spite of this, the rate of growth of the staples showed uniform progress throughout the year, the actual increase from the first measurement of 30·26 mm. in November to the corresponding time in the following year being 114·20 mm. (3·3 in.). It is probable that the principal effect of the seasonal drop in weight of Australian sheep in autumn, when the nutritional value of the natural pastures falls away, is reflected in the thickness of the wool fibre instead of in the staple length.

**Habit and Physiology of *Calanus*.**—The Annual Report (1930–31) of the Scottish Marine Biological Association shows that research is flourishing at the Millport Marine Station. Mr. A. P. Orr and Miss S. M. Marshall have devoted themselves mainly to the study of *Calanus finmarchicus*. Samples of about a hundred individuals were taken from the tow-nettings at least once a month throughout the year, the proportions of males, females, and young stages determined and a certain amount measured. The main breeding period is early spring but reproduction goes on sporadically throughout the summer. The largest specimens are to be found in April. During autumn and winter, when *Calanus* was very scarce elsewhere, there were always large numbers to be found in the deep waters of Loch Fyne, mainly immature. Experiments have been made on the rate of metabolism, as measured by the oxygen consumption, of males, females, and stage v. (the stage immediately preceding maturity) under different temperatures, oxygen content, and hydrogen ion concentration. It is found that lower oxygen concentration can be tolerated at lower temperatures. The lowest values they can tolerate are met with only occasionally in the sea, and *Calanus* is apparently insensitive to the changes in the hydrogen ion concentration which are likely to be met with under natural conditions in the sea. Males and females behave similarly so far as they have been compared, but immature *Calanus*, in spite of their greater activity, have a lower oxygen consumption. Research on the digestive enzymes of *Calanus* gives much promise for future work. Enzymes have been obtained which will split cane sugar, starch, and glycogen to give reducing sugars, and others which liquefy gelatine and attack fibrin to a slight extent.

**A Fungus Disease of Lavender.**—Price-competition and the 'shab' disease have combined to send lavender out of cultivation in England. It only remains for growers to make a fresh start, in view of the recent imposition of duty on foreign perfumes and the fact that the 'shab' disease is now known to be caused by a fungus—*Phoma Lavandulæ* ("The 'Shab' Disease of Lavender", by C. R. Metcalfe; *Trans. Brit. Mycol. Soc.*, vol. 16, parts 2 and 3, pp. 149-176, Dec. 1931). Mr. Metcalfe has shown this conclusively by inoculation experiments, but has also demonstrated that certain climatic and edaphic factors may produce similar symptoms. Methods of control based on plant hygiene have proved successful in

several instances. The main trouble, however, lies in the fact that a plant may be infected for a considerable time before it shows symptoms. This has resulted in the spread of the disease under the older conditions of propagation, such as the splitting of whole plants to form cuttings. A method of taking small cuttings from soft, green woody shoots has given good results in controlling the disease. *Lavandula dentata* and the dwarf French variety of *L. vera* are reported to be immune from the disease, though non-fragrant, and offer good possibilities for the production of perfume-bearing immune varieties.

**Bermuda during the Ice Age.**—Mr. Sayles has now summarised his study of the Bermuda Islands during the last eight years ("Bermuda during the Ice Age", *Am. Acad. Arts Sci.*, vol. 66, No. 11). The Bermuda volcanoes, erupted during the Tertiary or earlier, were reduced by the end of the Tertiary to submarine platforms. With the coming of the Pleistocene glaciation, water was subtracted from the oceans to cause a fall of the strand line to as much as 260 ft. below present sea-level. While the ice-cap grew large, parts of the Bermuda banks, covered by marine deposits and unprotected by vegetation, were exposed to the sweep of the winds, and the dried sands were piled up into great dunes. These dunes were preserved owing to the very quick cementation that takes place when this eolian shell sand is exposed to the atmosphere. Their formation was favoured by the inevitably harder and more stormy conditions of the ice age in this latitude. The sea rose at the close of each glacial stage; the bases of the dunes were buried beneath the waves, the winds became less violent, and a permanent flora anchored the dunes. Soil accumulated, but with the advent of new glacial stages conditions became again favourable to the formation of dunes, which covered up the earlier soil layers. The geology and palæontology of these interglacial soils are carefully studied, and enable the author to suggest in detail the history of the formation of these islands in the Pleistocene. Lastly, a twelve-foot drop in sea-level is recorded by an emerged bench, cut probably only a few thousand years ago. Bermuda has long been known not to be an atoll, its corals being only the thinnest of veneers. Its basin, about sixty feet deep, perhaps owes its existence to the protection of the central parts of the former land by the dunes which lie round it to the south and east. We judge that the Challenger and Plantagenet Banks to the south of Bermuda, covered by about thirty fathoms, were probably too small for the permanent formation of dunes.

**Passage of Ionising Particles Through Matter.**—The question of the relation between the energy of a charged particle and the rate at which it can produce ions in a gas has become one of the main and most unsatisfactory problems connected with ionisation. Following upon earlier theories of the effect, due to Bohr and others, a new attempt at the analysis of what occurs was made two years ago by Bethe, on the basis of the wave mechanics. The *Proceedings of the Royal Society* for February contains two papers, by E. J. Williams and by P. M. S. Blackett, the main theme of which is the comparison of Bethe's theory with experiment. The general conclusion seems to be that Bethe's theory is an advance on earlier work, but that it is still not a completely adequate account of what occurs. Various ways of reconciling the divergence between theory and experiment are considered, but special interest is perhaps attached to the point made in Williams's paper that there is ambiguity in what have generally been considered straightforward ionisation experiments. This arises in two ways, from an electrode effect, and from an effect of impurity in the gas. The former is that, as has now been established in many experiments, there is an emission of electrons in most circumstances when positive ions are neutralised at a metal surface; this would increase the ionisation current recorded over that due to the primary production of ions in the gas. The latter is that excited atoms may ionise impurities in the gas, and again produce an additional source of current to the collecting electrodes. It is not clear if these will account completely for the discrepancy between theory and experiment, and there is in fact some indication that this will not be the case, but it has been shown that there is need for reconsideration and improvement of technique in this type of work.

**Testing Broadcast Receivers.**—The testing of broadcast receivers is much more difficult than testing other electrical appliances. It is possible to get definite results under definite conditions, but to use these results to compare the relative merits of receivers under widely different conditions is practically impossible. The paper, therefore, read on March 2 to the Institution of Electrical Engineers by H. A. Thomas on the methods of testing radio receivers at the National Physical Laboratory should prove useful to both manufacturers and users of broadcast apparatus. A suggested specification of the requisite tests is given, together with the experimental results obtained. This specification is examined as to how far it is applicable to the relative comparison of widely varying types of receiver, the number of necessary tests being reduced to a minimum, and a new method of expressing the results of the tests by a 'figure of merit' is explained. It is possible with modern receivers to obtain a very large range of sensitivity, but this test by itself is not of great importance. The author suggests that a definite value of the sensitivity be fixed and the other properties of the receiver determined at this rated value. Most receivers are required to operate under known local conditions. The field strength is known when the receiver operates in a known broadcast service area. So also, the amount of interference from other radio stations, the hum from the supply mains, the noise from tramways, etc., are approximately known. The receiver should therefore be tested as nearly as possible under the known conditions of working. The field is divided into three service areas, *A*, *B*, and *C*, the field strength of *A* exceeding 10 millivolts per metre and that of *C* 2·5 millivolts per metre. As the output of receivers differs so widely, they are divided into five classes according to their output. A '*B*3' receiver, for example, is one which gives a medium output—that is, one lying between 500 and 1000 milliwatts when a field strength of 5 millivolts per metre is applied to the standard aerial.

**Induced Molecular Asymmetry.**—Prof. Richard Kuhn, of Heidelberg, has observed (*Ber. deutsch. chem. Gesell.*, Jan. 1932) some optical effects in solution which he suggests may help to throw some light upon the biological formation of optically active compounds from inactive substances. Thus the salts which *p.p'*-dinitrodiphenic acid forms with quinine and cinchonine are very strongly dextrorotatory, the value for the specific rotation for sodium light of the quinine salt being about +700°, whereas the salts which these bases form with *m*-nitrobenzoic and phthalic acids exhibit merely normal lævorotatory values. The strong dextrorotations are attributed to the development of an asymmetric configuration of the diphenyl nucleus similar to that described by Christie

and Kenner. In the present case, however, the asymmetry and consequently the activity disappear as soon as the optically active base is eliminated, since there is no sterically hindering substituent present in the ortho position to interfere with the free rotation of the two aromatic nuclei about their common linkage. The author suggests the term 'asymmetric rearrangement (*Umlagerung*) of the first kind' to distinguish it from that 'of the second kind', which is permanent and is the usual type involved in the usual resolution of racemic compounds. If the explanation is correct, this would appear to be a remarkable case of 'induced asymmetry', first described by Lowry and E. E. Walker (NATURE, April 19, 1924, p. 565) in connexion with semi-polar double bonds.

**Magnetism of Bivalent Copper and Silver Compounds.**—For atoms of the first transition period (scandium to copper) the magnetic moment in Bohr magnetons is $\mu_a = \sqrt{4s(s+1)}$ or $\mu_\beta = \sqrt{4s(s+1)+l(l+1)}$, where $s$ is the total spin moment of the electrons in the sub-group and $l$ the orbital magnetic moment. Most simple salts of elements in this period give values corresponding with $\mu_a$. Univalent copper and silver have a complete sub-group of 10 electrons, in a $3_3$ level for copper and a $4_3$ level for silver. They are therefore diamagnetic. Bivalent copper and silver ions have nine electrons in this sub-group and should be paramagnetic. With $s = \frac{1}{2}$ and $l = 0$, 1, or 2, the values of the moments are $\mu_a = 1{\cdot}73$ and $\mu_\beta = 1{\cdot}73$, 2·24, or 3·00. It has already been shown (NATURE, **128**, p. 31; 1931) that the bivalent silver in tris-$\alpha\alpha'$-dipyridyl argentic chlorate is paramagnetic, and Sugden (*J. Chem. Soc.*, Jan.) has now examined a number of other co-ordination compounds of bivalent silver and also cuprous and cupric compounds. Bivalent silver is known only in the form of co-ordination compounds of its salts with substances such as pyridine and dipyridyl. He finds that both copper and silver in the univalent condition have zero magnetic moment, whilst the bivalent atoms of both elements exhibit moments of 1·72-2·16 Bohr units, in fair agreement with the value predicted for one unbalanced electron. In the same issue of the *Journal* this author also describes the measurement of the moment of a paramagnetic organic compound which contains an odd electron, prepared by Kenyon and Banfield in 1926. This gave a moment of 1·68, close to the value 1·73 for one unpaired electron. Excluding substances which contain transition elements with incomplete inner groups, chlorine dioxide, nitric oxide, and nitrogen peroxide have previously been examined. The first two give approximately the values expected for one unpaired electron, but the nitrogen dioxide is somewhat anomalous.

## Astronomical Topics

**Astronomical Notes for April.**—Venus is resplendent in the evening sky. It is at its greatest elongation, 46° east of the sun, on April 19, being then half-illuminated. The illuminated portion of the disc diminishes during April from 0·60 to 0·44; the stellar magnitude rises from −3·8 to −4·1. Jupiter is still observable for more than half the night, but its diameter is diminishing. On the evening of April 19 only two satellites are visible after 7.25 P.M., III being eclipsed and II occulted.

A star of mag. 6·4 is occulted by the moon on April 9 at $10^h\ 14^m$ P.M. The moon is barely 4 days old, and the earthshine should be conspicuous; this makes it easier to note the approach of the moon's limb to the star.

Two periodic comets, Grigg-Skjellerup and Neujmin (2), should be telescopically observable; ephemerides are given in the British Astronomical Association's Handbook for 1932.

Only two minima of Algol occur at convenient hours; on April 2 at $8^h\ 12^m$ P.M., and on April 22 at $9^h\ 54^m$ P.M.

Summer Time begins on April 17; $1^h$ must be added to the times given above, to express them in Summer Time. Note, however, that Summer Time should not be used in astronomical records.

**An Ancient Conjunction of the Moon and Venus.**—Dr. P. V. Neugebauer has published a note (*Astr. Nach.*, 5847) on a cuneiform record which describes an observation made at Babylon on the morning of the 25th of Sivan in the 5th year of Darius Ochus (−418 June 19). He uses it to test various values of the mean motion and secular acceleration of the bodies concerned. The record uses the word 'night' and states that Venus coincided with the moon's southern horn. It may therefore be assumed that the conjunction occurred some time before sunrise, which fixes the time within rather narrow limits. The author concludes that Dr. Cowell's large value of 4″ per century for the sun's acceleration is ruled out. The use of Brown's Tables for the moon, and those of Newcomb for the sun and Venus, brings the time of conjunction into daylight. Schoch's values for the secular accelerations give a satisfactory representation of the observation, but it is also possible to satisfy it with values considerably different. The observation is, however, sufficiently definite to receive some weight in a discussion of ancient records.

**Interesting Object with Rapid Motion.**—M. Delporte, assistant at the Royal Observatory of Belgium, Uccle, discovered an object of the ninth magnitude on March 12 that was almost in opposition to the sun and yet was advancing more than 1½° daily, and moving north at about the same rate. Its aspect was stellar, but its motion indicates cometary nature. Though approaching both sun and earth, it faded quickly, Dr. Steavenson finding the magnitude 13·2 early on March 18.

An I.A.U. telegram gives the following parabolic orbit computed by Dr. Bengt Strömgren:

| | | |
|---|---|---|
| $T$ | 1932, April 10·897 U.T. | |
| $\omega$ | 34° 7′ | 1932·0 |
| $\Omega$ | 171 38 | |
| $i$ | 19 30 | |
| $q$ | 1·1208 | |

| | | R.A. | N.Decl. |
|---|---|---|---|
| Ephemeris for $0^h$ | March 26 | $13^h\ 55^m\ 0^s$ | 25° 45′ |
| | March 30 | 14 38 56 | 31 42 |

Almost identical elements were deduced by the Rev. M. Davidson. Dr. A. C. D. Crommelin notes that the orbit is very similar to that of the comet Tuttle-Giacobini, 1858 III and 1907 III. If it is identical with that comet, $T$ is about April 11, period about 6·2 years, $q$ about 1·11, the remaining elements being nearly the same as Dr. Strömgren's. The identity of the above two comets was not immediately recognised. It was first suggested by Prof. W. H. Pickering, and is highly probable, whether the present object is the same body or not. If it is the same, it has lost most of its gaseous envelopes since 1907, but there must have been some kind of outburst about March 12 to explain its temporary brightness then.

## Quantitative Methods in Vitamin Assays

THE variability in the responses of a group of animals to the administration of the same substance usually necessitates taking, as criterion of response, the average for the group. In many instances, even with the use of a large number of animals, the average response shows significant variations when the administration of the same dose is repeated on different occasions. If the assay is to have any quantitative value, it is essential to use a standard of reference, with which the substance under test can be directly compared. Thus the individual variations within the group are controlled by the use of a sufficient number of animals, such that each time the group selected is truly representative of the population available for test, whilst the variations in sensitiveness from day to day are controlled by the use of the standard of reference.

These principles have been applied, in certain recent investigations, to the improvement of the animal tests for some of the vitamins. A further complicating factor here is the difficulty, frequently encountered, of estimating the degree of response: in other tests, death or convulsions, for example, are definite end points; and it is often possible to measure accurately the amount of a drug which will just arrest the heart. In vitamin assays, the growth rate is often a valuable criterion, susceptible to a fairly wide range of quantitative expression; but it suffers from the disadvantage of being affected by a variety of factors other than the one under test. In other cases, it may not be possible to give any numerical expression, other than a purely arbitrary one, to the degree of response: thus, in vitamin D assays, it is usually possible to say whether a degree of calcification induced by its administration is greater or less than that observed in the bones of other animals, but not how much greater or how much less.

A recent report from the National Institute for Medical Research describes a method for overcoming these difficulties in vitamin D tests and for obtaining results accurate to within a few per cent.[1] The general management of the animals was that usual in such tests: young rats were fed on a restricted diet until 45–50 gm. in weight and 3–4 weeks old, and then given Steenbock and Black's rachitogenic diet for four weeks. At the end of the first two weeks, the animals were anæsthetised with ethyl chloride and their right knee joints radiographed: for the second two weeks they were given daily doses of vitamin D in oil by pipette. They were then killed and the right knee joints again radiographed. The first radiographic examination enabled the observers to reject animals showing imperfect rickets, since it was found that the degree of healing obtained in the subsequent two weeks did not give the same picture as that shown by animals with severer rickets, and also that the variations between litter mates were greater when the rickets was milder. Too severe a degree of rickets also increased the variability of the response to the vitamin. The doses of the latter were always in the ratio of 2 : 1; in each litter, equal numbers of animals were placed on the standard solution and on the solution under test. The odd animal in uneven litters was kept as a negative control. The standard solution used was about thirty per cent stronger than that now issued by the Institute for general use.

For their assays, the authors constructed a scale of healing: photographs were selected showing just perceptible differences from each other and arranged in order from no healing up to complete healing. Twelve such steps were distinguishable, although the dose of vitamin D which caused complete healing was sixty-four times that which just failed to produce any visible calcification. When the differences in scale reading for doses of vitamin in the ratio 2 : 1 were averaged for large numbers of pairs of rats from the same litter, it was found that the mean scale difference was constant at about 1·9 divisions. Hence, although the dose given is increased twice at each step from the bottom of the scale, the degree of healing only increases two divisions at a time; in other words, the scale is approximately logarithmic in nature, the change in scale number produced by a given change in dose being directly proportional to the change in the logarithm of the dose. It is probable that this indicates that the rate of healing is proportional to the logarithm of the dose, at any rate over a limited range.

It was not found possible to use the scale without a standard preparation, owing to the great variations in sensitiveness of the animals at different seasons of the year, as well as between litters at the same season. They appeared to be most sensitive in summer and least so in autumn and winter. For the same dose of vitamin, the healing figure might vary six divisions on the scale at different times. The relationship between difference in dose and difference in scale reading was checked by selecting all rats which had shown a given degree of healing and then finding the scale numbers of all litter mates which had received half or twice this dose. The two sets of figures thus obtained were then averaged and indicated that, for the middle ranges of the scale, doubling or halving the dose produced a change of two scale divisions. Possible errors in this calibration were taken into consideration. The change of two scale divisions for doubling or halving the dose appears to be constant over long periods of time, but since it is possible that variations occur, it is advisable in routine testing to choose doses of unknown solution both above and below those of the standard.

In several recent investigations, attempts have been made to construct curves relating dose and effect in the case of other vitamins. The scale used by K. M. Key and G. K. Elphick for the assay of vitamin C bears the closest resemblance in type to that used by Bourdillon and his co-workers.[2] When guinea-pigs are given a scorbutic diet, changes occur in the structure of the teeth: Höjer was able to recognise ten stages in the development of scurvy based upon these alterations. Key and Elphick, in re-examining these observations with the view of finding a basis for a quantitative method of assay, were only able to define five stages between scurvy and complete protection. Groups of young guinea-pigs were given a diet of bran, crushed oats, and dry skim milk with cod liver oil twice weekly. The experimental animals received also 0·75, 1·5, or 3·0 c.c. orange juice daily. The test was continued for fourteen days and the animals then killed. In this period, there were no differences in rate of growth amongst the experimental animals and the negative controls. The degree of scurvy developed in this time was only slight, although more definite in the latter. It was estimated by examination of transverse sections of the roots of the incisor teeth, the disease being characterised by disorganisation of the odontoblasts, the presence of an inner dentine, calcification of the predentine, and absence of Tomes' canals.

When the degree of scurvy was given a scale number

from 0 to 4, it was found that the average degrees of protection for groups of fifteen animals were 0·6 for the negative controls and 1·4, 2·4, and 3·9 for the groups receiving 0·75, 1·5, and 3·0 c.c. orange juice respectively. The relationship between dose and degree of protection is thus linear. In the case of vitamin D, as already stated, the linear relationship held between degree of healing and the logarithm of the dose. The authors found the response of individual guinea-pigs to be very variable. Consistent results could be obtained, however, when groups of five on each dose were employed. The method has the advantages of speed and of giving more precise results than that involving the determination of the mimimum protective dose. The curve obtained can be employed as a standard of reference for the assay of materials containing vitamin C.

For the assay of vitamin A, which is usually tested by its growth-promoting power, a curve relating growth rate to dose given is required. It is possible that other methods may be developed in the future; for example, Coward has found that the number of rats dying when given small doses of the vitamin after a preliminary depletion period, during the second to fifth weeks of vitamin administration, is proportional to the dose given. The same observer has also published curves relating growth rate to dose of vitamin, from which it is possible to determine the potency of an unknown preparation in terms of a selected standard.[3]

It was found that the type of casein used in these tests played an essential part. A quantitative relationship between dose and growth was not obtainable when the casein used had first been heated. The synthetic diet was therefore prepared from 'light white casein', dextrinised rice starch, dried yeast, and a salt mixture. Small doses of vitamin D were given weekly or the diet was irradiated. The young rats were given this diet until they ceased to grow. They were then divided into groups, to each of which the same dose of cod liver oil was given daily by hand for five weeks. With doses ranging from 1 mgm. to 7·5 mgm. daily, the average growth rates varied from 2·0 gm. to 10·0 gm. per week for this period. The curve obtained by plotting growth against dose given was logarithmic in type: a simple formula could be fitted to it. It was later found that it could be resolved into two similar curves, one for the bucks and one for the does, the formulæ for which are:

$$y = 11{\cdot}3 + 50{\cdot}3 \log x \text{ (bucks) and } y = 12{\cdot}4 + 27{\cdot}4 \log x \text{ (does)}$$

where $y$ is mean increase in weight of group in five weeks and $x$ is dose of cod liver oil in milligrams.

Analysis of the results showed that with five rats per dose the error is usually within fifty per cent; with ten, within thirty-three per cent; and with twenty, within three per cent. No seasonal variation in response was noted. The curve is used as a standard of reference in the assay of preparations of vitamin A: the growth responses to several doses of the latter are determined on groups of ten rats each and from the curve the doses of the standard cod liver oil which would have given such responses read off: the potency is proportional to the ratio of the dose of standard to that of the unknown at each level.

The necessity for an accurate biological test for vitamin A has been emphasised by some recent work on the possible chemical and physical characteristics of these vitamins.[4] It has been generally supposed that the blue colour given by an oil containing vitamin A with antimony trichloride is a good indication of its growth-promoting potency. The investigations of the above authors have now demonstrated that in cod liver oil at least two substances giving a blue colour are present. Comparative biological, chemical, and physical tests of a series of cod liver oils showed that the best agreement with the biological method was given by the measurement of the ultra-violet absorption band (at 3280 A.) of the oil itself, and also by that of the blue value of the unsaponifiable fraction of the oil. Less good agreement was obtained with the measurement of the intensities of the two bands present in the blue colour produced with antimony trichloride, while the least good agreement was shown by the measurement of the blue values of the oils themselves. In other experiments it has been shown that the intensity of the band at 5720 A. in the antimony trichloride test runs parallel with that of the band at 3280 A. in the oil. The intensity of the absorption at 6060 A. in the colour test shows no such relationship. This band appears to be due to the presence of another chromogen; its intensity is low in fresh oils but can be considerably increased by oxidation. It appears, therefore, that until the chemistry of vitamin A has been further elucidated, the final resort for its quantitative estimation must still be the biological test.

[1] "The Quantitative Estimation of Vitamin D by Radiography", by R. B. Bourdillon, H. M. Bruce, C. Fischmann, and T. A. Webster. Medical Research Council: Special Report Series, No. 158. Pp 46+2 plates. (London: H.M. Stationery Office, 1931.) 1s. net.

[2] *Biochem. J.*, vol. 25, p. 888; 1931.

[3] K. H. Coward, K. M. Key, F. J. Dyer, and B. G. E. Morgan: *ibid.*, vol. 24, p. 1952; 1930: vol. 25, p. 551; 1931.

[4] K. H. Coward, F. J. Dyer, R. A. Morton, and J. H. Gaddum: *ibid.*, vol. 25, p. 1102; J. A. Lovern and R. A. Morton: *ibid.*, pp. 1336 and 1341 (with R. H. Creed); A. E. Gillam and R. A. Morton: *ibid.*, p. 1346; I. M. Heilbron, A. E. Gillam, and R. A. Morton: *ibid.*, p. 1352.

## Climate of Southern Rhodesia *

THE meteorological service of Southern Rhodesia is, of course, in its infancy. Nevertheless, for the period under review 46 climatological stations and 550 rainfall stations were available, a network sufficient to give a good idea of the course of the weather. For the purpose of obtaining a general survey of the rainfall, the element which is of paramount economic importance to agriculture in such a region, the Report states that a gauge to each 120 square miles is sufficient. Southern Rhodesia contains about 1200 such squares, and of these, 322 are at present occupied by gauges. Just as in the case of the British Isles, the rainfall observers are practically all voluntary helpers in meteorological work.

Rhodesia is one of those countries where the figure representing the average rainfall of any part for a long period of years is in itself a very uncertain guide as to the suitability of that region for particular branches of agriculture. The principal reason for this is the great variability from year to year of the fall in any part of the rainy season, but to this must be added the fact that much of the rain is received in violent storms—often accompanied by thunder—and the rain, even when of reasonable amount as judged by weekly or monthly totals, may be to a great extent lost to agriculture through the rapidity of its 'run-off'. Some striking examples of abnormal

* Southern Rhodesia. Meteorological Report for the year ended June 30, 1930, by the Department of Agriculture. Pp. 94. (Salisbury.)

rainfall are given in this Report: for example, 2·05 inches in fifteen minutes at Riversdale (Charter) on March 7, 1930, and 6·50 inches in one hour at Lundi (Chibi) on Jan. 18, 1930. The latter figure represents very nearly the normal total for the wettest quarter of the year in London. It is natural that every effort should be made to forecast the amount of rain to be expected in each rainy season, and for this purpose it appears that a trial is being made of an equation connecting the general rainfall of Southern Rhodesia with the Nile Flood, pressure at Rio Janeiro, temperature at Mauritius, and minimum temperature at Bulawayo. The necessary values of the independent variables are not available until early in December; they give a combined correlation coefficient of +0·77 only, which is rather low for forecasting purposes. For the season 1928–29 the forecast departure from normal was −1·2 inches, and the actual departure −1·9 inches. This matter is in the experimental stage, and consequently the forecast was not made public.

The Report contains a good deal of statistical matter relating to the period under review, most of which is in tabular form. There are excellent rainfall maps, giving the geographical distribution of the year's total and of the normal year's total, both of which illustrate the general tendency for rainfall to decrease with distance from the Indian Ocean. This is a well-recognised feature of most of British South Africa, due to the fact that, apart from local convectional storms in the spring and occasional rains due to tropical hurricanes out on the ocean in late summer or autumn, much of the season's fall is due to dynamical cooling of the south-east trades as they rise over the elevated plateau of South Africa, which winds naturally lose much of their moisture in this way as they penetrate into the interior. Climatic investigation is being extended into the upper atmosphere by means of observations of wind with the aid of pilot balloons liberated at Salisbury. Some of these were followed to a height of ten kilometres. At the higher levels, the predominance of easterly and south-easterly winds appears to be lost, both in summer and winter, at ten kilometres, the directions most favoured in 1929–30 being west and north-west. Since this work was only begun in October 1928, this is the first full year's observations of upper winds. E. V. N.

## Glasgow Meeting of the Chemical Society

HOLDING its annual general meeting at Glasgow on March 17, the Chemical Society paid its first visit to Scotland. The choice was particularly appropriate in view of the association both of the president, Prof. G. G. Henderson, and of the Society's first president, Thomas Graham, with that city; moreover, as Sir Thomas Kelly said at the civic reception, the Corporation has a particular interest in chemistry, for they themselves are chemical manufacturers on a very large scale.

In his presidential address, Prof. G. G. Henderson dealt with a matter of pressing importance to all societies which essay to publish the results of scientific investigation, and one which at the present time occasions acute anxiety to those organisations which are nobly attempting to continue to finance an adequate service of abstract publications out of the subscriptions of their members. The burden has fallen very heavily on the Chemical Society. The chief work for which it exists has grown very considerably during the past year; the number of original communications published in the *Journal* is 24 per cent higher then in 1930, and the number of chemical papers abstracted by the Bureau and published in *British Chemical Abstracts* "A" is also very much greater than in the previous year. The consequent financial burden is too great for the Society, with its present income, to bear, and at no other period in its long history has the Society been faced with such great difficulties in carrying on its work.

It is, and always has been, the function of the Chemical Society to encourage the development of chemical science in all branches and to provide a regular and complete record of all new additions to chemical knowledge; nevertheless, it was the Society of Chemical Industry, inaugurated in 1881, which gave to technological chemistry the stimulus then lacking owing to the restricted resources of the older Society, and afterwards the development of other branches of the science has been fostered by the creation of specialist societies. "Looking back on what has happened since 1841," said Prof. Henderson, "the thought arises that if those of our predecessors who managed the affairs of the Chemical Society during the first forty years of its existence had taken a broader and a longer view, some at least of the various societies to which I have referred might not have been founded, and we might now have one great chemical society, with a membership of 10,000 or more, with the members organised into divisions dealing with the different branches of chemistry and possessing a large measure of autonomy. . . ."

Possibly the suggestion that an endeavour should be made to bring about the merging into one organisation of all the various societies concerned with chemistry might be considered impracticable, but Prof. Henderson urged that no effort should be spared to promote the closest possible co-operation between them; so far as the Chemical Society and the Society of Chemical Industry are concerned, a very good case can be made out for reunion. Such a union would almost indubitably effect economies, and the proposal *ipso facto* merits consideration. Even if the difficulties which stand in the way of bringing about a complete fusion of interests prove to be too great, it should be as possible as it is desirable to arrange for a working partnership of the most intimate character.

An important step in that direction was taken in 1923, when the Bureau of Chemical Abstracts—a joint committee of the two societies responsible for the production and publication of *British Chemical Abstracts* "A" and "B"—was formed. Upon these two societies alone falls the financial burden of this great work, a task which is performed for the benefit of every chemist in the country. Prof. Henderson pointed out that it is singular and anomalous that there are hundreds, perhaps even thousands, of professional chemists in Great Britain who make no contribution to this burden, who do nothing to help the cause of chemistry in the way that is most urgent, most necessary, and most expensive. He appealed to all chemists to support one or both of the two Societies, even though the *Journals* may be consulted by non-members in the general and departmental libraries of practically all universities and colleges, in the libraries of many chemical works and scientific societies, and in a number of public libraries; and even though they rightly find it desirable to subscribe to professional organisations such as the Institute of Chemistry and the British Association of Chemists.

A large addition to the membership of the Chemical Society would assist in easing the situation, but income derived from annual subscriptions is always subject to fluctuations, and something more permanent is desirable. Prof. Henderson appealed for additions to the Society's capital fund, which supports the publication of the results of original investigations in chemistry, and in particular suggested that the Institute of Chemistry might not find itself precluded by its charter from widening the range of its beneficent influence by giving a substantial annual contribution to the Publications Fund of the Chemical Society. Referring to co-operation with the Institute and the Society of Chemical Industry in another direction, Prof. Henderson advocated the formation of local committees of fellows of the Chemical Society in each city where there is a section of the Institute or of the Society of Chemical Industry, in order that joint meetings might be arranged for the reading and discussion of papers.

Of the various suggestions which have been made for the reduction of expenditure, that which proposed the abolition of the Bureau of Chemical Abstracts and the purchase of copies of *Chemical Abstracts* from the American Chemical Society is not likely to appeal to either of the societies. Another suggestion which deserves consideration, but is attended with risk of loss of income without marked diminution in the cost of publication, involves the payment by fellows of a nominal subscription, additional payment being made for whatever publications they desire to receive. A direction in which a certain reduction of expenditure could be effected was indicated by Prof. Henderson. There is a tendency towards the publication of the results of research work in more numerous instalments than was formerly the custom; each instalment requires introductory discussion, and repetition is almost inevitable. If authors published their results in a more limited number of more comprehensive papers and safeguarded priority by means of short communications, little if any loss would be suffered and valuable space would be saved.

The problems discussed by Prof. Henderson are very real and their solution will be correspondingly difficult; nevertheless, it may be supposed that members of a great scientific community will approach them boldly and skilfully as a profession, and not sectionally or with hesitation; unity is strength, and success proverbially comes to the strong.

During his speech at the anniversary dinner after the meeting, Lord Weir referred to a matter of policy which has frequently been emphasised in the columns of Nature: the status of science in politics and the nation's neglect to make adequate use of scientifically trained men in high places. The man of science must nowadays be mainly a specialist; accordingly, the politician or the so-called business man becomes the framer and controller of policy. While admitting great respect for both the politician and the business man, Lord Weir doubts whether sufficient use is made of the trained scientific intellect when the major lines of national policy are being decided upon. Experience has taught him, for example, that at no time should the Board of Admiralty, the Air Council, or the Army Council—any one of them—be without a member having scientific or engineering attainments; he referred to no question of status or recognition, but the simple wisdom of having representation of that type of brain. Whether or not this is a matter which can be appropriately pursued by the Chemical Society is for that organisation to determine; there can, however, be no two opinions concerning the place of exact knowledge and organised inquiry in the art and practice of government.

## University and Educational Intelligence

Oxford.—The School of Geography at Oxford was established, with the assistance of the Royal Geographical Society, in 1899. In 1921 it entered into possession of its present quarters in Mansfield Road, where lectures and practical and tutorial instruction are given and other geographical work is carried on. For some years past a diploma in geography has been granted by the University to qualified candidates, and it has lately been decided to raise geography to the status of a final honour school for the arts degree. A new professorship has been established, and the first holder of the chair will be Major Kenneth Mason, who has a distinguished record for service in France, Persia, India, Mesopotamia, and Central Asia. He will be an *ex officio* fellow of Hertford College. The conditions and regulations for the new honour school are not yet determined. Major Mason will take up his duties on May 1.

St. Andrews.—The Senatus Academicus has agreed to confer the honorary degree of LL.D. upon the following, amongst others, on June 28: Sir James Frazer; Sir Richard Livingstone, vice-chancellor of the Queen's University of Belfast; Mr. James Robb, secretary of the Carnegie Trust for the Universities of Scotland; Prof. L. R. Sutherland, emeritus professor of pathology in the University of St. Andrews.

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Mr. W. E. Shewell-Cooper, horticultural superintendent, Cheshire County Council, has been appointed horticultural superintendent at the Horticultural College, Swanley, and will take up his duties in July.

At the National Union of Teachers' annual conference at Folkestone, the president, Mr. A. E. Henshall, of Stafford, protested energetically against the postponement of school building programmes, the employment of capacity tests for free places in secondary schools, and the 'cuts' in their salaries to which teachers have recently been subjected. The teachers of the country, he stated, continue to believe that they have been harshly and unjustly treated. As regards the services the teachers may be expected to render to the community, he directed attention to the difficulty of preparing pupils for life in a rapidly changing world, and suggested (somewhat optimistically) that the teacher can train them to seek to use their own powers, lead them to exercise initiative and to achieve self-reliance, and cultivate open-mindedness, intellectual curiosity, accuracy of thought, tolerance, and a sense of personal responsibility. The time has arrived, in Mr. Henshall's opinion, for a reconsideration of the relation between school and workshop, for no education can be complete which disregards the need of earning a livelihood. Increased leisure, "the gift of science", must also be prepared for, and in the schools must be cultivated interest in those arts and crafts the practice of which demands only relatively easy technique but provides means of self-expression. The May Committee is blamed for checking progress in this direction.

Until quite recently, science as a subject in a girl's education received scant attention. Towards the end of last century, if in the school curriculum at all, it consisted chiefly of descriptive botany and some geology. The method was therefore essentially didactic. At the beginning of the present century the pendulum began swinging in the other direction and laboratory work was initiated. A preliminary drilling in physical measurements formed the basis of this scientific way of obtaining knowledge by personal observation and experimentation; but this heuristic

method proved to be very slow. As Miss I. M. Drummond, former president of the Association of Women Science Teachers, points out (Association of Women Science Teachers, Report for 1931), it is impossible to force ontogeny to repeat phylogeny in educational method. Progress by such a method would be tedious and defeat its own ends. It is necessary to keep in view the sciences and the greatness of scientific conceptions. The practical method is still essential, and experiments, while they are a means of illustration, should not be treated merely as such, but rather as the basis of the lessons. Thus results would come as surprises, and force the individual to trust her own powers of observation. Training in accurate expression, too, comes via the laboratory practical notebook. Teachers have in their hands an instrument of pre-eminent value for training real integrity of the mind. The cultural value of science can be brought out through its past glories. The history of science has a twofold value in endowing science with a human interest and enabling our people to cultivate the mental equipment necessary for the present-day scientific atmosphere of thought.

## Calendar of Geographical Exploration

### April 4, 1931.—Haardt's Last Journey

M. Georges Marie Haardt, the famous French explorer, set out from Beirut, Syria, on an attempt to cross Asia by motor car. The journey was successfully accomplished, and Peking reached on Feb. 12, 1932; but the explorer contracted pneumonia and died at Hong Kong in March. Iraq, Afghanistan, the Indus valley, and the Pamirs were traversed, but travel by motor had to be abandoned after ascending the Bourzil Pass to 13,775 ft., the heavy rains compelling the party to take to ponies and yaks. In one place the motors had to be taken to pieces and reassembled, in order to avoid the effects of a landslide. M. Haardt had made many previous overland journeys, the most famous being the crossing of the Sahara in 1922–23, which resulted in the opening up of new routes between Algeria and the Niger.

### April 5, 1752.—South-East Africa

An expedition led by A. F. Beutler, and including among its members two surveyors and a botanist, reached the last settlement towards the east from Mossel Bay, just beyond the Little Brak River. Keeping near the coast, the party explored the shores of Algoa Bay, crossed the Great Fish River, and arrived at the Keiskama River, which then formed the boundary between the Hottentot and Bantu peoples. The Kei River was crossed, but the fatigue of the party then made return necessary. A different route was taken, and much new country, including the valley of the Fish River, was explored.

### April 6, 1682.—The Mississippi Delta

Robert Cavelier de la Salle reached the Mississippi delta. La Salle went to Canada in 1666, and in 1669 began his famous series of explorations by discovering the Falls of Niagara and the Ohio River. The discovery of the Mississippi River was made by Joliet and Marquette, who reached it via the Wisconsin, but turned back near its confluence with the Arkansas. La Salle, with two companions, set out in December 1681 from Fort Mi'ami, descended the Illinois in canoes, and reached the Mississippi in February 1682. On April 6, when they reached the head of the great delta, each of them sailed down a separate arm and met later in the Gulf of Mexico. In July 1684, La Salle attempted to reach the delta by sea, but landed in the lagoons of Texas, 400 miles from it. His store ship and its companion vessel were wrecked. An attempt to lead his discontented party overland resulted in the murder of La Salle and three others of the party in the plains of Texas, before the valley of the Mississippi was reached.

### April 6, 1909.—The North Pole Reached

R. E. Peary, the American Arctic explorer, reached the north pole, accompanied by the negro Henson and by four Eskimos. They remained there about thirty hours, and in a sounding a few miles from the pole found no bottom at 1500 fathoms. Peary started on this journey in 1908, wintered in Grant Land, and set out over the ice from Cape Columbia on March 1, 1909. A party of six set out and were gradually sent back as supplies diminished, Bartlett turning back at 87° 48′ N. Peary began his work in 1886, when he made a study of Disco Bay on the west coast of Greenland as a possible base for polar exploration. In 1891 he undertook a polar expedition, his wife accompanying him, and in 1892 reached the north-east coast of Greenland, thus proving it to be an island. Studies were also made of Smith Sound Eskimo tribes. In 1902 Peary and Henson reached 84° 17′ N., and in 1906 Peary and his companions reached 87° 6′, but were compelled to return at that point. His success in 1909 crowned twenty-three years of continued effort.

## Societies and Academies

LONDON

Society of Public Analysts, Feb. 3.—N. L. Allport and G. H. Skrimshire: A new method for the determination of lead in organic substances, with special reference to dyestuffs. The organic material is destroyed by wet oxidation and the lead is removed by shaking with a chloroform solution of diphenylthiocarbazone. Finally the lead is determined colorimetrically as sulphide. The method is applicable in the presence of large amounts of iron, but bismuth interferes with the method, and special procedures are necessary when appreciable amounts of tin, aluminium, nickel, or cobalt are present.—B. S. Evans: (1) Some analytical applications of sodium hydrosulphide. A rapid and accurate method is described of separating tin from various other metals the sulphides of which are soluble in alkali cyanide. (2) A rapid method of dissolving lead alloys preparatory to the determination of tin and antimony. Lead dissolves rapidly and completely in a mixture of perchloric and phosphoric acids, whilst tin and antimony form insoluble compounds which are apparently of the nature of 'metastannic' and 'metantimonic' acids.—H. B. Dunnicliff and H. D. Suri: The phloroglucinol method for the determination of mechanical wood pulp in paper. The phloroglucinol method of Cross and Bevan was found to be unreliable in India, and the authors have therefore studied the effect of temperature on the results, the relationship between the volume of standard reagent and the weight of paper for quantitative reactions, the time required, and the mechanism of the reaction.—E. H. Bunce: Investigations relating to milk standards under the Burma Food and Drugs Act. There are no legal standards for milk in Burma, but in the Government Laboratory a minimum of 3 per cent of fat and 8·5 per cent of solids-not-fat is adopted for cow's milk, and a minimum of 5 per cent for fat and 9·0 per cent for solids-not-fat for buffalo's milk. A common fraud is the dilution of buffalo milk with water to imitate cow's milk.

### DUBLIN

Royal Irish Academy, Jan. 25.—J. J. Nolan and J. G. O'Keeffe: Electric discharge from water drops. The negative discharge from drops originally hemispherical exceeds the positive for the same field values. Rapid discharge for drops of radius $r$ exposed to a uniform field $F$ begins for values of the field given by the approximate relation $F\sqrt{r}=3600$, the units being volt and centimetre. In a pure atmosphere the ions produced by the discharge remain small ions.

### PARIS

Academy of Sciences, Feb. 15.—B. Bang was elected *Correspondant* for the Section of Rural Economy.—Bertrand Gambier: The points of contact of an algebraical curve and its envelope.—Gaston Julia: The prolongation of a Riemann $\sigma$ surface corresponding to a multiple convex area $\mathfrak{A}$.—N. Théodoresco: The employment of Hadamard's method in the solution of Cauchy's problem for certain systems of partial differential equations.—René de Possel: Ensembles of the maximum type and the prolongation of Riemann surfaces.—Henri Milloux: An inequality of the theory of functions and its applications.—Jean Louis Destouches: The integration of the equation with the first integrals of quantic mechanics.—André Coyne: A new method of testing concrete or reinforced concrete works, especially barrages, by means of sound. A stretched steel wire is fixed between two points; by an electromagnetic arrangement and amplifying valves, any change in the distance between the two fixed ends of the wire can be measured in terms of beats heard in a telephone, the note emitted by the wire being compared with a standard tuning-fork. Numerous problems of interest to which this method can be applied are indicated.—Edmond Brun and Pierre Vernotte: The heating of a thermometer by a gaseous current. Aerodynamical applications. The heating observed is the quotient of two complex phenomena, friction and convection. A theoretical formula is developed which gives a rise of temperature of the same order as that actually measured.—M. Mendes: The problem of $n$ bodies with variable masses.—A. Portevin and P. Bastien: The principal factors affecting the flow of pure metals. The flow is the resultant of several complex factors, in which the calorific properties (specific heat, latent heat, melting point) of the metals are at least as important as the viscosity.—G. Reboul: A particular form of activity of matter. Study of the action of various substances on a photographic plate.—Marcel Dufour: The suppression of astigmatism in oblique pencils in thin lenses.—J. Gilles: The relations between the quadruplets corresponding to N(I), O(II), S(II), and Cl(III).—E. Stahel: The number of the secondary $\beta$-rays emitted by radium. For every 100 atoms decomposed, 5 secondary $\beta$-rays are emitted. This leads to the unexpected conclusion that the greater part of the radium atoms decompose without emitting $\gamma$-rays (see also NATURE, Feb. 27, p. 314).—E. Calvet: The velocities and heats of saponification of the amides.—Adrien Karl: The estimation of radium in the presence of the sulphates of the alkaline earths. The radium barium sulphate is heated with the eutectic mixture of sodium, potassium, and lithium chlorides to a temperature just above the melting point (520° C.). No vapours are given off, and the emanation can be readily removed in a current of air.—Jarry: The extraction of the phenols in tar oils by liquid ammonia. A mixture of tar oil and liquid ammonia separates rapidly into two layers: the upper layer contains the whole of the phenols.—Marcel Godchot and Max Mousseron: Some new piperazine derivatives.—S. Sabetay and D. N. Mira: Some ether oxide aldehydes.—L. Royer: New observations on the orientation of crystals deposited in contact with a cleavage of mica or chlorite.—F. Dupré la Tour: Studies on the dimorphism in the normal saturated fatty diacid series as a function of the temperature.—M. G. Filipesco: The siliceous accidents of the Tisaru strata (Flysch of the Roumanian Carpathians).—Dalloni: The volcanoes of Tibesti.—André Demay: The conditions of orogenesis and of Hercynian metamorphism in the eastern edge of the central massif between Saint-Vallier and Privas.—Ch. Gérard: A Liassic fauna of Sierra Sagra, in the sub-betic zone (southern Spain).—G. Corroy: The Toarcian of Lorraine and of Haute-Savoie. The recurrence of the schistose facies at Posidonomyes.—Antonin Lanquine: The extension of the facies and fauna of the Argovian in the Provençal chains.—Mlle. Lucienne George: Observations on *Sorbus aria*.—J. Dufrenoy: Correlation between the air temperature and rate of growth of the vine.—L. Grigorakis: The morphology and evolutionary cycle of the Actinomyces.—H. Colin and P. Ricard: *Pelvetia canaliculata* as a source of *l*-fucose.—Émile André and Kiawo Hou: The presence of a lipide oxidase or lipoxidase in the seed of *Glycine soja*.—Marcille: Life in a confined medium. Protection against poison gas.—Mme. L. Randoin and Mlle. A. Michaux: Variation of the amount of sodium and potassium in striated muscle under the influence of a diet entirely deprived of the antiscorbutic vitamin. The absence of vitamin C from the diet causes an increase of the sodium and chlorine in the muscle and a reduction of the potassium.—Raymond-Hamet: The action of acetylcholine on the vasomotors of the penis in the dog.—H. Bierry and B. Gouzon: The fluorescent substances of egg-shell.—Étienne Rabaud: The rôle of the *stabilimentum* in the webs of *Argiope bruennichi*.—Mlle. Yvonne Garreau and J. Parrod: The oxidation products of *d*-galactose by ammoniacal copper oxide and the oxygen of the air, at laboratory temperature.—G. Delamare and C. Gatti: The rounded bodies of *T. dentium*.—C. Levaditi and N. Constantinesco: Syphilis and neoplasms.

### VIENNA

Academy of Sciences, Nov. 11.—R. Weiss and C. Alberti: The action of benzyl magnesium chloride on benzal phthalide. (2) Preparation of *o*-phenylene-bis-(phenylglyoxal).—K. H. Berg: Cytological observations on *Ægilops triuncialis* × *Secale cereale*.—K. H. Berg: A hybrid with four complete haploid species-genomes.—A. Winkler: Preliminary report on studies in the Tertiary on the north-east spur of the central Alps.

Nov. 19.—R. Weiss and A. Abeles: The separation of racemates into their optically active components by means of addition-compounds.—H. Bojko: The ecology of *Cynodon dactylon* and *Astragalus exscapus*.—A. Kohler: Geological and petrographic investigations on the primitive rocks of the Lower Austrian Waldviertel and its boundary regions. Second report. Two new analyses of granites.—K. Girkmann: Dimensions of girder frameworks on the assumption of an ideal plastic steel.—M. Mladenovic: Elemic acid from Manila elemi resin. (4) Dihydro-elemolic acid and its derivatives.—K. Cori and B. Finzi: Enumeration of the ants collected by K. Cori on the South Dalmatian islands in 1914.—E. Holesch: The evaporation of radium-*B* and radium-*C* in hydrogen and nitrogen.

Nov. 26.—F. Ackerl: The gravitational field of force of the earth. A map has been prepared with lines of equal force.—F. Kuba: Centric crank oscillations.—L. Kölbl: Tectonic of the Tauern 'fenster'.—H. Y. Graben: Report on geological and petro-

graphic researches in the Upper Austrian primitive rocks.—M. Sellnick: Zoological expedition to the Ionian Islands and the Peloponnesus. (10) Acari.—A. Zinke and O. Benndorf: Perylene and its derivatives. (34) The hydration of perylene.—Eder, Späth, and Wegscheider: Commission report concerning the discovery of red phosphorus. There have been two claimants, Dr. J. Goldmark and Prof. A. Schrötter. Schrötter's experiments began in 1845. Goldmark was a student in Schrötter's laboratory between 1845 and 1847. Goldmark lectured on red phosphorus in August 1847 at Oedenburg in Hungary. Schrötter's first announcement was to the Vienna Academy in November 1847, published in December 1847. The commission awards priority to Schrötter.

## Forthcoming Events

*FRIDAY*, APRIL 1

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (Annual General Meeting) (at Engineers' Club, Manchester), at 7.—F. J. Slee: Laboratory Tests of Lubricants and their Relation to Engine Tests (Lecture).

MANCHESTER ASSOCIATION OF ENGINEERS (Annual General Meeting) (at Engineers' Club, Manchester), at 7.—W. Core: Layout of Machines and Small Tools for Economical Production.

*MONDAY*, APRIL 4

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (Annual General Meeting) (at Birmingham University), at 7.—E. A. E. Woodward and W. A. Carne: An Analysis of the Costs of Electricity Supply and its Application in Relation to Various Types of Consumers.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Royal Institution), at 8.—Sir William Bragg and Dr. G. Shearer: The Application of X-Rays to Chemical Industry (Lecture).

*TUESDAY*, APRIL 5

ROYAL ANTHROPOLOGICAL INSTITUTE (African Research Committee), at 5.30.—Culture Distribution Maps for Africa.

LONDON NATURAL HISTORY SOCIETY (at London School of Hygiene and Tropical Medicine), at 6.30.—Prof. M. Culpin: Heredity and Disease (Bacot Memorial Lecture).

*WEDNESDAY*, APRIL 6

ROYAL SOCIETY OF ARTS, at 8.—Dr. F. H. Constable: Light Sensitive Cells in the Service of Man (Lecture).

*THURSDAY*, APRIL 7

INSTITUTION OF CIVIL ENGINEERS, at 6.—To consider a Provisional Report of a Sub-Committee of the Institution on the Drafting of Bills of Engineering Quantities, together with a List of the Units of Measurement to be Employed.

*FRIDAY*, APRIL 8

ROYAL SOCIETY OF ARTS (Indian Meeting), at 4.30.—Sir Richard Burn: Recent Developments in Land Revenue and Rent Policy in the United Provinces (Lecture).

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (at Royal Victoria Hotel, Sheffield), at 6.—T. G. Elliot and Dr. W. Cullen: Special Alloy Steels as applied to Chemical Engineering.

INSTITUTE OF FUEL (East Midlands Section) (Annual General Meeting) (at University College, Nottingham), at 7.—V. B. Harley-Mason: Conditioning of Boiler Feed Water.

SOCIETY OF DYERS AND COLOURISTS (Scottish Section) (Annual General Meeting) (at George Hotel, Glasgow), at 7.15.—J. Muir: Some Notes on *p*H Control by Colorimetric Methods (with demonstrations).

OIL AND COLOUR CHEMISTS' ASSOCIATION (Manchester Section) (at College of Technology, Manchester).—Annual Meeting.

APRIL 8 TO 11

CONGRESS OF GERMAN PHARMACOLOGICAL SOCIETY (at Wiesbaden).

APRIL 11 TO 14

CONGRESS OF GERMAN SOCIETY FOR INTERNAL MEDICINE (at Wiesbaden).

## Official Publications Received

BRITISH

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1436 (Strut. 50): Torsional Loading on Stripped Aeroplane Wings. By Dr. H. Roxbee Cox. Pp. 12+2 plates. (London: H.M. Stationery Office.) 9*d*. net.

The Imperial Council of Agricultural Research. Scientific Monograph No. 1: The Fungi of India. By Dr. E. J. Butler and Dr. G. R. Bisby. Pp. xviii+237. (Calcutta: Government of India Central Publication Branch.) 6.12 rupees; 11*s*.

The Indian Forest Records. Silviculture Series, Vol. 16, Part 6: The Use of Stumps (Root and Shoot Cuttings) in Artificial Regeneration. By H. G. Champion and B. D. Pant. Pp. vi+89+8 plates. (Calcutta: Government of India Central Publication Branch.) 2.4 rupees; 4*s*. 3*d*.

Journal of the Indian Institute of Science. Vol. 14A, Part 10: The Reactivity of Dimethyldihydroresorcin. Part 2: Behaviour towards *Ortho*-Nitro and *Ortho*-Aminobenzaldehydes. By B. H. Iyer and G. C. Chakravarti. Pp. 157-171. (Bangalore.) 1 rupee.

Tanganyika Territory: Geological Survey Department. Annual Report, 1930. By Dr. E. O. Teale. Pp. ii+34. 2*s*. 6*d*. Short Paper No. 9: Shinyanga Diamond Fields. By Dr. E. O. Teale. Pp. iii+39. 4*s*. (Dar es Salaam: Government Printer.)

Scientific Reports of the Imperial Institute of Agricultural Research, Pusa (including the Reports of the Imperial Dairy Expert, Physiological Chemist, Government Sugarcane Expert, and Secretary, Sugar Bureau), 1930-31. Pp. iv+150+3 plates. (Calcutta: Government of India Central Publication Branch.) 2.6 rupees; 4*s*. 3*d*.

FOREIGN

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 84. Additional New Birds from Peru with a Synopsis of the Races of *Hylophylax naevia*. By M. A. Carriker, Jr. Pp. 7. Geographical Variation in *Trachyphonus margaritatus*. By W. Wedgwood Bowen. Pp. 9-10. (Philadelphia.)

Publications of the Lick Observatory. Vol. 17. Part 1: A Study of the Solar Chromosphere based upon Photographs of the Flash Spectrum taken by Dr. William Wallace Campbell, Director of the Lick Observatory, at the Total Eclipses of the Sun in 1898, 1900, 1905 and 1908, by Donald H. Menzel; Part 2: Halley's Comet in its Apparition of 1909-1911, by Nicholas T. Bobrovnikoff. Pp. v+vi+482+21 plates. (Berkeley, Calif.: University of California Press.)

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