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Scientific Education in the Metropolis.

AMONG the great national problems rendered urgent by the world-war and its consequences not the least important are the highly complex questions affecting the scientific instruction of a large body of students who look to London as their educational Mecca. The matter of adjusting the diverse claims of institutions the interests of which appear to clash is rendered more perplexing and delicate by the circumstance that these establishments embody in varying degrees older policies and ideals of teaching from which it is undesirable and, in point of fact, impossible to separate the educational aims of the immediate future.

The University of London, founded by Royal Charter in November, 1836, when higher education of academic standard was a monopoly enjoyed by the older universities, but refused to many persons on the ground of sex or religious belief, represented an immense increase in the facilities for advanced instruction offered not only in the London colleges, but also in several provincial institutions.

The supplementary Charter of 1858 abolished practically the exclusive connection of the University with these affiliated colleges, and threw open the degrees to all who were prepared to undergo the prescribed examinational tests. This far-sighted development, a practical realisation of the high ideal of "la carrière ouverte aux talents," rendered the University increasingly the *alma mater* of the student whose scanty opportunities for self-improvement compelled him to make use of whatever adventitious aids to education were available within his immediate surroundings.

The University of London Act of 1898, in recognising again the principle of an intimate connection between the University and the principal teaching establishments of the Metropolis, gave a dual aspect to the work of the University, which henceforward had an internal, as well as an external, side to its activities. The dual system is not without difficulties, and at one time it seemed likely that extreme advocates of the internal side would succeed in abolishing the older external side. This step, however, which is less probable now than it was a few years ago, would have extinguished the most characteristic function of the University as an "Imperial institution granting degrees and honours to all comers on condition of examination only."

It is significant of this Imperial aspect of the University's work that in recent years examinational centres have been established in Ireland and Ceylon of which increasing advantage is being taken by the students in those islands. The beneficial effect of this policy is too obvious to need emphasis. The young Irish or Ceylonese graduate, subjected as he probably is to the propaganda of a separatist movement, will view this insidious appeal to his insularity from a somewhat different angle after his affiliation with the metropolitan University; at an impressionable age he will have learnt to think Imperially.

The teaching institutions offering facilities for graduation on the internal side are the three incorporated foundations (University, King's, and the Goldsmiths' Colleges), together with other teaching establishments registered as schools of the University. In addition there are the polytechnics, controlled by the London County Council, which are institutions having recognised teachers, who may arrange their curricula in accordance with the University requirements; students of such courses form an important section of the internal candidates.

The Department of Science and Art, which for many years encouraged the study of science by a national system of examinations and scholarships, provided also higher systematic training and laboratory instruction at the Royal College of Science, with which was incorporated the Royal School of Mines. These two Governmental colleges formed the nucleus of the Imperial College of Science and Technology, which came into being in 1907 by the amalgamation under one governing body of these establishments and the Central Technical College, founded by the liberality of the great Livery Companies acting together through the City and Guilds of London Institute for the Advancement of Technical Education. The Imperial College, which became a school of the University, has since extended the scope of its work by the establishment of several new departments, and, having made good in these varied activities, especially during the war period, now presents itself as a formidable rival of the University in appealing for statutory powers to confer degrees on its *alumni*. In this claim to recognition as a university of technology, the Imperial College points to the established reputation of its staff and the admittedly high standard of its teaching, to the honours gained by its students in the University examinations, and to the scientific interest attaching to the investigations pursued in its research laboratories. From the point of view of the Imperial College, the University examinations are an unnecessary incubus, requiring from their students in November examinational tests precisely similar to those which these candidates passed successfully in the preceding June, sometimes under the inspection of the same examiners.

In order to appreciate the position of the University in the light of this objection, it is desirable to recall the changes which have occurred during the last two or three decades in the regulations relating to degrees in science. Formerly, candidates for the intermediate examination in science were required to qualify not only in mathematics, physics, and chemistry, but also in biology, the requirements in the last-named science being of a generalised but practical character. Moreover, candidates for the B.Sc. with honours were required first to qualify for the pass B.Sc. by examination in any three of the sciences, after which they could present themselves for honours in one or more of the three selected subjects. The effect of these older regulations for the intermediate and pass examinations was to encourage the attainment of a wide knowledge of science and to counteract the evil of premature specialisation.

At present the training in biology has disappeared entirely except for those who wish to specialise in this direction. The broad basis of a knowledge of three sciences is maintained only for those B.Sc. candidates whose natural modesty or lack of self-confidence prevents them from aspiring to the honours standard, where one principal science and one subsidiary subject only are required. The present B.Sc. with honours is in reality a lower measure of comprehensive scientific scholarship than the pass degree; it is largely a degree in physics, chemistry, zoology, or some other single branch of science. The substitution of narrow specialisation for broad scholarship in its science degrees has left the University in this respect with no effective reply to the criticism of the Imperial College. Nevertheless, if the graduate in technology is to be not merely a capable technologist, but also a well-informed member of an enlightened democracy, he will need to learn many things not contained within the purview of a degree in applied science, and it is the proper function of the University to provide him with facilities for acquiring this wider and more liberal education.

On the other hand, the Imperial College cannot hope to establish, and still less can it expect to maintain, a monopoly in applied science. Many teachers of the affiliated schools of the University have in the past made notable contributions to the improvement of industry, and, given adequate facilities for unfettered research, such successes will certainly recur even more frequently in the future. It would be nothing short of a calamity if the tendency towards concentration of educational effort should lead, for example, to the extinction of the Finsbury Technical College, the oldest school of technology in London, which, founded in 1878 by the City and Guilds of London Institute, and developed along original lines by an inspiring band of teachers, including Ayrton, Armstrong, Meldola, Perry, and Silvanus Thompson, has a record of scientific achievement not less meritorious than that of any other college in the metropolitan area. The contemplated closing of this college illustrates one of the risks of over-centralisation; for, while it is vitally important to establish institutions giving the highest specialised instruction and providing the fullest equipment for the most advanced training and research in science, yet due regard must be paid to the claims of the other less pretentious scientific colleges and institutes situated in the various metropolitan boroughs, since these more localised establishments play an important twofold part, first in supplying scientific students sufficiently trained to profit by post-graduate work, and secondly in bringing university teaching within easy reach of the inhabitants of their respective districts.

General Dynamics.

Higher Mechanics. By Prof. H. Lamb. Pp. x+272. (Cambridge: At the University Press, 1920.) Price 25*s.* net.

WE have here, as was to be expected from its author, an excellent statement and explanation of the principal theorems of what may properly be called higher dynamics. Prof. Lamb's title is "Higher Mechanics," which is in accordance with the usage which obtained before the appearance of Thomson and Tait's "Natural Philosophy." In his preface to the "Principia," Newton says: "Mechanicam vero duplicem veteres constituerunt, rationalem, quæ per demonstrationes accurate procedit, et practicam." Thus Newton uses the word "mechanica" qualified by the adjective "rationalis" in the sense of "scientia motuum qui ex viribus quibuscunque resultant," the science of the motions of bodies. The point is not one of great importance, but we prefer with Thomson and Tait the name "dynamics" for the whole science of rational mechanics.

The book begins with chapters on the kinematics of a rigid body, in which degrees of freedom, displacements of a rigid body, and theorems regarding these are very clearly explained and illustrated. Then follows a chapter on statics, in which the usual theorems are set forth, with a short but adequate account of the theory of screws. A treatment of moments of inertia is given which, perhaps, might with advantage have been fuller. Binet's theory of plane quadratic moments is included, while his theorem that the principal axes of inertia at any point P are the normals to the three quadrics which are confocal with the central ellipsoid of gyration, and which intersect at P, is not attributed to its author. The subject of plane quadratic moments does not seem of any but a purely mathematical interest, and one rather grudges the page devoted to it in this brief chapter.

After a chapter on instantaneous motions, we are led on to the equations of motion of a rigid body, with reference to a system of moving axes, which finally, when the body turns about a fixed point, is identified with the principal axes of moment of inertia passing through the fixed point. In connection with the equations of motion for this case—Euler's equations—which are of the form

$$A\dot{p}-(B-C)qr=L,$$

the usual statement is made that the equations may be written:

$$A\dot{p}=L+(B-C)qr,$$

and that then the quantities typified by $(B-C)qr$ are referred to as the components of a "centrifugal couple." This couple is quite rightly designated "fictitious"; but, apart from the lack of reality which afflicts it, its introduction seems undesirable. To speak of these quantities as "centrifugal couples" seems a perfectly artificial, unphysical, and almost unintelligible mode of regarding the matter. Centrifugal couples are worse than centrifugal forces, those unrealities against which Tait used to fulminate vehemently.

What one wants to convince the student here is that $A\dot{p}$ is not the whole rate of growth of angular momentum about the fixed axis, with which the principal axis at the instant coincides, and must be supplemented by the rate of growth $-(B-C)qr$ which exists in consequence of the motion of the axes. The whole rate of growth is $A\dot{p}-(B-C)qr$, and there is no ray of light thrown on the subject by carrying the second part from its proper place to the other side of the equation and calling it a couple. The use of "centrifugal couples" is justifiable only when the action of, or reaction on, an axis is in question.

We hope that we shall not be misunderstood. Of course, Prof. Lamb is perfectly aware of all this; but our point is that, as the question is one of getting correct ideas into the minds of students, this venerable and "Through the Looking-Glass" mode of referring to these terms would be better forgotten. Students, and even some writers, are all too prone to suppose that the component growths of angular momentum are $A\dot{p}$, $B\dot{q}$, $C\dot{r}$, and the equations are naïvely written as $A\dot{p}=L$, etc.

It is, by the way, very important, and very easy, to take the terms $A\dot{p}$, $-Bqr$, Cqr, and show how *each* of them arises.

We miss here what is certainly very instructive: the application of the hodograph to the motion of a rigid body—for example, a top. A sequence of vectors all drawn from a point O is erected in space to represent the successive values of the resultant angular momentum. The curve in space on which lie their extremities is the hodograph for the rigid body motion, and the resultant couple at each instant is represented by the velocity of a point which moves so that it is always at the extremity of the vector which at the instant represents the angular momentum.

In connection with holonomous systems, the only reference is to Hertz, though the fact that there are systems which are not holonomous for which Lagrange's dynamical method "fails," and which require special treatment, was pointed out by Ferrers long before Hertz's treatise appeared.

The paper of Ferrers (*Q.J.M.*, vol. xii., 1873) appeared six years after the publication of Thomson and Tait's "Natural Philosophy," but it is curious that there is not in the second edition (1883) of that treatise any hint of the existence of the peculiar systems of which Ferrers gave examples. In his review of the second edition of the "Natural Philosophy" (NATURE, vol. xx., 1879), Clerk-Maxwell, in his own inimitable way, directed attention to the introduction in that work of the method of Lagrange. "The two northern wizards were the first who, without compunction or dread, uttered in their mother tongue the true and proper names of those dynamical concepts which the magicians of old were wont to invoke only by the aid of muttered symbols or inarticulate equations." The spell of the "northern wizards" was not free from defect, but either their good fortune or their instinct preserved them from the examples in which the use of an incantation insufficiently guarded in its terms might have led to disaster.

This has not been the fate of every wielder of the magic wand of Lagrange. In the first issue, about twenty years ago, of an important treatise on "Rational Mechanics" a discussion of the motion of a coin rolling and spinning on a horizontal table appeared, in which the method of Lagrange was used with erroneous results. The error led the distinguished author to the invention of a new method, in which a set of general dynamical equations, which could be used instead of those of Lagrange, and were applicable in all cases, was set up. The error thus had the fortunate effect of enriching dynamical science. It is not, alas! the fate of all who make mistakes to rise on the stepping-stones of their errors to higher and better things.

In our opinion, recourse is had to the method of Lagrange in far too many cases. The student flies to it on the appearance of the least difficulty. A proper training in dynamics, which should be experimental as well as mathematical, would give students the power of solving problems of all kinds by the direct application of first principles. The use of Lagrange's equations does not develop this—indeed, it has a directly contrary effect. In this power the dynamical students and graduates of our universities are sadly deficient.

A good account of Lagrange's method is followed in Prof. Lamb's book by an exposition of Hamilton's dynamical method, and this in its turn leads to Jacobi's discussion of the integration of Hamilton's canonical equations by means of the complete integral of Hamilton's partial differential equation fulfilled by his so-called principal function S. The corresponding function S' connected with S by the relation $S+S'=\Sigma(pq)$ does not seem to be mentioned. A partial differential equation similar to, and yet curiously different from, that for S also holds for it. S is a function of the *q*s, *t*, and as many constants, which depend on the initial co-ordinates of the system, as there are independent co-ordinates; S' is a function of the *p*s, *t*, and the same number of constants as before, which, however, depend on the initial motion.

One or two examples of the solution of these partial differential equations—for example, Jacobi's discussion of the elliptic motion of a planet referred to three co-ordinates—would have added to the interest of what is in itself a very interesting chapter of an excedingly interesting book.

A. GRAY.

Maya Civilisation.

The Inscriptions at Copan. By Sylvanus Griswold Morley. (Publication No. 219.) Pp. xii+643+33 plates. (Washington: The Carnegie Institution of Washington, 1920.)

IN this large quarto volume of more than six hundred pages, efficiently illustrated, Dr. S. G. Morley has produced a work which may justly be regarded as of the highest importance. It is necessary to enforce this statement, almost with a feeling of shame, because there are so few individuals in this country who have the faintest idea what enormous strides have been made in the elucidation of Central American archæological problems since our own countryman, Dr. Maudslay, published the results of his explorations in a series of volumes, which Dr. Morley generously, but no less justly, describes as "easily the most important field contribution to Maya archæology." Those volumes might have been expected to give a lead to British archæologists and explorers; as a matter of fact, not only did no one appear in this country to carry on Maudslay's work, but the fine series of moulds of the principal Central American carvings, which he made at the cost of enormous labour and expense, lie buried in the cellars of the Victoria and Albert Museum, and not even an approximately representative series of casts taken from them is available to British students.

It follows that such a work as this is almost the despair of the reviewer. Most people have heard of the Aztec, but the earlier Maya civilisation is familiar to few even by name. Yet the Maya had evolved a remarkably fine art, an elaborate hieroglyphic script, and a very highly developed calendrical system long before the first manifestations of culture made their appearance in the Valley of Mexico. To render a full appreciation and critique of Dr. Morley's book intelligible to the general reader, it would be necessary to write an introduction to Central American archæology; to deal with it from the purely scientific point of view is impracticable within the limits of an ordinary review, so many and important are the problems which the author raises. It is possible, therefore, to give only the merest sketch of the subject-matter, and to add a few remarks on the author's method of handling his material.

The early Maya settlements are found scattered throughout the forested region of Chiapas, eastern Guatemala, western British Honduras, and northern Honduras. It is clear that they had already been abandoned and veiled in thick jungle before the arrival of the Spaniards. The group with which Dr. Morley deals is situated in Honduras, in the valley of the Copan River, and covers a site of 30–35 sq. km. The ruins consist of sculptured monolithic *stelae* and "altars," temples, pyramids, "plazas," and a great complex, known as the "main structure," which exhibits evident signs of growth by accretion through many years. The site, apart from its architectural and artistic importance, is of paramount interest from the fact that it includes by far the greatest number of dated inscriptions, about 40 per cent. of those recorded for the whole of the Maya area, indicating that the "city" was in continuous occupation for about 350 years. It is the inscriptions which constitute the principal theme of the book, and the author has dealt faithfully with every inscribed monument, not only discussing the content of every inscription, but also giving a bibliography of each.

With regard to these inscriptions a word of explanation is necessary. The only portions which can be read with certainty are those connected with the Maya system of reckoning time. As much as 50 per cent. of the entire *corpus* of these inscriptions deals with calculations relative to the calendar; the rest are probably religious, with, perhaps, a small proportion of what may be historical data. But, while dated monuments may thus be arranged in sequence according to Maya chronology, no indisputable method has yet been reached of correlating that chronology with European time. Dr. Morley, in a very scholarly appendix, makes the attempt. His views are of particular interest to the present reviewer, who, some years ago, was rash enough to put forward a scheme on similar lines, producing, however, different results. At the same time, Mr. Bowditch, one of the greatest pioneers in the interpretation of Maya glyphs, working on other evidence, came to the same conclusion. Dr. Morley's theory would make the Copan monuments date from about the close of the second century A.D. to the early part of the sixth century, about 250 years later than the dating of Mr. Bowditch and the reviewer. Dr. Morley's argument does not carry absolute conviction to the reviewer; but discussion is perhaps unnecessary. The author gives good *prima facie* evidence that a certain group of glyphs, which accompanies the so-called "initial dates," relates to eclipses of the sun and moon. With this lead these glyphs should soon be deciphered, and the question will then be capable of proof on astronomical grounds. In this connection it might be mentioned that Dr. Morley has apparently overlooked, in his otherwise excellent bibliography, two papers by Mr. Richard C. E. Long dealing with the correlation of Maya and European time, which were published in *Man* during 1918.

The origin of the Maya civilisation is also closely argued by Dr. Morley in a well-written appendix, but here he lays himself open to criticism. His theory that the Maya came from the region of the Panuco Valley in the north is well argued on general grounds, but he certainly lays too much stress on dates which have been found on two small objects—the Tuxtla statuette and the Leyden plate. Considering the ritual and mythological importance of certain calendrical dates in the Maya religious system, it is impossible to regard specimens of this class as belonging to the same category as monuments which are so obviously commemorative as *stelae*, altars, and the like. The Tuxtla statuette, which bears almost the earliest date known in Maya chronology, he accepts as belonging to the area where it was found—*i.e.* considerably to the north of the "classical" Maya area—in spite of the fact that the glyphs are carved in the same style as the Dresden manuscript, which is recognised as belonging to a later period than the Copan monuments. The Leyden plate, which is carved in the earlier style, and was found in the southern Maya region, he assumes, is a specimen which has "wandered"—a hypothesis which he dismisses in connection with the Tuxtla statuette. This savours of "having it both ways," and his theory would have gained strength had he admitted that portable objects such as these are really *hors concours* as regards local dating.

One mistake—and that really of relative insignificance—may be recorded. Dr. Morley states that the few original monuments brought from

Copan to England by Maudslay, such as Altar R and part of the frieze of Temple II., are in the Victoria and Albert Museum. As a matter of fact, all the original sculptures collected by Maudslay were transferred to the British Museum shortly after their temporary deposition at South Kensington.

In conclusion, Dr. Morley's work is scientific and scholarly. As a scientific man and a scholar he aimed at perfection; he has achieved a landmark. Can higher praise be given?

T. A. JOYCE.

The History of Determinants.

The Theory of Determinants in the Historical Order of Development. By Sir Thomas Muir. Vol. iii., *The Period* 1861 *to* 1880. Pp. xxvi+503. (London: Macmillan and Co., Ltd., 1920.) Price 35*s*. net.

THE period covered by this volume is perhaps the most important in the history of the subject. During that time three important branches of pure mathematics attained vast dimensions—invariant-theory, analytical geometry, and the general theory of algebraic numbers. In each of these, familiarity with determinants and their manipulation is essential, so a great many students mastered the determinant calculus, and applied it to a variety of problems. Incidentally, the properties of determinants aroused interest for their own sake; numerous papers dealing with them were published, and, above all, several treatises on the subject made their appearance, in which a compact notation replaced all the old cumbersome symbols, and practically all the theorems of the determinant calculus proper were expounded in a simple and orderly way.

What we may call the derivative part of the theory consists mainly of classifying determinants of special types. Thus in the present volume we have separate chapters on axisymmetric determinants, symmetric determinants, alternants, recurrents, Wronskians, Jacobians, etc. (sixteen chapters or so). Broadly speaking, these types come from two sources—either as the outcome of a particular research, not primarily concerned with determinants (thus continuants arose from the theory of continued fractions); or else from intrinsic characters belonging to the array from which the determinant is formed, as in the case of symmetric determinants. Of course, any special type of determinant can be specified *per se*; we are thinking rather of the way in which the discussion of particular types actually originated. A remarkable example is Smith's arithmetical determinant (p. 116), of n rows and columns, the value of which is the product $\phi(1).\phi(2) \ldots \phi(n)$, where $\phi(m)$ means the "totient" of m—namely, the number of integers prime to m and not exceeding it.

In a book such as this, one feature is almost sure to present itself. We shall find some excellent work unaccountably neglected, and results of first-rate importance only becoming generally known and appreciated after re-discovery, when their original authors are dead. The cases in this volume which strike the attention are those of Trudi and Reiss. Reiss's work on compound determinants goes back as far as 1867; the analysis of it on pp. 181–90 (in modern notation) shows its importance, and is worth study, because the theory of compound determinants is perhaps the one part of general determinant-calculus not yet fully reduced to its complete and simplest form.

In many applications the rank and elementary divisors of a determinant (or matrix) are of primary importance. The elementary divisors of an array depend upon the arithmetical or algebraical character of the field to which the elements of the array belong. Consequently, the determination of them does not properly belong to determinant-theory; on the other hand, the rank of an array is immediately calculable, on the assumption that we can calculate the "value" of any minor determinant, or, at any rate, decide whether it is or is not zero. It must often have been difficult for the author to decide when a theorem in matrices should or should not be considered one relating to determinants. Rank is referred to several times; apparently theorems about elementary divisors have been omitted. In the case when the elements of an array are ordinary integers it is clear from Smith's paper on linear indeterminate equations and congruences (1861) that he was then perfectly familiar with the existence and properties of elementary divisors; to that extent he anticipated the theory of Weierstrass, Frobenius, and others.

Opinions may differ about Sir T. Muir's choice of a subject on which to bestow his labour; some readers may regret that he did not select a branch of mathematics of a less circumscribed and subsidiary kind than determinant-theory undoubtedly is. But all will agree in admiring the ability and impartiality with which this labour of love has been accomplished, and rejoice to know that the fourth and final volume is nearly complete in manuscript. Histories of other branches of mathematics are badly wanted, and this work is a model of what such histories ought to be.

G. B. M.

Science and Farming.

(1) *The Small Farm and its Management.* By Prof. James Long. Second edition. Pp. 328. (London: John Murray, 1920.) Price 7*s.* 6*d.* net.

(2) *Farm Management.* By J. H. Arnold. Pp. vii+243. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1919.) Price 7*s.* 6*d.* net.

(3) *Types and Breeds of Farm Animals.* By Prof. C. S. Plumb. Revised edition. (Country Life Education Series.) Pp. viii+820. (Boston and London: Ginn and Co., 1920.) Price 16*s.* 6*d.* net.

(1) PROF. LONG is a well-known believer in small farms, and has written much to help the men who embark on such enterprises. In the present volume he brings together in convenient form a great deal of the information which the small farmer ought to possess if he is to make his work a success. At the outset he disclaims any intention of deluding his readers into the belief that fortune awaits the small holder. The 20-acre farm, he says quite frankly, will not bring much money, though it will provide a healthy occupation full of interest to those who really do their best. In the main, the scheme proposed is the production of finished products—milk, pork, poultry, or mutton. Corn scarcely enters into consideration excepting only to provide oats for the farm stock.

The information given is useful so far as it goes, but we should like to have seen some references to other books which would give fuller information on specific points. The idea of rural libraries is growing, and the present deficiency may not always exist. On such points as the feeding of animals an intelligent man might easily like more information; the latest author quoted is Wolff, and no reference is given to Dr. Goodwin's translation of Kellner's book.

Similarly, reference might have been made to the system of advisory officers now established over the country, whose function it is to deal with the questions an intelligent man asks, but which no book ever seems to answer. In spite of these minor defects, however, the smallholder will find this a useful book, both before and after he enters his farm.

(2) Mr. Arnold's is a different type of book; it deals with the principles of farm management so far as they have been enunciated, and though it is only small and printed in large type, it contains much that will interest the farmer as well as the student of agriculture. It is American; we know of no corresponding English book; and the figures quoted all refer to the pre-war period. An inquiry is recorded as to the rate of interest earned on farms in three States of the corn belt: for "landlord's" expenditure (which includes much of our "farmer's" expenditure) the annual return was $3\frac{1}{2}$ per cent., and in an exceptionally good region $5\frac{1}{3}$ per cent., after allowing 800 dollars for management salary; this, the author states, "probably represents about what the best general farms are doing." An interesting historical summary traces the development of American agriculture during the last 300 years, and shows that American farm practice is largely derived from English agriculture, modified, however, by the experience of the Indians. Livestock, poultry (excepting turkeys), most of the common grains, vegetables, grasses, and legumes all came from England, as also did the principles underlying the cultivation of the soil and the rotation of crops. It would be interesting to work out the interrelationships of British and American agriculture, for, if American agriculture developed from ours, British agriculture in the last twenty years owes a great deal to America.

(3) Prof. Plumb's book on "Types and Breeds of Farm Animals"—also American—brings out prominently the part played by the British Isles in the evolution of modern types of farm animals; the author draws a map showing the areas in which no fewer than twenty-eight important types were first bred. These have now gone out to all parts of the world, but buyers still come here to replenish their stocks.

The book gives probably the best account published of modern farm animals, and there are good illustrations of many of the best examples to be found to-day. Another very interesting feature is the history of the families which the author has diligently worked out; the leading families in America date back to about 1880, although in England they are much older. Pedigree is more important to a high-class cow than to a human being, and no animal without a clear record can enter the highest bovine circles. The best foreign buyers insist on a pedigree going back a good many years—a great advantage to the English breeder. But the records of the animals described by the author in America show that the American stockman is doing great things, while the book itself proves that the younger generation of American agricultural experts is thoroughly familiar with the characteristics of the breeds and with the uses to which they can be put. It is a book to make the British agricultural lecturer think.

E. J. R.

Our Bookshelf.

Animal Ingenuity of To-day. By C. A. Ealand. Pp. 313. (London: Seeley, Service, and Co., Ltd., 1921.) Price 7s. 6d. net.

MR. EALAND describes in a lively way the ingenious or apparently ingenious behaviour of a great variety of animals, and we strongly recommend his book of wonders to the young in years and to the young in spirit. It deals with such matters as the humble-bee's nest, the wasp that uses a little pebble for beating down the soil closing the entrance to its burrow, the animated honey-pots of the honey-ants, the aquatic beetle that taps the water-lily's store of air, the male water-bug called Zaitha, which is made to carry the eggs, and the male cuckoo's abetting of his "paramour's" foisting of her egg into another bird's nest, for he takes advantage of his likeness to a sparrowhawk to distract attention from the "nefarious" deed. This case of "mimicry" takes our breath away, and we must rest awhile. But Mr. Ealand's book is extraordinarily interesting, though he is sometimes not critical enough. There is a good account of birds' nests and eggs, though we do not believe in the woodcock's "all-too-conspicuous eggs." With the usual withered leaves around them they do not seem to us to be conspicuous at all. Of courtships, migrations, modes of hunting, engineering triumphs, parental care, and of the whole gamut of animal behaviour, Mr. Ealand has vivid illustrations to give, and we should like it all, both old and new, without reserve, if he were a little more careful. Let us give one example. As he himself says: "Friendship between a crab and a pond-mussel seems to savour of the improbable," and we should think it did, for, friendship apart, the pea-crab in question lives in the sea. We have referred to credulity and inaccuracy, but we must make another criticism of what, after all, we regard as a wholesome book. Is it right and proper to quote long passages within inverted commas without telling us who wrote them? The illustrations of the book are very clever.

Prospector's Field-book and Guide. By H. S. Osborn. Ninth edition, revised and enlarged by M. W. von Bernewitz. Pp. xiii+364. (London: Hodder and Stoughton, Ltd., 1920.) Price 12s. 6d. net.

A QUANTITY of new material has been added to this handbook since the last edition was published in 1910. Some of it, particularly those portions referring to the description of ore deposits and ore-testing, has been drawn from the bulletins of the United States Geological Survey and the Bureau of Mines, and various publications of schools of mines and the technical Press. Other additions which have been made are lists of outfits suitable for prospecting, fresh field tests, notes on sampling, and a new chapter dealing with alloy minerals. In face of the claim that the new edition is thoroughly up-to-date, it is curious to find "chloride of formyl" given in the appendix as the chemical name for chloroform. A glossary of more than twenty pages gives brief explanations of the technical terms in use, and, in addition, a very full index is provided.

Dictionary of Explosives. By A. Marshall. Pp. xiv+159. (London: J. and A. Churchill, 1920.) Price 15s. net.

THIS book is essentially a work of reference for the specialist in explosives, and has little interest for the general reader. It consists of three sections. The main section is descriptive, and arranged alphabetically. This is prefaced by a list of explosives classified according to the uses for which they are intended, and followed by a list of the separate ingredients showing the explosives in which each is used.

In the dictionary the composition and some of the properties of a large number of explosives are given, including many of foreign origin, but only those explosives are dealt with which are, or have been, in practical use in the industries. It is easy to see that the author has been handicapped by the reticence of explosives manufacturers with regard to the composition of their products, only about half the authorised explosives mentioned in the 1914 Annual Report of H.M. Inspectors of Explosives, for instance, being described. For the same reason, many of the descriptions lack the detail desirable in a work of this kind.

A considerable amount of useful and accurate information is, however, presented in a compact and handy form. The book is well printed and free from typographical errors.

W. L. TURNER.

Report on the Quantum Theory of Spectra. By Dr. L. Silberstein. Pp. iv+42. (London: Adam Hilger, Ltd., 1920.) Price 5s. net.

THIS small and unpretentious work is one of great value. Many important developments in the application of the quantum theory to spectra, especially to the fine structure of spectrum lines, have taken place during the last few years, and these are almost entirely due to workers in other countries. The literature of the subject is very inaccessible to English readers, who find it difficult to obtain any real idea of the fundamental advances which have been made, or of the logical suppositions on which such advances rest. Dr. Silberstein would have done good service if he had only collected together the original papers, in translation, as they stand. He has, however, done much more. The matter is presented as an orderly scheme, and great discrimination has been shown, so that there is nothing of real importance omitted from the work. At the same time, the author has modified the original treatment in many respects, and apparently always to its advantage. The work is especially noteworthy in that it gives a clear view of the problems which still await solution. We can give nothing but praise to this book, and can recommend it without reserve to those who are anxious to have a simple and not very mathematical account of a subject which is now fundamental in physical theory.

Smithsonian Physical Tables. Seventh revised edition. Prepared by F. E. Fowle. Pp. xlvi+450. (Washington: Smithsonian Institution, 1920.) Price 18*s*. net.

SINCE the sixth edition of this standard volume of tables was reviewed in NATURE for July 5, 1915, extensive changes have been made, in the form of new data on both new and old topics. The volume has grown to 450 pages, and the number of tables given from 409 to 579. The new tables include useful material dealing with astrophysics, meteorology, geochemistry, atomic and molecular data, colloids, photography, etc. A great improvement is the renumbering of the pages; in the sixth and fifth editions new matter was inserted without altering the paging, with the result that there was no logical sequence of tables. This fault has now been rectified, and the tables have been arranged in order according to subject. The volume can be obtained from the London agents for the Smithsonian Institution, Messrs. W. Wesley and Son, 28 Essex Street, Strand, W.C.2.

Letters to the Editor.

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

The Late Srinivasa Ramanujan.

IN the notice contributed to the issue of NATURE for June 17 last, Prof. Hardy was unable to give any account of the late Srinivasa Ramanujan's early life, and made no attempt to describe his appearance or character. The June number of the Journal of the Indian Mathematical Society has memorial articles by Prof. P. V. Seshu Aiyar, of Madras, and Dewan Bahadur Ramachandra Rao, and the first of these gives biographical details that have not hitherto been published in England.

Ramanujan was born at Erode on December 22, 1887.[1] His mother, a shrewd and cultured lady who is still alive, was the daughter of a Government official at Erode, his father a cloth-merchants' accountant at Kumbakonam, and it was in the latter town that his boyhood was spent. As is usual with Brahmin boys, he was sent to school at the age of five; before he was seven he was transferred to the Town High School, and there he remained until 1904, leading an inactive life and building an astounding edifice of analytical knowledge and discovery on the foundation of Carr's "Synopsis of Pure Mathematics," the only book on higher mathematics to which he had access. Having matriculated already in 1903, he went from the Town School to the Government College at Kumbakonam, but in January, 1905, his progress was stopped, and a scholarship on which he was dependent forfeited, owing to a weakness in English of which those who recall his fluency and the range of his vocabulary in later life will be surprised to learn.

Of Ramanujan's next few years no clear account has come to my notice. After a stay at Vizagapatam, he joined the Pachaiyappa's College at Madras, but, failing in his first examination, he gave up the idea of taking a university course. A nomadic period, during which his own researches progressed, came to an end in the summer of 1909, when he married and returned to Madras in search of permanent employment. There Prof. Seshu Aiyar, who had seen something of him at Kumbakonam in 1904, gave him a letter of introduction to Mr. Ramachandra Rao, at that time district collector at Nellore. Possibly Ramanujan was too timid to make direct use of the letter; Mr. Rao's story follows in his own words:—

"Several years ago, a nephew of mine, perfectly innocent of mathematical knowledge, spoke to me: 'Uncle, I have a visitor who talks of mathematics. I do not understand him. Can you see if there is anything in his talk?' And in the plenitude of my mathematical wisdom, I condescended to permit Ramanujan to walk into my presence. A short, uncouth figure, stout, unshaved, not over-clean, with one conspicuous feature—shining eyes—walked in, with a frayed note-book under his arm. . . . He was miserably poor. He had run away from Kumbakonam to get leisure in Madras to pursue his studies. He never craved for any distinction. He wanted leisure; in other words, simple food to be provided for him without exertion on his part, and that he should be allowed to dream on.

"He opened his note-book and began to explain some of his discoveries. I saw quite at once that there was something out of the way, but my knowledge did not permit me to judge whether he talked sense or nonsense. Suspending judgment, I asked him to come over again. And he did. And then he had gauged my ignorance and showed me some of his simpler results. These transcended existing books, and I had no doubt that he was a remarkable man. Then step by step he led me to elliptic integrals, and hypergeometric series, and at last his theory of divergent series, not yet announced to the world, converted me. I asked him what he wanted. He said he just wanted a pittance to live on so that he might pursue his researches. It is a matter of considerable pride to me that I was in some way useful to this remarkable genius in his earlier days. In a year's time, I introduced him to Sir Francis Spring (the president of the Madras Port Trust), who gave him a sinecure post in his office."

The last two sentences conceal that, throughout the interval of a year, not only was Mr. Rao trying to find some scholarship for which Ramanujan's original work might qualify him in spite of failure in examinations, but he was also maintaining Ramanujan in Madras at his own expense.

At the Port Trust Ramanujan remained until Dr. G. T. Walker, on an official visit to Madras, was made acquainted with his history, and joined forces with Sir Francis Spring. Their combined attack on the University and the Government of Madras resulted in the creation of a research studentship, which was of sufficient value to set him wholly free, and secured him access to the lectures and the library of the university; he was in possession of this studentship when I met him in 1914.

To Prof. Hardy's account of his correspondence and my intervention I have little to add. My task was an easier one than I anticipated. From the Government and the University of Madras I had every encouragement. On the other hand, Ramanujan was ready to put complete confidence in me simply because to him and his friends I came from outside the official machine. The only cold water was thrown

[1] This is the year given by Seshu Aiyar, and the date is consistent with the undisputed statements that Ramanujan was twenty-six when he came to England and thirty-two when he died; I have no doubt that the date 1888 commonly given is due to a natural misinference from these last figures.

from the India Office in London, but my efforts had succeeded before this reached Madras.

Throughout his life Ramanujan kept religiously to a diet of vegetables, fruit, and rice, and in England, outside his own rooms, food and clothing were a continual trial to him. I have known him ask with unaffected apologies if he might make his meal of bread and jam because the vegetables offered to him were novel and unpalatable, and with a pathetic confidence he has appealed to me for advice under the discomforts of shoes and trousers. His figure was short, and until his health gave way it was stout. His skin, never of the darkest, grew paler during his stay in England. His head gave the impression, which photographs show to have been false, of broadening below the ears, which were small. His face was clean-shaven, with a broad nose and a high forehead, and always his shining eyes were the conspicuous feature that Mr. Rao observed them to be in 1910.

Ramanujan walked stiffly, with head erect, and his arms, unless he was talking, held clear of his body, with hands open and palms downward. In conversation he became animated, and gesticulated vividly with his slender fingers. He had a fund of stories, and such was his enjoyment in telling a joke that often his words struggled incomprehensible through the laughter with which he anticipated the climax of a narrative. He had serious interests outside mathematics; he was always ready to discuss whatever in philosophy or politics had last caught his attention, and Indians speak with admiration of a mysticism of which his English friends understood little.

Perfect in manners, simple in manner, resigned in trouble and unspoilt by renown, grateful to a fault and devoted beyond measure to his friends, Ramanujan was a lovable man as well as a great mathematician. By his death I have suffered a personal loss, but I do not feel that his coming to England is to be regretted even for his own sake. Prof. Hardy speaks of disaster because of the hopes he entertained. If he pictures Ramanujan as he might have been throughout a long life, tormented by a lonely genius, unable to establish effective contact with any mathematicians of his own class, wasted in the study of problems elsewhere solved, Prof. Hardy must agree that the tragedy averted was the greater. Shortly before he left England, at a time of great depression, Ramanujan told me that he never doubted that he did well to come, and I believe that he would have chosen as he did in Madras in 1914 even had he known that the choice was the choice of Achilles.

E. H. NEVILLE.

University College, Reading, December 7.

The Mechanics of Solidity.

THE letters under this title from Mr. R. G. Durrant, Mr. V. T. Saunders, and Dr. H. S. Allen (NATURE, December 2 and 23 and January 6) are very interesting and suggestive, but melting points are of little value in discriminating between the hard and soft varieties of the same steel, and molecular weights, volumes, and frequencies have not yet any very definite significance in relation to solid metallic mixtures. My initial proposal that certain simple measurements might with advantage be substituted for the complicated tests now used by engineers and metallurgists was a "practical," if myopic, one; it has evidently been misunderstood, so perhaps I may be allowed to state the case in greater detail.

By "solidity" I meant to imply all the properties covered by the adjectives strong, elastic, stiff, flabby, tough, hard, mild, brittle, and many others. Solidity may eventually be specified in terms of atoms and molecules, but the specification would be very complicated, and I cannot at present "take sanctuary among the atomists"; solidity may be referred to its origins or to its manifestations, and for the moment the latter course seems to be the only practicable one. Solidity may be analysed in various ways, but Hertz has explained the meaning of "strength" very clearly, and it is convenient to take strength as the starting point; solidity seems to comprise elasticity, strength, and something more, namely, the variation of elasticity and strength with deformation. Isotropic solidity appears to be a continuum which fades into fluidity; it would be very desirable to know how many dimensions define this continuum, but the problem of mechanical testing is rather simpler, viz. How many dimensions are important, and what is the best way to measure them?

For the convenience of readers of NATURE who are unfamiliar with current engineering practice I may refer to the recent report of the Steel Research Committee of the Institution of Automobile Engineers; this, of course, is primarily a report on certain metals, but incidentally it serves as a report on the tests employed. The procedure is as follows: Test pieces are cut to three standard shapes and broken under prescribed conditions; four different measurements are made on the first piece and one measurement on the second and third pieces. The second and third tests are each repeated three times, and Brinell measurements are made on all test pieces. The report represents practice of a very high standard, and the foregoing programme is carried out thrice for each of some two hundred mechanical varieties of twenty chemically distinct steels; the report records about ten thousand measurements in all, each of them involving considerable care and labour. I feel sure the committee would endorse my view that in certain tests the concordance of nine individual measurements leaves a great deal to be desired; whatever these tests may determine, they do not determine anything very accurately.

To obviate all possibility of misconception, I should state the proposed alternative plainly. Six simple mechanical properties of a metal—density, two elasticities, and their temperature coefficients—can be measured fairly easily and with some precision; the temperature coefficient of intrinsic energy makes a doubtful seventh. The connection between these properties and practical engineering is admittedly obscure, but in the writer's limited experience this is true also of some of the other tests. None of the six properties referred to are customarily measured, but the single one that is well known—the thermal coefficient of density—bears a decided general resemblance to a strength, the particular strength to which Hertz has appropriated the word "hardness." My suggestion is that these six properties, and possibly others, would be worth investigating, and that some of them may prove convenient indicators of mechanical consistency; they would certainly serve as indicators of uniformity, and it may be doubted whether the other tests do much more.

Both Mr. Durrant and Mr. Saunders refer to the question of definitions, and these are certainly required for many of the attributes of solidity; hardness, however, appears to be an exception, and has been defined by Locke, Hertz, and Clerk-Maxwell. A definition established in the seventeenth century and supported by such high authorities cannot lightly be set aside; it seems that Mr. Saunders is right, and that "Brinell hardness" is not hardness. Verbal difficulties of this kind beget confusion, but, as Locke says: "Vague and insignificant forms of speech and abuse of language have so long passed for mysteries of science; and hard and misapplied words, with little or no meaning, have, by prescription, such a right to be mistaken for deep learning and height of speculation, that it will not be easy to persuade, either those who speak or those who hear them, that they are but the covers of ignorance and hindrance of true knowledge." J. INNES.

12 Edward's Road, Whitley Bay,
Northumberland, January 4.

Stellar Development in Relation to Michelson's Measurement of the Diameter of Betelgeux.

ABOUT thirty-five years ago Sir Norman Lockyer held that certain of the reddish stars are probably in an early stage of development. It was given out yesterday in Press dispatches from Chicago that Prof. Michelson had announced to the American Physical Society and the American Association for the Advancement of Science that the experiments with the Mount Wilson 8-ft. reflector at Pasadena, California, had enabled him successfully to measure the diameter of α Orionis by interference methods, and that the diameter is about 300,000,000 miles, or approximately three hundred times that of our sun. The volume of Betelgeux is therefore about 27,000,000 times that of the sun; so that, if concentric with the sun, the surface of Betelgeux would extend about to the orbit of Venus.

Now Betelgeux is a single star, and the mass, therefore, is not definitely known; yet if the mass be not immensely larger than that of the sun we shall have to conclude that the density is slight. Hence this red star is in an early stage of development, which confirms Lockyer's views first put forth about 1886. If we make the density equal to that of our sun, Betelgeux could not fill the orbit of Venus without giving the star 27,000,000 times the solar mass, which is quite inadmissible.

Dr. Elkin's Cape heliometer measures made the parallax of Betelgeux 0·023″ and of Sirius 0·37″, so that Betelgeux is only sixteen times more remote than Sirius; and if we neglect a slight difference in magnitude, largely due to colour, we may conclude that Betelgeux gives about 256 times the radiation of Sirius, which is itself ten-thousandfold more luminous than our sun. Accordingly, Betelgeux gives about 2,560,000 times the sun's light. Now with any admissible mass of Betelgeux this immense luminosity indicates an early stage of development, corresponding to the large absolute diameter found by Michelson.

T. J. J. SEE.

Naval Observatory, Mare Island,
California, December 30.

Heredity and Variation.

IN a brief criticism of Sir Archdall Reid's letter to NATURE (November 25, p. 405) in which he sought to attach new meanings to certain well-recognised biological terms, I pointed out (NATURE, December 2, p. 440) that if his contention that all characters are both innate and acquired in exactly the same sense and degree is true, then it would follow that all variations are also of one type, while experimental biologists are universally agreed that this is not the case. At least two categories of variations are postulated, whether they be called blastogenic and somatogenic, germinal and somatic, mutations and fluctuations, genotypes and phenotypes, innate and acquired, karyogenetic and cytogenetic, or by any other terms which contrast an inherited and a non-inherited departure from the parental type.

Yet Sir Archdall Reid's only attempt to answer my criticism that the universally admitted existence of two types of variations undermines his whole position is the very weak one of quoting Darwin's tentative theory of pangenesis, which no modern biologist would consider seriously as an explanation of heredity, variation, or anything else. He says (NATURE, January 6, p. 596): "If we believe with Darwin in his theory of pangenesis that the parts of the child are derived from the similar parts of the parent . . . the distinction between variations and modifications vanishes." But we do not believe anything of the kind. The advance of knowledge made any such belief impossible a generation ago. Even Sir Archdall Reid himself admits this when he says later in the same letter (p. 598) that "Darwin . . . went hopelessly wrong . . . in his theory of pangenesis"! Why, then, did he quote it as a reply to my criticism?

This is only one, but it appears to me to be the most fundamental, of the many contradictions in which Sir Archdall Reid has landed himself in his attempt to remodel the usage of well-established terms to his own liking. R. RUGGLES GATES.

King's College, Strand, W.C.2, January 15.

The Mild Weather.

A SPELL of mild weather set in shortly before Christmas and continued until the second week of January. It followed a sharp touch of frost, when the sheltered thermometer at Greenwich registered 16° on December 13, and for two consecutive days, December 12 and 13, the temperature remained below the freezing point, whilst for ten consecutive days the thermometer did not rise to 40°. A few facts relative to the mild spell may be of interest.

Greenwich temperatures are used throughout; they refer to the civil day, commencing at midnight, and naturally differ at times from the ordinary meteorological day readings ending at some hour between 7 and 9 a.m. The results used are absolutely comparable.

The period dealt with is from December 21 to January 10, twenty-one consecutive days. This period for 1920–21 was warmer than any corresponding period in the last eighty years—since 1841. The mean maximum temperature, the mean minimum temperature, and the mean temperature obtained from the mean of maximum and minimum were all the highest. These three readings for the 21-day period in 1920–21 are: 52·0°, 43·4°, and 47·7° F. The next highest means, for 1872–73, are 51·2°, 42·8°, and 47·0°, followed by 1915–16 with 50·9°, 41·9°, and 46·4°, and by 1852–53 with 51·3°, 40·7°, and 46·0°.

Dealing with the first ten days of January this year, they are the warmest on record for this period for eighty years, with the mean (mean maximum and minimum) 47·8°, followed by 1873 and 1916 with 46·8°, and by 1853 with 46·0°.

Considering the days with a temperature of 50° or above for the 21-day period, December 21 to January 10, there were 17 days in 1852–53, 15 in 1872–73, 14 in 1920–21, and 13 in 1876–77. The absolute maximum temperature in the recent warm period rose to 56° on three days, and in the past there has been no temperature higher than 57°.

The mild weather we have just passed through had ten nights with the minimum temperature at 45° or above, which is more than in any corresponding period since 1841, and in all there were previously only two periods with more than five such warm nights.

The mean temperature for the twenty-one days to January 10 this year is about 10° warmer than the normal. CHAS. HARDING.

65 Holmewood Gardens, S.W.2, January 15.

Nature of Vowel Sounds.

By PROF. E. W. SCRIPTURE.

II.

IN a preceding paper (NATURE, January 13, p. 632) it was explained that the analysis of vowel curves showed (1) that the fundamental, or voice tone, must consist of a series of puffs, and not of smooth vibrations; and (2) that the overtones, or the specific vowel tones, must be quite independent of the fundamental—that is, they can just as well be inharmonic as harmonic to it.

The Manufacture of Vowels.

For the manufacture of vowels Helmholtz used tuning-forks that gave smooth vibrations and not puffs; moreover, the only overtones tried were harmonic to the fundamental. Some years ago I made an attempt to manufacture vowels on the principles discovered by the analysis of vowel curves.

The fundamental was produced by a puff siren (Fig. 7) similar to the familiar one of Seebeck.

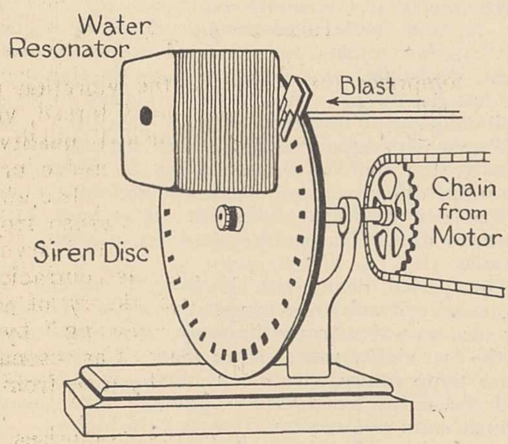

FIG. 7.—Puff siren with water resonator.

As a slit passes across the blast tube a jet of air issues for an instant. This is heard as a faint puff. As the disc is rotated more rapidly the puffs come oftener, until at one region a low tone appears. With still greater rapidity the pitch of the tone rises.

When a brass resonator is placed in front of the tube of the siren it sounds loudly when the frequency of the puffs is the same as that of the tone of the resonator, and also less loudly when it is in some other harmonic relation. For inharmonic relations the resonator is silent. Resonators with hard wells, therefore, cannot be used to produce sounds containing inharmonic components.

The soft-walled resonators of the mouth can be imitated by spreading pieces of meat over wire frames. As this has its inconveniences, a wire frame may be covered with a layer of absorbent cotton soaked in water. Such a resonator is shown in Fig. 7. The walls are quite inelastic. When such a water resonator is placed in front of the tube of the siren, it responds equally well to all tones of the siren, whether harmonic or inharmonic. Two or more resonators can be combined to meet the requirements for various vowels.

The theory of this vowel siren can be illustrated by the diagrams in Fig. 8. The puffs come as sharp blows almost instantaneous in character; they are indicated by the crosses. When such a blow strikes a resonator with soft walls, it arouses a vibration in the cavity that dies away very rapidly, as is indicated in the first line of the figure. The vibration is entirely gone before the next puff hits it. The response of the resonator is quite independent of the frequency of the puff. When, however, a puff strikes a resonator with hard walls, it arouses a vibration that dies away

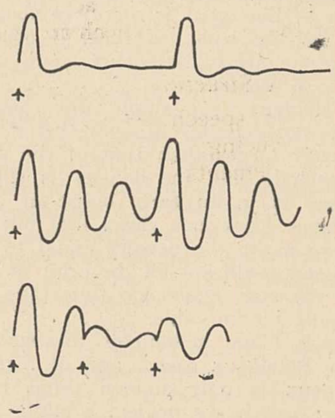

FIG. 8.—Vibrations in a resonator in response to puffs. The puffs are indicated by the crosses. The first line shows the response of a resonator with soft walls. In the second line the puffs hit a resonator with hard walls in such a way as to maintain strong vibrations. In the third line the puffs hit the same resonator in a way to produce little or no effect.

very slowly. When the next puff comes, the result depends on its relation to the vibration still going on in the cavity. If the puff hits the resonator at a moment when its frequency would be a sub-multiple of the frequency of the resonator, then it will reinforce the vibration and make the resonator tone louder. This is illustrated in the second line of the figure. If, on the other hand, it hits the resonator at a moment one-half a period short of a harmonic relation, it will kill the vibration it finds. A very weak tone may be aroused by puffs with a frequency that is not a sub-multiple of the frequency of the resonator, but no strong response can be obtained outside the harmonic relation.

The siren with water resonators was constructed with the aid of the Hodgkins fund of the Smithsonian Institution of Washington. It produced most of the typical vowels with success. Under the Carnegie Institution the work was continued with an attempt to imitate more closely the conditions in the living body. Although the cheeks can be represented by water resonators, the roof of the tongue is somewhat more difficult; the roof of the mouth is quite an approach to a hard resonator. To imitate these conditions, a resonator was made of a skull supplied with cheeks and a tongue of gelatine. The tongue was removable, so that models of different forms could be inserted. The voice tone was obtained from a vox humana organ-pipe. The ultimate object was to find vowel resonators that would respond with specific vowels to any tone. These were then to be mounted on a reed organ as an extra register. All tones issuing from the organ could be made to pass through one of the vowel cavities, and the organ would thus sing the vowels. In most singing the consonants are a subordinate matter, and such an organ would aid the singing of a choir or a congregation. The beauty of such a vowel register in a large organ in a cathedral is quite beyond imagination. This investigation was also supported by the Hodgkins fund, but was discontinued on account of the work required for the study of speech curves.

The Structure of Vowels.

The study of speech curves and the making of vowel-producing instruments show that two groups of elements are to be found in a vowel.

The first is the voice tone. Three properties of this tone are to be considered. The pitch of the tone is given by the rapidity with which the laryngeal puffs are repeated. If V indicates the number of puffs per second, then $V=f(t)$ is the general expression of the fact that the pitch of the voice tone depends on the elapsed time. It might be supposed that, in singing a vowel on a given note, the pitch would remain constant. A study of a record by the tenor Caruso (not yet published) shows that he never keeps his voice on a constant pitch during a vowel, but makes continual small changes. A study of the vowel "oh" used as an interjection shows that the pitch of the voice tone changes to express the emotion and the meaning of the interjection according as it is spoken to express sadness, admiration, or doubt. In fact, it is quite possible to obtain an equation for V for each of the three cases. In ordinary speech the pitch of the voice tone changes from instant to instant. Every individual vowel has a melody of its own. This melody varies with the emotion, the meaning, and possibly other factors.

The intensity of the voice tone depends on the energy of the puffs from the larynx. If I indicates the puff energy, then $I=f(t)$ expresses the fact that the intensity varies from moment to moment. The speech curves show changes of intensity that express emotion and meaning. Even in song—as Caruso's curves show—the intensity is constantly varied in a way that makes his song a production of art, and not a mechanical performance.

The third factor of this group is the musical character of the voice tone. This depends on the *shape* of the puff from the larynx. The matter is of such importance that the following statement seems to be needed.

After a tuning-fork has been struck its vibrations slowly die away. Its curve is really not that of a simple sinusoid, but that of a frictional sinusoid

$$y=a.e^{-\epsilon t}\frac{2\pi}{T}t, \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where y is the elongation at the moment t, a the amplitude or maximum elongation, T the period, e the basis of the natural system of logarithms, and ϵ the factor of friction or damping. The period T is affected by the factor of friction, but the amount is so small that it can be neglected here. The effect is to cause a decrease in the amplitude. When the value of ϵ is great, the curve is that of a sharp puff. When it is less, the puff is more gentle. If it were 0, the ordinary simple sinusoid would be obtained.

The puff from the larynx may be of a complicated form that should be represented by the sum of a series of frictional sinusoids. The complete equation would be

$$v=\Sigma a.e^{-\epsilon t}\sin\frac{2\pi}{T}t. \quad . \quad . \quad . \quad . \quad (2)$$

This comprises the whole of the vibration of a single puff. It is a free, and not a forced, vibration. The musical or unmusical quality of the voice depends solely on the presence or absence of the various members of (2). The quality of the voice that distinguishes a Caruso from a costermonger lies exclusively in the laryngeal puff. This fact is of importance as contradicting the almost universally accepted theory of vocal training that is based on "tone-placing" by the supposed action of the vocal cavities as resonators to give the musical quality to the tone from the larynx.

The other group of elements comprises the tones aroused in the vocal cavities. A puff striking a cavity arouses one or more vibrations of the form of a frictional sinusoid as in (1). Each cavity will have its own factor of friction and its own period. As shown by the vowel siren, this response will be a free vibration independent of the voice tone and the periods that go to the vibration that makes up the puff. Every change in the sizes or openings of the cavities will alter the periods of these vibrations. The possible combinations for the cavities of the chest, pharynx, mouth, and nose provide for an almost endless variety of vowels.

The speech curves show quite unexpectedly that there is no such thing as a constant vowel. The vowel "o" in "so" changes its specific vowel character from beginning to end. The least change is found in German; more change appears in American. There is so much change in English that an American hears the vowel "o" as a sound starting like "oh" and ending like "oo." The statement that this English vowel is a diphthong composed of two vowels is incorrect. The vowel is a single sound that gradually changes greatly in character. There is no objection to calling it a diphthong provided it be recognised—as the speech curves show—that all diphthongs are really single vowels that change greatly in character. At the same time, it must be recognised that what is called a single vowel may change even more in character than a so-called diphthong; the change in a very short vowel, as in "but," is often surprising.

Just what constitutes the differences between the different vowels is a problem at present beyond the reach of science. The ear tells us that there are many sounds which we group together under the type "ah"; many others that would go to form the type "oo," etc. The speech curves show that the multiplicity of varieties under each type is almost beyond belief. In a general way we know that the impression from "ah" is that of a higher tone than from "oo," from "ee" higher than from "ah," and so on. All details of the tones in a single vowel are lacking. Every investigator has differed from every other one in regard to what tones constitute any particular vowel. As shown in this article, we can get so far as to say on what principles a vowel is built up. We can even get curves of the vowels of an accuracy that leaves nothing to be desired. We have not, however, any method of analysing these curves accurately into a series of frictional sinusoids with independent periods and factors of friction. We must probably wait for some mathematician to do for this problem what Fourier did for harmonic motion.

Toxic Root-interference in Plants.

THE earlier investigations of the late Mr. Spencer Pickering at the Woburn Experimental Fruit Farm on the action of grass on fruit trees, which were described in the third (1903) and thirteenth (1911) reports issued from that station, sufficed to show that, in spite of some variability in degree, there is a definite deleterious effect on the health and development of fruit trees caused by grass grown immediately around them. That this is a general result and not a matter of special soil or other local conditions at Woburn has been demonstrated by independent experiments conducted in this country at Long Ashton, Wisley, and other places. So marked is the crippling effect of the grass in some cases that death of the trees has resulted. On the other hand, the presence of numerous grass orchards in apparently healthy and vigorous condition in many parts of the country made the existence of any direct toxic action on the part of the grass, such as Mr. Pickering was led to postulate, appear doubtful. It was evident that the action, if any, must be relatively complex, and the later work at Woburn now shows that this is so. In the seventeenth (1920) annual report from that centre new evidence is recorded which indicates not only direct toxicity of grass on fruit trees, but also a similar effect for any one plant on another when the two are grown in close association.

It is therein claimed that the action of grass is shown to be due to toxic substances derived from the grass, and is not the indirect result of any adverse effect on soil conditions as regards aeration, available moisture, or plant food. In a series of experiments in which apple trees were grown in pots and the grass in shallow, perforated trays resting on the soil of the pots, the injurious effect was secured, notwithstanding that the grass roots, by being confined to the soil in the tray, could neither impoverish the soil in the pot below, nor deprive it of oxygen or water. A similar result was obtained when the grass was grown in sand, instead of soil, in the perforated trays. The presence of grass roots in the soil in which the tree was growing was thus immaterial for the manifestation of the dwarfing effect, and it follows that nothing which might be abstracted from the soil by them could be held accountable for the results. The converse view that grass added to the soil something deleterious to the tree appears to offer the only explanation, the toxic material presumably being conveyed from the trays to the soil in the pots by means of the drainage water from the former. Direct evidence was secured on this point by utilising for watering the trees the leachings from the grass trays, the trays in this case not resting on the soil of the pots, but being placed elsewhere. The injurious effect on the tree was as marked as before. When, however, the leachings were allowed to stand for twenty-four hours exposed to the air before being used for watering the pots, the trees apparently were unaffected.

It was considered by Mr. Pickering that these experiments prove that the leachings contain an oxidisable substance derived from the roots of the grass which in its unoxidised form is detrimental to the growth of the trees, but after oxidation is no longer of a toxic character. The suggestion that it is nothing more than carbon dioxide given off by the grass roots was, according to him, disproved by the results of a series of experiments in which the plants were grown in pots as above, "with or without a surface crop in the trays, watering them in one case with ordinary water, in another case with a saturated solution of carbon dioxide, and in a third case with clear lime water, which, since lime absorbs carbon dioxide, would presumably have the reverse effect of the carbon dioxide water." They were of a purely negative character, and in no way indicated that the toxic action of the surface crop was modified by the differential treatment. Also bearing on this point are observations, direct and indirect, in several of the numerous series of experiments made which tend to show that the toxin after "oxidation" actually serves as a nutrient to plants exposed to its action. As to the nature of this substance and the manner in which it is communicated by the roots to the soil, no positive views are put forward, but Mr. Pickering held that there was no reason to assume that it is excreted by the roots, and he was inclined to attribute its origin to the débris which roots furnish to the medium in which they grow.

The later phases of Mr. Pickering's investigations were mainly directed towards proving that the grass injury to fruit trees is only a particular case of the action of one growing crop on another. By means of experiments on lines similar to those already reviewed, he showed for a wide variety of plants a corresponding toxic effect, and, moreover, demonstrated that the action is reciprocal. It is not confined to plants of a different kind; it is at least equally marked when the associated plants are similar. Further, it follows that the individual plant tends to restrict its own growth through the toxin which it produces so long as that remains "unoxidised" in the immediate range of the root system.

A new light is thus thrown on the question of soil drainage, it being evident that soil conditions facilitating rapid removal of the toxin or its oxidation must tend to promote healthier growth, provided that food supplies do not escape. Differences in efficiency of drainage may accordingly be held to account for the divergences of grass effect on trees which have been recorded in various localities.

With every plant exerting a direct toxic effect on all others within its range, the phenomena of root-interference do not merely represent the outcome of competition for food supplies. Mr. Pickering gave particular attention to the aspect of the case where similar plants are grown massed together, and his observations are interesting not only in themselves, but also because of considerations raised by them of economic significance as applied to agricultural and horticultural crops. He found that where the mass of soil available is below a certain limit, the total amount of plant growth produced is independent of the number of plants present. This holds whether the individual plants are grown with their roots in separate compartments of the soil-containing receptacle, so that root-interference is eliminated, or in a similar-sized vessel without divisions which permits unrestricted root-interference; but it applies only to cases where the plants are of the same age. When some are younger than others, the latter grow more vigorously at the expense of the former in the undivided containers, but the total combined growth falls considerably short of the amount which the mass of soil is capable of producing with plants of equal age. The latter point is, however, reached when plants of unequal age are grown in the divided vessels with no root-interference. In such cases the toxic action of the older plant on the younger was thus definitely illustrated where root-interference was possible and the available growth standard was not nearly reached, indicating that the plants were prevented from utilising all the nutrient present.

The question of range of root-interference has become latterly of considerably increased importance in fruit culture. The present high cost of labour has driven fruit-growers to consider how to reduce the expenses of cultivation of their orchards and plantations. In some cases this has been attempted by grassing them down, but the trees generally suffer so severely that this method can be practised successfully only where local conditions minimise grass influence. Cover cropping, followed by the ploughing in of the cover crop to serve as green manure, is also receiving attention, particularly on account of the increasing difficulty of obtaining adequate supplies of farmyard and stable manure. Where the trees are grown on strong and relatively deep-rooting types of root-stocks, such as the stronger free stocks for apples, the toxic effect of the cover crop or grass may be relatively negligible, provided that the soil is deep and well-drained. With superficial rooting types of root-stock, such as the Paradise or dwarfing stocks for apples, however, the toxic influence of the surface crop will certainly be more strongly marked, and may be sufficiently pronounced to render grassing or cover cropping other than for periods of short duration not only dangerous in many cases, but entirely impracticable in some. The use of the latter forms of root-stock is accordingly open to objection on this score, and, in so far as the grower may be debarred from these alternatives in the treatment of his plantations, and confined to clean cultivation, the modern English policy of advocacy of dwarfing stocks may perhaps prove to be misguided.

The recent announcement of the closing down of the Woburn Experimental Fruit Farm, followed so closely by that of the regretted death of its distinguished director, marks the end of the most important systematic attempt to grapple with the problems of fruit culture since the days of Thomas Andrew Knight. Hotly disputed as some of the conclusions reached there have been, the general value of its contributions to pomological science stands, nevertheless, beyond question. Although further development of the subject in this country must now be left to other stations, the influence of Woburn will persist, and future investigators will find their work materially simplified not only by the constructive results achieved there, but also by the illustrations afforded of the pitfalls to which field experiments in pomology are liable.

B. T. P. B.

Obituary.

SIR WILLIAM PETERSON, K.C.M.G.

NOT only his own university, but also the university world at large, has suffered a great loss by the regretted death, on January 4, of Sir William Peterson at the comparatively early age of sixty-four. Among university presidents Peterson's range of college experience and activities was exceptional and probably unrivalled. A Scottish education at the High School and University of Edinburgh was followed by a course at the University of Göttingen, from which he went with high classical distinction to Oxford as a scholar of Corpus. After Oxford an assistant mastership at Harrow introduced him to the life of an English public school, and as assistant professor of classics at Edinburgh he strengthened his association with that ancient university. From that post he was selected at an unusually early age for the principalship of the newly established University College of Dundee, over the growth of which he watched for thirteen years. Its affiliation with St. Andrews gave him intimate acquaintance with that ancient institution.

When, therefore, Peterson went to McGill in 1895 to enter upon the main work of his life, he carried with him the classical and literary spirit of the old Scottish and English universities, the critical training of Germany, and experience in directing university work on modern lines at an industrial centre. It was an excellent preparation for one who had to build at Montreal on the foundations so nobly laid by the distinguished Canadian man of science, Sir William Dawson. He had to deal with the practical needs of a young country busy in developing great natural resources, and at the same time to uphold the best intellectual traditions of the motherland. Both aims were kept steadily in view during his twenty-five years as principal of McGill.

Peterson had the good fortune to secure the support of men whose ample means were reinforced by high ideals of civic duty. Sir William Macdonald had already begun his generous benefactions to the university in aid of applied science. To the Schools of Engineering and Physics and of Chemistry and Mining, and for the foundation and endowment of the Macdonald College of Agriculture, Household Science, and Teaching, he gave during his life or by his will more than 12,000,000 dollars. The School of Medicine had already gained a well-earned fame, but large contributions from Lord Strathcona helped to confirm its place in the front rank of medical institutions. The same benefactor supplied the money for building and endowing the Royal Victoria College for Women, and, in conjunction with Sir W. Macdonald, that for the Conservatorium of Music, both in close alliance with McGill.

In giving direction to these and other streams of munificence, Peterson found a large and congenial field for his marked organising ability. His knowledge of English and Scottish universities and the close connection he maintained with them gave him a great advantage in filling the numerous posts created by the new foundations.

A striking proof of the growth of McGill under Peterson's rule, of the large lines on which he planned, and of the insatiable demands of a great and growing modern university is furnished by the fact that his successor in office, Sir Arthur Currie, found it necessary to appeal for a further sum of 5,000,000 dollars to carry on the work. That the graduates of the university and the citizens of Montreal responded by subscribing more than 6,000,000 dollars indicates the confidence felt in McGill as Peterson left it.

Peterson's selection as one of the trustees of the Carnegie Foundation for the Advancement of University Teaching—of which he was for some time chairman—opened up for him a new field of experience, since it gave him an intimate acquaintance with the leading university presidents of the United States, and made him familiar with all aspects of American university life. It emphasised the unique position he held among heads of universities.

The strain put upon Peterson by the war broke him down. An ardent believer in the British Empire, he spared no personal effort in speech and writing to maintain Canada's interest and full share in the struggle for its safety. What he accomplished in his own institution to this end is best shown by the terms in which the Carnegie Foundation made it a grant of a million dollars "in recognition of the noble and devoted service and sacrifice of McGill towards Canada's part in the Great War." It was while speaking in support of an appeal for the sick and wounded that the collapse occurred which closed his academic career.

G. R. P.

ALEXANDER MUIRHEAD, F.R.S.

ALEXANDER MUIRHEAD, F.R.S., who died at Shortlands, Kent, on December 13, 1920, was born in East Lothian in 1848. His father, John Muirhead, abandoned farming and was attracted to London in the early days of cable telegraphy, starting a business in Regency Street, Westminster, in partnership with Mr. Latimer Clark. Young Alexander, who was afflicted with partial deafness all his life, the result of a childish accident, went to University College School, Gower Street, and then to the college, where he made rapid progress in chemistry and mathematics, and became a devoted pupil of De Morgan. He afterwards worked at St. Bartholomew's Hospital under Mathiessen, in whose laboratory, amongst other things, he worked out the problem of the Latimer Clark standard cell, and laid the foundation of life-long accurate work in connection with electrical standards. He took the D.Sc. in 1872, in electricity, and became scientific adviser to his father's firm, where John Perry and many another later distinguished man took advantage of the opportunities, then novel, for accurate and absolute electrical measurement.

Muirhead's great achievement was the invention of the artificial line with distributed capacity, and the consequent duplexing of submarine cables. This he accomplished, in the first instance at Aden, with great and permanent success.

After carrying on research work in his own private laboratory, and perfecting the electrical standards of capacity, which he practically established and afterwards handed over to the National Physical Laboratory, Muirhead began instrument-making at Elmers End, constructing especially those beautifully designed instruments employed in cable telegraphy.

In 1894 Muirhead's attention was directed to the possibility of practical telegraphy by means of Hertzian waves, and he afterwards devoted his attention to getting them recorded by a syphon-recorder, with elimination of all disturbances, and with accurate tuning. He communicated a joint paper to the Royal Society on this subject (see Proc. Roy. Soc., A, vol. lxxxii., 1909, pp. 240–256).

But in the early 'nineties a serious illness had made Muirhead permanently lame, and his bodily disabilities were such that only his pertinacious and enthusiastic spirit enabled him to continue in harness and to remain as mentally alert as ever. He gave sound and helpful advice in connection with the Pacific cable, and his judgment and experience and scientific caution, together with his profound devotion to accuracy, were universally respected.

Muirhead was elected a fellow of the Royal Society in 1904, but a few years later a slight paralytic stroke added to the already formidable incapacities which prevented him from taking his true place among British men of science. By the few who really knew him he was highly esteemed and much beloved. OLIVER LODGE.

AN excellent Colonial servant of the Empire has passed away in the person of WILLIAM HARRIS, Government Botanist and Assistant Director of Public Gardens in Jamaica. Mr. Harris was born at Enniskillen on November 15, 1860, and after some years' experience in gardening was in 1879 taken on the staff at the Royal Botanic Gardens, Kew. Two years later he was appointed, on the Director's recommendation, to take charge of King's House Garden, Jamaica, Sir Daniel Morris then being Director of Public Gardens and Plantations. In due course Mr. Harris acted as superintendent in each of the five gardens in that island. On Mr. W. Fawcett's retirement in 1908, Mr. Harris became Superintendent of the Public Gardens in the Department of Agriculture; in 1917 he was appointed Government Botanist, and in 1920, a few months before his death, he was promoted to be Assistant Director. By his loss botanical exploration in Jamaica has suffered greatly. He was an indefatigable collector, and spent his holidays in the botanical exploration of every part of the island, roughing it in the bush, with the most meagre shelter for the night. Last year he suffered from his throat, and went to Kansas City, where his eldest son was living, to consult a specialist. The disease was found to be cancer, and he died in hospital on October 11, 1920. Mr. Harris had been a fellow of the Linnean Society since 1899. Botanically, he is commemorated by the genera Harrisia, Britton (Cactaceæ), and Harrisella, Fawc. and Rend. (Orchideæ), and many species have been named after him.

THE death occurred on Friday, January 7, of MR. S. A. VASEY, who for twenty-eight years directed the *Lancet* laboratory. Mr. Vasey was born on March 9, 1866, and received his medical education at Charing Cross Hospital Medical School, but he was early attracted to chemistry, and in 1883 became a fellow of the Chemical Society, and assistant to Prof. Heaton at the medical school. Prof. Heaton was at that time also supervising the *Lancet* laboratory, so Mr. Vasey joined him there as assistant, and on the death of the former in 1893 he took entire charge. His investigations covered an extraordinarily wide field; he undertook inquiries into the physics of gas lighting and cooking, the standardisation of disinfectants, the chemistry of natural waters, the food value of oysters and the risks involved in their breeding and supply, and many similar questions relating to public health. These topics will be sufficient to indicate the extent of the work he accomplished. Mr. Vasey was largely self-taught, and he was remarkable for the natural and easy way in which he applied the facts of science to the most commonplace occurrences of life. By his untimely death both the public health service and our contemporary have lost an old and trusted servant.

THE death has occurred of the veteran microscopist, MR. THOMAS MALTWOOD, in his ninety-fourth year. Mr. Maltwood was a fellow of the Royal Microscopical Society, and took an active part in the proceedings of that society in the middle of last century. He is best known as the inventor in 1858 of the Maltwood finder, which consists of a scale of vertical and horizontal lines reproduced photographically upon a glass plate, by reference to which the location of a particular object or structure in a microscopic specimen may be recorded.

THE death of MR. WALTER PITT is announced in *Engineering* for January 14. Mr. Pitt was one of the leading authorities on harbour construction plant, and was chairman of the firm of Messrs. Stothert and Pitt, Ltd., of Bath. He was born in 1853, and was a member of the Institutions of Civil Engineers and Mechanical Engineers; he served on the council of the latter body from 1907 to 1917, and was chairman of the institution's research committee on wire ropes.

Notes.

THE Royal Geographical Society and the Alpine Club for some time have been planning an expedition to scale Mount Everest. The political obstacle which stood in the way has now, fortunately, been removed by the permission granted by the Tibetan Government, on representation by the Government of India, for the expedition to pass through Tibet. Mount Everest, which lies on the borders of Tibet and Nepal, probably within the latter State, has an altitude of 29,142 ft. The surrounding mountainous country has never been explored, and, in consequence, much preliminary work is required before the actual ascent begins. In the *Geographical Journal* for January Brig.-Gen. the Hon. C. G. Bruce discusses the lines of approach and the probability of the feat being accomplished. The route proposed by Gen. Bruce is from Darjeeling through Sikkim to Kampa Dzong in Tibet, and then eastward for about 120 miles by the Taya Sampo Valley, through the Tingri Maidan, to the northern slopes of Mount Everest. This route he believes would enable a base to be established both as high as, and as near as possible to, Everest itself. It might be possible to arrange for supplies to be sent through Nepal up the Arun River or by other routes. This year an expedition is to make a preliminary reconnaissance of the ground, and in 1922 the actual attempt will follow. So far the highest altitude reached in mountain-climbing is 24,600 ft., attained by the Duke of the Abruzzi's party on Mount Godwin-Austen in 1909. Bad weather prevented a higher altitude being gained. Dr. Longstaff reached 24,000 ft. on Gurla Mandhata in 1905. In the ascent of Mount Everest an attempt will be made to push a camp to at least 25,000 ft., and, by use of ample porterage and the best of food, to have the climbing party in perfect fitness for the last effort.

AN article in the *Pioneer Mail* of November 19 last "from a correspondent in Mesopotamia" throws doubt on the general optimistic estimates of the results that may be achieved there by irrigation. The difference between the former widespread fertility of the country and its recent barrenness is usually attributed to political influences; but the author considers that it is due to changes in the soil and in climatic conditions, and not to deterioration of the population. He explains the recession of the sea for 100 miles from Ur of the Chaldees by an upheaval which has so lowered the gradient that the irrigation of that area must prove unusually difficult. There appears, however, to be no trustworthy evidence of essential climatic change, and the retreat of the sea is probably due to silting. The arguments based on possible changes in the soil appear more weighty; the author holds that the good soil is limited to narrow strips beside the rivers, and that most of the land "may easily prove to be irreclaimable," as "a gigantic subsoil sea charged with salts" has slowly collected under the plains. He considers this waterlogging incurable by simple drainage as in India, owing to the lack of adequate slope. The conditions described in the article indicate that irrigation in Mesopotamia is a far more difficult undertaking than in India.

SIR OLIVER LODGE's suggestions for the designation of the unit of positive electricity (NATURE, December 9, p. 467), and Prof. Soddy's rejection of them, provide the theme for a humorous ode in *Punch* of January 12. The concluding lines are as follows:

"And then the bellicose and caustic SODDY,
Who treats Sir OLIVER as if he were Poor Pilly-
coddy,
Or any ordinary hoddy-doddy,
Winds up with a sardonic observation
Upon the modern 'hydrophobic school,
With its inveterate aversion to anything wet;'
Showing that by a curious transmigration
The hate which theologians as a rule
Monopolised may now be met
In the most learned and exalted set
Of those whose scientific zeal and piety
Form the chief glory of the Roy'l Society."

It is typical of our ever-welcome contemporary to take a broad survey of individual and national characteristics, and to present them with knowledge as well as wit. We admire one and enjoy the other, and are flattered that correspondence in our pages should have provoked such sprightly verse. We trust, however, that the transference of the *odium theologicum* to scientific controversy will remain a fancy, even though Mr. Punch may thereby lose opportunities for his inimitable banter.

A SOCIETY for scientific research into psychic phenomena has been formed in Glasgow, with Mr. A. J. Balfour as president. Other officers are as follows:—*Vice-Presidents:* Prof. W. Macneile Dixon, Sir George Beilby, Dr. A. K. Chalmers, the Duchess of Hamilton, Miss Janie Allan, Mr. J. Arthur Findlay, Mr. Peter Fyfe, Prof. R. Latta, the Rev. John Lamond, Dr. Neil Munro, Dr. L. R. Oswald, Lord Sands, Prof. W. B. Stevenson, and Dr. Henry J. Watt. *Chairman of Council:* Prof. W. Nacneile Dixon. *Vice-Chairman:* Mr. J. Arthur Findlay. *Hon. Librarian:* Dr. J. Knight. *Hon. Secretary:* Miss Margaret H. Irwin, 58 Renfield Street, Glasgow.

THE short general account of the annual meeting of the Headmasters' Association published in last week's issue of NATURE ascribed to Dr. Mary Bell the remark that "there is no sin in a child helping itself to the contents of the mother's purse in order to buy presents for a teacher." Dr. Bell writes to say that these words do not represent exactly what she said. The meaning she intended to convey was that "the impulse to gratify a self-regarding instinct by gaining recognition by giving flowers to a teacher might be so powerful as to outweigh any idea of stealing on the part of the child. The stealing is wrong, but the thing to tackle is the desire to gain recognition, or whatever it was that led to the giving of the flowers, without the wherewithal to do so."

A GENERAL meeting of the Association of Economic Biologists will be held at 2.30 p.m. on Friday, January 28, in the botanical lecture theatre of the

Imperial College of Science, South Kensington, S.W.1. Mr. Llewellyn Lloyd will describe greenhouse white-fly and its control, and Mr. W. B. Brierley will give his personal impressions of some American biologists and their problems. Mr. Brierley was one of three foreign representatives invited to attend the American Phytopathological Conference held last year, and afterwards visited the chief educational and research institutions in Canada and the United States and many geographical areas of botanical and agricultural interest.

THE Air Ministry has issued a table showing the numbers of aircraft of all nationalities which departed for and arrived from the Continent and the total numbers of passengers who travelled on Continental air services during the quarter October–December, 1920. The totals of departures and arrivals of aircraft to and from the Continent since the opening of the first service on August 26, 1919, until the end of 1920 were: Departures, 2131; arrivals, 2022; grand total, 4153. British machines contributed 3321 to the latter figure, French 721, Belgian 104, and other nationalities 7.

THE PRINCE OF WALES has expressed his intention of being present at the Hunterian festival dinner of the Royal College of Surgeons on February 14 to receive the diploma of honorary fellowship to which his Royal Highness was elected on July 24, 1919.

DR. ROBERT S. WOODWARD retired from the presidency of the Carnegie Institution of Washington at the end of last year, and the duties of that office have been assumed by Dr. John C. Merriam.

IN the December issue of *Man* Mr. J. J. S. Whitaker gives an account of recent archæological research at Motya which has been going on since 1906, and of which no information, except a few letters in English newspapers, has hitherto been procurable. Motya differs from its sister-cities in Sicily which have passed from one control to another and in course of time have undergone total transformation. Motya, once destroyed, ceased to exist as a town, and its site remained desolate. One remarkable discovery is that of a cemetery in which the burials are formed by single urns, the contents of which, so far as it has been possible to determine them, consist almost completely of the cremated remains, not of human beings, but of domestic and other animals. If this conclusion is verified it will raise a very interesting problem for the archæologist and anthropologist.

A COMMITTEE has been appointed to organise a presentation to Prof. Percy F. Kendall upon the occasion of his retirement from the chair of geology at the University of Leeds, which will take place under the age-limit in June next. As a teacher Prof. Kendall has been stimulating and successful; as a scientific worker he has shown himself possessed of a brilliantly original mind, and he has achieved especially notable work in glacial geology and in studies of coal and the coalfield. Some recognition of this work is richly earned. Sir William Garforth is the chairman of the presentation committee, and the treasurer is Mr. J. E. Bedford, of Arncliffe, Headingley, Leeds.

ENCEPHALITIS lethargica, a disease characterised by stupor and paralysis, which came prominently into notice in 1918, is stated to have made its appearance again in France. A number of cases are reported from Marseilles, and at Douai an epidemic is said to be raging. It is suggested that the malady is periodic in appearance, like influenza, and it is of interest that epidemics of stupors are again and again recorded by the old medical writers. Cases apparently cured seem to be subject to fresh attacks, and there is some evidence that the cured cases may be "carriers" of the virus and convey infection to others.

"ANILIN-VIOLET in Copying Pencils Acting as a Spreading Caustic" is the subject of a review in *Medical Science: Abstracts and Reviews* for December (vol iii., No. 3, p. 239). If the point of a violet copying pencil penetrates into and is broken off in the tissues the result is quite different from a similar accident occurring with an ordinary graphite lead pencil. If the removal of the violet point be delayed it slowly dissolves, and the area of tissue around undergoes sub-acute inflammation with irritation of the nerve-twigs and pain at first, followed by anæsthesia owing to destruction of the nerves. The tissues undergo necrosis or death, and finally a sinus leading to the surface forms, through which the violet-coloured débris is discharged. There is an absence of suppuration, as the anilin-violet is an antiseptic.

DRS. CALMETTE AND GUÉRIN, of the Pasteur Institute, Paris, state that they have been able to protect animals against tuberculosis by means of a vaccine. Ten healthy heifers, six of which were vaccinated, were housed with five tuberculous cows for thirty-four months and then slaughtered. Of the four unvaccinated heifers three showed advanced tuberculosis. Of the six vaccinated heifers two which had been vaccinated only once showed a small amount of tuberculosis, while the four other animals which had been vaccinated three times showed no trace of the disease. It is now proposed to experiment with apes, and for this purpose an island has been acquired in French Guinea and liberal grants have been made by the Government for building and equipping laboratories and for their upkeep. The vaccine referred to is probably that described by Dr. Calmette (*Ann. de l'Inst. Pasteur*, vol. xxxiv., 1920, p. 554), which consists of tubercle bacilli that have been grown on a glycerin-bile medium for several generations.

IN the *Journal of Anatomy* for October (vol. lv., part i., p. 68) Mr. G. S. Sansom describes observations on the parthenogenetic segmentation of the ovum of the water-vole (*Microtus amphibius*) within the ovary. The process continues as far as the formation of two blastomeres and the division of these so as to give rise to the four-celled stage. Conditions of atresia of the follicles then become so acute that further development is impossible.

ACCORDING to the *Scottish Naturalist* (November–December), a walrus was seen off the Shetlands on many occasions from early in July until the middle of October. When first seen, about twenty-four miles north-west of Lerwick, the animal followed a fishingboat for some distance. It is described by the lighthouse-keepers as bearing tusks about 15 in. long; it was almost black on the top of its head, but lighter about the rest of the head and back. This issue also contains an account of the breeding of the brambling in Perthshire, which makes the first authentic record of the breeding of this finch in the British Isles.

The curious discovery of a diurnal variation in the size of human red-blood corpuscles is announced by Dr. Price Jones (*Journal of Pathology and Bacteriology*, vol. xxiii., p. 371). They are smallest on first waking in the morning, soon swell up when the subject becomes active, and reach a maximum about noon, which is maintained until bedtime. Short, violent exertion imposes a sudden rise on this daily curve, followed by a rapid return to normal; gentle exercise of longer duration has no special effect. Resting quietly in bed is evidently not the same as sleeping soundly, since it does not abolish the diurnal variation. Forced, violent breathing, whereby much carbon dioxide is washed out of the blood, causes a marked shrinkage, which disappears again in less than half an hour. The obvious inference that the size of the red cells varies inversely with the alkalinity of the blood is confirmed by experiments *in vitro*; but whether the phenomenon is due to the cells behaving like pieces of gelatin or to osmotic changes due to the exchange of salts between the plasma and cells is left undecided. It is possible that the increase of size in venous blood is of use in delaying the passage of the corpuscles along the pulmonary capillaries until the excess of CO_2 has been eliminated.

In vol. v., part 8, of the Scientific Results of the Australasian Antarctic Expedition several kinds of insects from Macquarie Island are brought to light. Hitherto only a single species of springtail and two of shore-inhabiting flies were known from that desolate place. The present report, by Dr. R. J. Tillyard, is accompanied by appendices by Prof. C. T. Brues and Mr. A. M. Lea. Described therein are two new species of springtails, a new genus of wingless Diapriid Hymenoptera, and the larvæ and adults of a new Staphylinid beetle. It is noteworthy that the island contains no trees and the hillsides are clothed with dark green tussock grass, scattered among which are patches of the more brightly coloured Maori cabbage (*Stilbocarpa polaris*). Penguin "rookeries" are a striking feature of the island, and wherever they are present the vegetation is destroyed. The Collembola and the wingless Hymenopteron occurred under stones in these "rookeries," while among the great masses of kelp cast ashore during stormy weather various flies undergo their transformations. A Pyralid caterpillar and the larva and pupa of a Tipulid fly are also described in this report, without definite names being assigned to them. The occurrence of these few insects on this desolate island affords an interesting problem to students of geographical distribution.

A complete and up-to-date catalogue of all the species and subspecies of birds of the Nearctic and Neotropical regions from northern Greenland to Tierra del Fuego, including the West Indies, the isles of the Caribbean Sea, and those of the South Atlantic and Pacific Oceans the faunal relations of which are American, is attempted in the "Catalogue of Birds of the Americas," by Charles B. Cory (the Field Museum of Natural History, Chicago, Zoological Series, vol. xiii., 1918–19). The first instalments issued form vol. ii., those of vol. i. being held over in order that Mr. Cory may have the benefit of Prof. Ridgway's latest investigations on the aquatic and gallinaceous groups, which will appear in the concluding volumes of that author's great work on the birds of North and Middle America. The parts under notice deal with the forms comprised in the orders Strigiformes, Psittaciformes, Coraciformes, Trogones, Coccyges, Scansores, and Piciformes. The geographical distribution of each species and its racial forms, often numerous, is concisely given, also a short and judiciously selected series of synonyms—a very desirable adjunct in these days of never-ending changes in nomenclature, resulting in the disappearance of time-honoured names in favour of obscure dug-outs. Another important feature is the author's foot-notes, devoted mainly to descriptions of the plumage of the many new species and still more numerous subspecies described since the publication of Prof. Ridgway's volumes, and of the American forms added to the great "Catalogue of the Birds of the World" published by the Trustees of the British Museum. Mr. Cory's work will be greatly appreciated by all who are engaged in the study of birds generally, and of their geographical distribution in particular.

The inheritance of ten factors in the cow-pea (*Vigna sinensis*) has been studied by Dr. S. C. Harland (*Journal of Genetics*, vol. x., No. 3). The characters investigated included the presence of anthocyanin in stem and leaf-stalk, the colour of the seed-coat pattern, and pod and flower colour. The presence of anthocyanin is due to a dominant factor, while the seed-coat colours, which are black, brown, buff, maroon, red, and white, are believed to be due to various combinations of four factors. Several other relationships of factors are also made out. In another paper by the same author the results of breeding experiments with the castor-oil plant, *Ricinus communis*, are given. The presence of bloom on various parts of the plant is due to a single partly dominant factor, while the spininess of the capsule is also partially dominant to its absence. As regards stem colour, crosses between green and mahogany brown indicated the presence of two factors which show repulsion. Dr. Harland has also crossed certain varieties of the tropical hyacinth bean, *Dolichos lablab*. He finds the indeterminate habit of growth dominant to the determinate. Two white-flowered varieties gave a purple F_1, due to the presence of the factors C and R, the former producing a purplish seed-coat and stipular hairs, the latter, in the presence of C, converting white flower into purple, purplish seed-coat into black, and causing pigmentation at the nodes.

The Oreodontidæ from Upper Eocene to Pliocene genera are reviewed by F. B. Loomis in a paper on *Ticholeptus* (*Merycochaerus*) *rusticus* (*Amer. Journ. Sci.*, vol. l., p. 281, 1920). The wealth and variety of material for the study of these artiodactyls, especially in Lower Miocene strata, and their peculiar limitation to American deposits render the diagram of their evolution useful to students of the mammalia.

BULLETIN 663 of the U.S. Geological Survey on "The Structural and Ornamental Stones of Minnesota," by Oliver Bowles, is effectively illustrated with coloured plates of polished specimens—a method of imparting information that in our islands has, we think, been left to private enterprise. A publication of this kind is obviously a distinct service to a community that also contributes liberally to research in the so-called "purer" branches of geology.

SOME broad features of Hawaiian petrology are dealt with by S. Powers in the *American Journal of Science* (vol. l., p. 256, 1920). The olivine nodules in the basalts are regarded as early products of differentiation brought up from lower levels, and the occasional trachytes that are described seem to be due to differentiation in local volcanoes after their connection with the main subterranean cauldron had been cut off. Useful maps are given of several of the islands.

ATTENTION may be directed to a very convenient glossary of the economic mineral productions of the United States published by the U.S. Geological Survey under the title of "Useful Minerals of the United States," Bulletin 624, a revision of Bulletin 585. This consists of two parts—the first a geographical index, in which the various States of the Union are given in alphabetical order, and under each the most important mineral productions of that State, also alphabetically arranged. The second part consists of a list of the names of some six hundred minerals in alphabetical sequence, in which the composition and general uses of each are given briefly, together with a list of the States in which it occurs in important quantities or in some noteworthy form. The work thus forms a very convenient index to the mineral production of the United States, and it would be a very great advantage if all important mining countries published lists on similar lines. The suggestion might with great advantage be followed by our Imperial Mineral Resources Bureau.

LIVERPOOL Observatory at Bidston, under the directorship of Mr. W. E. Plummer, has issued its report for the years 1917–19, which is published by the Mersey Docks and Harbour Board. It has not been found possible to issue annual reports as was the custom prior to the war. The signal-gun for time, which is for definite nautical purposes, was fired, without alteration for summer time, one hour after Greenwich mean noon. Seismological observations are regularly recorded, and in the tables published notes are made respecting the different phases. Temperature records in the reports are from thermometers mounted on the north side of the observatory; in former years, when observations were made from instruments mounted on the south side, the results gave too high a reading. There were 76 days in 1917 with no sunshine, 68 days in 1918, and 68 days in 1919. For wind velocity it is still assumed that the velocity of the wind is three times greater than that of the cups of the Robinson anemometer, although this factor is recognised as too large. The detailed daily meteorological observations are most complete, and a summary is given for the several months and for the year. The number of hours that the different winds blew during each day affords very useful information and is of great interest as associated with the varying character of the weather. There is much that can be followed with advantage at other subsidiary observatories.

VOL. XIV. of the Collected Researches of the National Physical Laboratory extends to more than 300 pages, and is devoted entirely to optics. Its characteristic feature is the aid it affords to the manufacturer of optical instruments, and of telescopes in particular. One of the fifteen papers reprinted is devoted to a description of the methods adopted at the Laboratory for the calculation of telescope objectives, and a second gives the corrections to the curvatures of the lenses of an objective when the glass of a new melt is not quite identical in refractive index with the glass previously used. Charts for assisting in the selection of suitable glasses for cemented doublets are given, and those cases in which the curvatures do not allow a doublet to be cemented are met by the substitution of a cemented triplet. In a paper devoted to refractometers of the critical-angle type, such as are used in commercial testing, it is pointed out how extensive the powers of these instruments are and how the actual instruments have in the past fallen short of the accuracy possible owing to mechanical defects. Modifications of the original Zeiss form of construction are suggested which, when the instrument is used with the proper precautions, should raise the accuracy considerably.

A MARKED degree of red sensitiveness in some "ordinary" gelatino-bromide plates was observed and recorded many years ago; it seems possible that the key to this unexpected result has been found by Mr. F. F. Renwick, who contributes a paper on "The Action of Soluble Iodides on Photographic Plates" to the January issue of the Journal of the Royal Photographic Society. Mr. Renwick finds that by treating a plate for a few seconds with a very dilute solution of potassium iodide there is really no fogging effect (as Dr. S. E. Sheppard stated about a year ago), but that the plate is rendered markedly orange and red sensitive. This he demonstrates by bathing an ordinary plate for from 15 to 60 seconds in a 1 in 20,000 potassium iodide solution, washing it with water and exposing it to a spectrum. This appears to be the first instance recorded of a colourless solution conferring colour sensitiveness. Mr. Renwick has tried a fair number of different salts, but so far has discovered only one other that acts similarly. Sodium or potassium cyanide in solution of a strength of one in from 2000 to 10,000 gives an exactly similar effect. The author leaves a theoretical discussion of these results to a future occasion.

THE investigation of soap solutions by Dr. McBain and his students at the University of Bristol has been continued by the demonstration that aqueous sodium oleate at temperatures between 0° C. and 25° C. can exist in any one of three forms: clear oily liquid sol, clear transparent elastic gel, or white opaque solid curd, all at one and the same concentration and temperature. Hitherto the last two types have not been differentiated; probably all previous communications dealt with soap curd, and some confusion has been introduced into the discussion of the nature of gels on this account. Soap sol and gel have been shown to be identical in all respects except elasticity and rigidity, which are characteristic of the gel form alone. A curd is a sol or gel from which nearly all the soap has been abstracted through the formation of white curd fibres of barely microscopic diameter. These researches, described in the December issue of the Journal of the Chemical Society, have important bearings on the theory of gels, and support the micellar view of Nägeli.

MESSRS. J. AND A. CHURCHILL announce for early publication a new edition—the eighth—of Lee's "Microtomist's Vade-Mecum." It has been prepared by Dr. J. B. Gatenby, who has had the collaboration of several other well-known biologists; thus Prof. Bayliss contributes a chapter on the theory of dyes and staining, Dr. Da Fano has recast the chapters on neurological methods, Dr. A. Drew has written a chapter on protozoological techniques, Dr. W. Cramer and the editor a section dealing with the fatty substances, the chapter on bone and teeth has been revised by Dr. J. T. Carter, and sections on mitochondria, Golgi apparatus, fat and yolk, chromatin, chromosomes and nucleoli, embryology, microchemical tests, colloid intra-vitam dyes, and tissue culture methods have been contributed by Dr. Gatenby.

WE have received a copy of the new edition of its catalogue of second-hand scientific instruments from the firm of Charles Baker, of 244 High Holborn, W.C.1. It is divided into twelve sections, each of which deals with a particular class of apparatus. Prominent sections are those devoted to microscopes, surveying instruments, physical apparatus of various types, and photographic material. That on microscopes contains some seventy items, ranging from single sliding-tube instruments to those carrying all the modern improvements. The firm has also a number of second-hand scientific books and periodicals for sale, including collections of various journals of microscopy and NATURE, vols. xxviii. to civ.

Our Astronomical Column.

APPROACHING RETURN OF PONS-WINNECKE'S COMET. —Among the periodical comets due to return this year that of Pons-Winnecke presents the most interesting possibilities. The comet will be near the earth at the time it arrives at perihelion at about the end of June or early in July next, and as its orbit lies very near that of the earth a meteoric shower seems highly probable.

The first abundant exhibition of meteors from this source appears to have taken place on June 28, 1916, when it was witnessed by Mr. W. F. Denning at Bristol, who pointed out in NATURE of July 27 of that year the significant resemblance of orbit between the meteors and Pons-Winnecke's comet.

The last return of the comet to perihelion occurred on September 1, 1915, and, the shower of meteors having been observed at Bristol ten months later, the stream must be fully 600,000,000 miles long. If the display should fail to be visible at the end of June next it should certainly return next year.

The radiant point is situated a few degrees north-east of the star Eta in Ursa Major, and the radiation appeared to be very diffused in June, 1916, so that it was difficult to ascertain the exact centre. In former years the comet of Pons-Winnecke was always sufficiently distant from the earth to escape contact of its materials with our atmosphere, but during the last half-century the planet Jupiter has materially disturbed its orbit, and brought that section near perihelion extremely close to the earth.

STELLAR PARALLAXES.—Yerkes Observatory Publications, vol. iv., part 3, contains parallaxes of fifty-two stars obtained photographically with the great Yerkes refractor by Mr. G. van Biesbroeck and Mr. H. S. Pettit. A yellow colour-filter was used, and the bright stars were cut down 6 mags. or thereabouts by a double rotating sector. The stars are partly fundamental ones, partly faint stars with large p.m. The following are some of the more interesting results:—Aldebaran 0·047″, Castor 0·059″, Procyon 0·307″, B.D. +67·552° 0·106″ (this is the first determination made for this star), Lal. 21185 0·382″, ζ Herculis 0·095″, Barnard's p.m. star 0·509″, and Vega 0·114″. The average probable error is 0·010″.

Two more Publications of the Allegheny Observatory (vol. v., Nos. 4 and 5) have been received, and contain parallaxes of eighty stars, many of them now determined for the first time. The average probable error is 0·008″. There are only two parallaxes exceeding 0·1″, viz. Pi II. 123 0·145″ and O.A.N. 21338 0·134″ (first determination). Other interesting stars are α Trianguli 0·045″, δ Cephei 0·006″, 54 Piscium 0·096″, β Andromedæ 0·033″, Furuhjelm's companion to Capella 0·071″ (this is easier to measure than Capella itself, and from the common p.m. the parallax must be appreciably the same), η Geminorum 0·016″, Lal. 33439 0·095″ (Adams and Joy found 0·087″ spectroscopically), and Pi XXIII. 218 0·092″.

CATALOGUE OF NOVÆ.—The Japanese *Astronomical Herald* for October, 1920, contains a very useful catalogue of novæ, giving their R.A. and decl. for 1900, the date of outburst, and other particulars. Tycho Brahe's star of 1572 is No. 1, and Mr. Denning's nova of last August No. 41. The average in the last thirty years has been just one per annum. The nova of 1885 in the Andromeda nebula and the other faint novæ recently detected in spiral nebulæ have not been included in the list. The galactic co-ordinates are given, and the distribution of novæ in the four quadrants is as follows:

Galactic Long.	No. of Novæ
0° to 90°	14
90° to 180°	8
180° to 270°	3
270° to 360°	16

The deficiency in the third quadrant does not seem to be explicable as a result of south declination, for there are practically as many stars south of the equator as north of it (twenty to twenty-one). There are fourteen stars south of decl. −20°, which is the full number to be expected in this zone, one-third of the whole sphere. Hence the unsymmetrical distribution gives some grounds for conjecturing that the galaxy may be nearer to us in the first and fourth quadrants.

Federal Science during the World-war: Geology in Austria-Hungary in 1914–19.

By PROF. GRENVILLE A. J. COLE, F.R.S.

IN NATURE, vol. xciv., p. 94, on the last day of the eventful year 1914, a sketch was given of the publications of the Geologische Reichsanstalt of Vienna from 1911 to 1913. The reduction in the scope of the institute, necessitated by political rearrangements, was recently referred to with some regret, and, now that international communications are restored, we are enabled to welcome the volumes issued during the years of war. The maintenance of the *Jahrbuch* in its well-known handsome form is a remarkable testimony to the energy of Dr. Tietze and his staff. While machine-guns rattled above the glaciers of the Ortler and slaughter surged from Caporetto to the sea, the Reichsanstalt not only discussed questions of philosophic interest, but even printed the results in anticipation of the return of happier times. Colour-printed maps and sections and photogravures of fossils accompany these volumes, which from January, 1914, to December, 1918, occupy a width of 15 cm. on our shelves. The *Verhandlungen* give us an extra thickness of 7 cm. This method of statement may appear crude in a matter of scientific output; but could we have claimed as much from H.M. Stationery Office in London if a lithe and indefatigable enemy had been battering our defences no farther away than the line Middlesbrough—Baugh Fell—Morecambe Bay?

Many of the recent papers in the *Jahrbuch* naturally treat of local details, and describe observations made during long mapping in the field; but few of them are devoid of wider applications. The fascinating mass of the Wetterstein on the northern wall of Tirol occupied O. Ampferer and O. Schlagintweit in the *Verhandlungen* in 1912. K. C. von Loesch (*Jahrb.*, 1914, p. 1) has now made a close study of its "Schollenbau" and that of the parallel Mieminger range immediately to the south, which is well known to travellers down the Inntal between Imst and Innsbruck. Von Loesch is particularly concerned with the lateral movements that followed, after an interval of repose, the main overfolding from the south. His summing up fails to give a comprehensive view of the westerly movements of the isolated blocks—a feature first indicated by Ampferer. One would like to know whether these may be fairly compared with the settling down and spreading of the front of a wave that has subsided on a shore. The question of how far the tension evidenced by "explosive" outbreaks of rocks in Alpine mines and tunnels is a heritage from the Miocene movements is considered a few pages later by K. A. Weithofer, of Munich ("Ueber Gebirgsspannungen und Gebirgsschläge," *Jahrb.*, 1914, p. 99). His paper discusses such occurrences in general, and concludes that no single explanation applies equally to all.

E. Fugger (1914, p. 369) describes the delightful country of the Tennengebirge south of Salzburg, where the Triassic rocks of the Eastern Alps first reveal their beauty and fascination to the traveller on the road to Radstadt. He quotes from F. Wähner an explanation of the double gorge of the Salzach above Golling, where a climb is made to the Lueg Pass along a dry ravine partly choked with glacial detritus. After the Ice age the river failed to return to its old groove, from which it was banked out by débris, and it carved the deep and impassable gorge of the Oefen close alongside. A rock-ridge only 200 m. wide separates the two ravines.

As an example of research into the stratigraphical problems of the Eastern Alps we may cite W. Hammer's far-seeing paper on the Bündnerschiefer of the Upper Inntal, with its numerous sections, and two coloured maps on the large scale of 1 : 25,000 (1914, pp. 441–566). The Bündnerschiefer, corresponding with the *schistes lustrés* of the Western Alps, occupy small areas south of Landeck on the margin of the gneiss, and present the usual difficulties of correlation. Hammer records interesting breccias with limestone fragments containing radiolaria; but fossil evidence is practically wanting. He inclines to the view that the beds are metamorphosed elements of Upper Cretaceous rather than older Mesozoic strata. Exotic Triassic masses appear among them in a disconcerting way (section on p. 453, etc.), and pebbles of Triassic rocks occur in conglomerates of the Bündner series.

Hammer continues (1918, p. 205) his studies in the Landeck district by a description of the zone of phyllites, associated with mica-schists, that runs along the north side of the Silvretta and Oetztal gneiss from St. Anton on the Arlberg to the village of Roppen in the Inntal. The series dips towards and under the gneiss, just as the Bündnerschiefer do from an opposite direction. The phyllites are overlain unconformably by the Verrucano, which was formed between the Armorican movements and the Triassic period. Their relations with the gneisses seem due to the early earth-movements, but here and there intrusive gneisses have invaded them. An interesting type (p. 216), the "Feldspathknotengneis," occurs in the phyllite series, and is marked by the development of albite in an originally sedimentary rock. The growth of the felspar has no connection with contact-action.

F. Angel and F. Heritsch, both of Graz, found an almost ideal working-ground on the Stubalp, part of the noble wall of crystalline rocks that hems in the basin of Graz on the west. The position of Austria in the world-war was so enforced and so anomalous that we may sympathise with these geological enthusiasts when they write of their mountain fastness: "Die Liebe zur Heimat, die Freude an den Bergen hat uns immer wieder dorthin geführt, wo wir den Jammer des Krieges vergessen konnten. Die Forscherlust war die Begleiterin unserer Wanderungen." F. Angel contributes detailed petrographic studies of the rocks encountered, which include both a sedimentary and a gneissic series; but the chief point of general interest lies in Heritsch's conclusion (p. 203) that the whole mass and its present structure are of pre-Cambrian age. The Stubalp thus seems to be an antique block worked up, perhaps, but by no means obliterated in the later tectonics of the Alps.

The attention given in these recent volumes to Bohemia, mainly through the work of Czech geologists, leaves a serious heritage to the revived States that look to Prague as their intellectual centre. The old question of the Silurian "colonies," and the work of J. E. Marr in giving them a tectonic significance, come up again in E. Nowak's researches on the southern edge of the basin (1914, p. 215) and in F. Wähner's paper (1916, p. 50) on the structure of central Bohemia, which recognises in the basin the remains of a formerly extensive and crumpled mountain range. This seems to have existed in Upper Devonian times, and one is tempted to ask if, with the north-east strike impressed upon its constituents, it cannot be regarded as part of the Caledonian continent so well revealed in north-western Europe. The main folding, however, in Bohemia and Moravia, accompanied by great intrusions of granite and the formation of large areas of gneiss, occurred in connection with the "Variscan" movements—that is, in Upper Devonian and Lower Carboniferous times—thus heralding, and still at a long distance, the Armorican movements of the west. This fact is emphasised by Radim Kettner, writing from Příbram (1917, p. 251).

In the same year (p. 267) J. Woldřich examined the Cretaceous fauna of Neratovic, where concretions containing 50 per cent. of calcium phosphate interestingly occur. This discovery is compared with the presence of phosphatic nodules in the Cretaceous of France and England, and (p. 321) the fauna is described in relation to its western representatives. In the volume for 1915 (p. 1) C. Zahálka contributes a far-reaching memoir on the Cretaceous system in the Sudetic region and its equivalents in the western lands of Central Europe. This includes many pleasant references to the comradeship shown to the author by French geologists, and the name of Valmy, where the First Republic answered the proclamation of the coalised kings, appears here happily (p. 109) in connection with field-work on the zone of *Inoceramus labiatus*. There is much in this extensive paper to interest English geologists, who must, by the way, not overlook Richard J. Schubert's paper (1915, p. 277) on otoliths of Barton Cliff in Hampshire, collected by H. Elliot Watson and sent to the author by Col. C. D. Shepherd. Schubert's death at the head of his company in the heroic fight at Gorlice on the Russian front (obituary by O. Ampferer, 1915, p. 261), removed a very active and much-loved personality from the ranks of the Reichsanstalt.

British and Indian geologists may also note Rudolf Zuber's contributions to the geology of the Punjab (1914, p. 327), resulting from explorations organised by an English oil company in 1913. There are two highly suggestive diagrams showing the interlocking of different types of Eocene strata, including the salt-clay series, and their folding in the great Himalayan movements to form the present Salt Range.

Broad questions of petrography have not escaped the attention of the Reichsanstalt, such as Bruno Sander's "Beiträge aus den Zentralalpen zur Deutung der Gesteinsgefüge" (1914, p. 567), in which the stratified and folded structures in many crystalline rocks are recognised as of earlier date than the crystallisation of their present mineral constituents; or the extensive study of peridotites and their allies involved in F. Kretchmer's memoir on "Der metamorphe Dioritgabbrogang im Spieglitzer Gebirge" (1917, p. 1). Palæontology is represented by a number of short papers, including one by J. V. Želizko (1918, p. 113) on a small species of lion from the Pleistocene of Wolin, in southern Bohemia. One large folio memoir, on Oxynoticeras, by J. von Pia, was issued in 1914; it includes the usual considerations in regard to what constitutes a genus or a species, to which we are accustomed when ammonites are brought into the arena. In critical biography E. Tietze's "Einige Seiten über Eduard Suess" (1916, p. 333), a paper of more than 200 pages, is a very memorable review of the recent history of geology. Even the papers on economic subjects reflect the calm detachment of the institute, encouraged to carry on its work with a cosmopolitan outlook, during a catastrophe that has broken the bonds of man to man by more than inexorable death. Even F. von Kerner's study (1916, p. 145) of the water-supply in the Middle Dalmatian karst-region, with its valuable series of sections, will be to the advantage of the Slavonic peoples rather than to those who blasted their trenches on the Carso in the hope of retaining a sovereignty at Trieste. And so, indeed, it should be always. The Austro-Hungarian *Festland* has become broken into horsts and *Graben*; but will not time smooth the fault-scarps that now loom up as separating walls? The best guarantee of scientific co-operation is to be seen in the names of those who have, during years of bitterness and division, contributed in serene hopefulness to the sum of human knowledge.

Measurements of the Angular Diameters of Stars.

AFTER the successful measurement of Capella as a double star by Prof. A. Michelson's interferometer method applied to the 100-in. reflector at Mount Wilson, it was known that he intended to attempt the more difficult feat of measuring stellar diameters. The most hopeful stars to choose for the purpose are the giant red stars. Prof. Eddington made some estimates of their angular diameters in his inaugural address to Section A of the British Association last August (NATURE, September 2, 1920, p. 14). Taking the temperature and surface brightness derived from the distribution of energy in the spectrum, the angular diameter (which is independent of the assumed distance) is deducible from the apparent magnitude. The highest estimate for any star was that for Betelgeux, the value being 0·051″.

The daily Press of December 31 announced that Prof. Michelson read a paper before the American Physical Society in which he stated that he had determined that the diameter of Betelgeux was 260,000,000 miles, or three hundred times that of the sun. As the assumed distance of the star was given as 150 light-years, we may infer that the measured angular diameter was 0·061″—a close agreement with Prof. Eddington's estimate.[1] Once the angular diameter of a single Ma star is determined, those of all the stars of the same spectral type can be deduced from their apparent magnitudes. The huge bulk of Betelgeux is a striking illustration of Prof. H. N. Russell's theory of giant and dwarf stars. Its density is presumably very low, otherwise an improbably high value of the mass would result.

Some further details of the result obtained at Mount Wilson were communicated in a letter from Prof. G. E. Hale which was read at the meeting of the Royal Astronomical Society on January 14. The apparatus consists of two periscopes fixed to a frame at the object-end of the tube of the 100-in. Hooker reflector. The outer mirrors are some 20 ft. apart, but the distance is capable of being varied. The inner mirrors are about 4 ft. apart; this is merely a matter of convenience, the beams being brought down the tube on opposite sides of the Cassegrain mirror. An additional plane mirror is used for reflecting the light up the polar axis. The measurement of a star's diameter is effected by varying the distance between the outer mirrors and finding the points at which the interference fringes disappear. The actual observation is very tedious and difficult; it was stated that half an hour was required each time the mirror was moved before the visibility of the fringes could be tested. Moreover, in measuring a star disc, observations are

1 A later communication gives 0·046″ as the measured diameter.

required in different azimuths to ascertain that we are dealing with a single circular disc, and not with two neighbouring discs, as in the case of Capella. The resulting angular diameter is 0·045″; Prof. Eddington had predicted 0·051″ from the visual magnitude and assumed surface brightness, and Prof. Seeliger deduced 0·042″ in a somewhat similar manner. The linear diameter found (about 300 times that of the sun) depends on the assumed parallax, which, unfortunately, is decidedly uncertain; further determinations seem urgently to be called for. Prof. Lindemann pointed out the extraordinarily low density that such a diameter implies if we assume that the mass is of the order of twenty-five times that of the sun.

Other stars for which a diameter determination is hopeful are Antares and Aldebaran, and possibly Arcturus. Sirius and Vega will doubtless be attempted, but with less prospect of success.

A. C. D. C.

Culture and Environment in the Cameroons.

FEW areas in the African continent present problems of greater interest to the anthropologist than the Cameroons. Although the Germans produced a considerable amount of literature relating to the area while it was under their rule, there is still a great deal of work to be done before the complex ethnology of the country is elucidated. Capt. L. W. G. Malcolm, who saw service in the Cameroons during the war, is preparing a monograph which will be one of the first-fruits of our occupation. At a recent meeting of the Royal Anthropological Institute he gave a preliminary account of certain questions connected with the distribution of types of culture and its relation with the geographical environment.

In the Cameroons there are three main racial stocks, namely, the Bantu-speaking tribes, the Sudanese, and the Pygmies. Subsidiary immigrant races occupy certain areas in the north-east. Between the Bantu-speaking tribes and the Sudanese there are a number of tribes, some of which do not speak Bantu languages, and there is a distinct boundary between the Bantu-speaking and Sudanese races which is determined solely by the geographical nature of the country.

The material culture of the grassland area reveals the fact that the problem is of a most complex character. When dealing with tribes of mixed affinities it is extremely difficult to determine the various strata. Not only is there a local mixing of the tribes, but there are also various elements which have been brought in by invading tribes. This is particularly the case in Bagam, where the tribe has been influenced particularly from Bamum, in the north-east, while from Babanki, in the north, various forms of iron weapons have been introduced. The Balis have introduced among the grassland tribes the sleeveless gowns worn by the men. After Hausa and Fulani elements and the influence of the forest-belt tribes have been eliminated, it would appear that the chief characteristics of the grassland culture are weapons of copper, iron, and brass; socketed spearheads; a simple bow made from raphia palm, with a flat bowstring; arrows with wooden points; shields, either plaited or reinforced with wood; wooden slit-gongs; drums with skin tympana and wooden tautening wedges; flanged iron bells; iron-working (smelting and smithing); brass castings (Bagam and Bamum); pottery (coiled in the north-east); jutan cloth and woven fibre; decorative art with triangles and zigzags; cicatrisation; filing or chipping of the incisors; smoking pipes of metal and clay; animal and ancestral cults; and the use of carved masks and images. One of the most obvious and striking peculiarities of the grassland culture, however, is the quadrangular hut, with pyramidal or conical roof, ranged in streets, which differs distinctively from the forest-belt hut standing in its own irregularly placed clearing.

Capt. Malcolm's careful analysis of the culture of one area only of the Cameroons, even in this preliminary form, was not merely an indication of the extremely interesting material which still awaits investigation; it was also a valuable object-lesson of the method of studying a backward population which should form the essential basis of our administration in this and similar areas.

The Science Masters' Association.

AT the invitation of the Board of the Faculty of Natural Science, the annual meeting of the Science Masters' Association was held in Oxford on January 4–7. About two hundred members attended, and by the kindness of the Master of Balliol and the President of Trinity they were housed in these two colleges.

The meeting began on the evening of January 4 with the address of the president (Mr. A. Vassall, of Harrow) on "Some Aspects of Science and Education." Mr. Vassall dealt with education in science from the preparatory school to the university, and showed the evils of teaching in the earlier stages as if all the boys were ultimately to become specialists. The teaching should be such as to give every boy an opportunity of realising the scope and aims of science. It should impart to every boy the understanding of scientific problems necessary for the equipment of a modern State, and not be merely a training for future work in science, which in many cases will never be taken up seriously.

A lecture on spectroscopy, given by Prof. T. R. Merton, was concerned largely with the part played by observation and technique; observation cannot be effective with faulty apparatus. In the spectroscopy of gases the influence of traces of impurities is very great, and many beautiful experiments were shown to illustrate the methods of dealing with them. The conditions under which nitrogen gives a band spectrum and a line spectrum were shown; a tube was exhausted and filled with helium sufficiently free to enable the conditions for obtaining either a band spectrum or a line spectrum to be demonstrated. Also, a striking experiment was shown by which the presence of neon in the atmosphere was made evident. The method of getting hydrogen into and out of tubes by means of a heated side-tube of palladium was illustrated, and the curious fluorescence of parts of the human body was shown by illuminating the audience by light of wave-length about 3660 Å.U., obtained by using a quartz mercury vapour lamp and a screen of special glass devised by Prof. R. W. Wood.

There were demonstrations in the various University laboratories, illustrating much of the teaching work of the University and some of the current investigations. Demonstrations were also given of the use of the microscope for the study of crystallisation, by Mr. T. V. Barker, who had prepared a pamphlet outlining a course of study suitable for schools, and of glass-blowing by Mr. B. Lambert, who gave many valuable hints on dealing with operations which are constantly a source of difficulty in making apparatus. All these demonstrations were repeated next day, and the association is greatly indebted to the distinguished University teachers who expended so much time and care on them.

A lecture on the control of growth was given by Mr. J. S. Huxley. After explaining the characteristics of the life-cycle of all animals, the lecturer showed how the growing stage could be accelerated or retarded by external conditions in the case of some lower organisms, and illustrated cases where it can be reversed. Two opposing processes may be distinguished, and by stimulating one or the other the progress of the resultant change can be controlled. An interesting case was related of an Australian soldier whose mind, as the result of shell-shock, reverted to the infantile stage, but, happily, on his return to Australia it developed again to the normal condition. Mr. Huxley went on to describe experiments with mice, the average life of which had been extended about 20 per cent. beyond the normal duration, and the treatment of a rat which had its youth restored after reaching a state of marked senility. In conclusion, the opinion was expressed that in the course of time it would be possible to extend the duration of man's life very appreciably.

A lecture on indicators and the law of mass action was delivered by Brig.-Gen. Hartley. The lecturer pointed out and illustrated the confusion resulting from the idea of neutralisation, and showed that the way to obtain a clear insight was to regard the indicators as weak acids or bases (fortunately the tautomeric changes need not be considered here) and work quantitatively in terms of the hydrion concentration from the known dissociation constants. Brig.-Gen. Hartley illustrated this by making four sets of solutions in which the hydrion concentration varied by factors of 10 from 10^{-3} to 10^{-10} (made by adding to *N*/10 acetic acid the calculated amounts of a solution of sodium acetate, as by this method the accidental introduction of impurities does not seriously alter the hydrion concentration), and adding to all the members of each series methyl-orange, methyl-red, phenolphthalein, and litmus respectively. It was then evident between what limits of concentration the colour change occurs in each case. Graphs were made showing the resultant hydrion concentration when various amounts of a particular alkali were added to 25 c.c. of a given acid. From these graphs it was at once evident what would be a suitable indicator and how sharp the colour change would be. Some further graphs showed the immense difference that would result if the constant for water were to have a different value.

In a lecture on the Hedjaz Mr. D. G. Hogarth gave an account of the geographical conditions and a most interesting review of the political positions since 1914 and their bearing on the war in the East.

Throughout the meeting there was an exhibition of apparatus and books by manufacturers and publishers.

Research on the Pink Boll-worm.

THE pink boll-worm, the larval stage of the Tineinid moth, *Gelechia gossypiella*, Saunders, is responsible for considerable damage to cotton in most cotton-growing regions, and its importance in Egypt has led to an extensive study of its habits and of methods of control (H. A. Ballou, 1920, "The Pink Boll-worm," Report of Ministry of Agriculture, Egypt; L. H. Gough, 1919, "On the Effect Produced by the Attacks of the Pink Boll-worm on the Yield of Cotton-seed and Lint in Egypt," *Agricultural Journal of Egypt*, vol. ix.).

The pink boll-worm was first discovered in Egypt in 1910, probably having been introduced in cotton from India, and in 1912 it had attained a position of first importance as a pest of cotton in that country, and since that time it has been the principal pest of this crop.

In its adult state *Gelechia gossypiella* is a small moth with a wing-spread of between 15 and 19 mm. The general colour of fresh specimens is coppery-brown with blackish spots varying in size and intensity. The eggs are laid on the green parts of the cotton plant, and the larvæ make their way to a boll or bud, where they feed inside the developing seeds or upon the ovules. When fully grown, the larva measures 10 to 12 mm. in length, the pinkish colour occurring in broad transverse bars on a yellow ground, and may pupate in the boll or seed or enter the earth. The larval state lasts from ten to nineteen days, but late in the season the larva, instead of pupating when full grown, may enter a resting stage, in which it may remain for as long as thirty months. This is the most important stage in the life of the insect, and the principal effort at control is directed at the larvæ before and during this stage.

The pink boll-worm damages cotton-seed in the boll, and its attacks result in reduced and weakened lint and reduced seeds, which may be light in weight and of low germinating power.

Legislation has made it compulsory for all plants to be pulled, and the remaining bolls destroyed, by a certain date, which varies between December 15 and January 15 in different districts; it has enforced the provision of approved machines for treating all seed in the ginneries by heat or fumigation, and made it compulsory for all stores containing cotton-seed to be screened from May to August to prevent the escape of adults.

The first campaign on a large scale against the pink boll-worm was carried out in 1916, and aimed at the destruction of resting larvæ in the bolls left in the field after the crop had been gathered. The method which is recommended for the future is for the cotton sticks to be removed from the field before cleaning, taken to a central place, and there cleaned by drawing through a comb or rake, no sticks to be allowed into a village until all have been passed by an inspector as clean, and the unclean sticks destroyed.

The picking of the crop should be as early as possible, as the attack of the pink boll-worm is more severe late in the season, and also the later larvæ are more likely to pass into the resting stage by which the infestation of the following year is caused.

Treatment of cotton-seed by heat at a temperature of from 53° to 73° C. was found to be effective in destroying all resting-stage larvæ, while having little effect on the percentage of germination of the seed.

The Optical Glass Industry.

THE *Daily Telegraph* published in its issues of December 28 and 29 two articles on the optical glass industry in this country. In a leading article of January 6 it says that, as England gave her scientific experimenters no assistance, supremacy in this highly skilled industry passed over to Germany, the Government of which had had the insight and the foresight to gauge its actual and potential value. When war broke out in 1914 there was but one firm—Messrs. Chance Brothers and Co., Ltd.—manufacturing optical glass in the British Empire. The consequence was that during the first year of the war our armies and our fleets could not be equipped with the optical glass required. Thanks to the brilliant research work of Sir Herbert Jackson and his colleagues on the Glass Research Committee of the Institute of Chemistry; to the investigations and work of Messrs. Chance Brothers; and, later, to the work done by the Derby Crown Glass Co., Ltd., by the end of the war British optical glass was as good as German, and was being produced in quantities sufficient to meet every demand. Messrs. Chance Brothers were manufacturing in one year optical glass sufficient to meet three years of the whole world's peace demand before the war. The Derby Crown Glass Co., which, before it was requested to do so by the Optical Munitions Department of the Ministry of Munitions, had not made an ounce of optical glass, is now producing some seventy or more different types and varieties "of a quality," says Prof. Cheshire, "which challenges comparison with the best in the world." Nor is this all. The establishment of the British Scientific Instrument Research Association, of the Department of Technical Optics at the Imperial College of Science and Technology, and of the Department of Glass Technology at the University of Sheffield, and the work of the National Physical Laboratory are all designed to consolidate and extend the ground gained, so that our manufacturers may keep in the front rank and not again allow themselves to be outstripped. But, the *Daily Telegraph* points out, the industry is again exposed to the full blast of German competition, more formidable now than ever because of the state of the German exchange. The editorial article in our contemporary concludes by endorsing the demand of the industry that the Government shall implement the verbal assurances given during the war, and, by a system of importation only under licence for a period of, say, seven years, enable this industry—"of all others a key industry"—to be safely tided over this abnormal period.

Mineral Resources of the United States.

ATTENTION may be directed to Bulletin No. 666 of the United States Geological Survey, recently issued, entitled "Our Mineral Supplies," which gives a brief account of the mineral resources of the United States, compiled from the point of view of the importance of rendering the United States economically independent of the rest of the world so far as mineral output is concerned. Even before America took part in the war it was recognised that her stocks of imported minerals were likely to be exhausted, or at any rate seriously depleted, and that it was necessary to take measures to ascertain how far it was possible to replace these minerals from home resources. Certain minerals were imported from choice rather than from necessity, because they could be obtained of higher grade, or more conveniently, or more cheaply from abroad, and in these cases it was only necessary to stimulate the home production. In a few other cases the minerals were imported because they either did not occur at all or did not occur in workable quantities or under workable conditions within the United States. The list of such minerals is, however, surprisingly short. All minerals are here classified under three heads, namely: Class 1, domestic mineral supplies adequate to all probable peace and war needs of the United States; Class 2, domestic mineral supplies sufficient for a large part of the peace and war needs of the United States; and Class 3, domestic mineral supplies inadequate in quantity or quality, or both, for the peace and war needs of the United States. This last class includes only asbestos, chromite, graphite, manganese ore, monazite, nickel, nitrates, platinum, potash salts and tin, and in only three of these, namely, monazite, nitrates and potash, was there no production at all in 1913, and only in the case of nitrates was there no production in 1917. In many cases, even amongst those minerals that occur but sparingly, the production had increased immensely during those four years. Thus, for example, the production of chromite was 255 tons in 1913 and 43,725 tons in 1917. Although not written with that object, this bulletin gives a vivid impression of the wonderful natural resources of the United States.

University and Educational Intelligence.

BRISTOL.—Mr. W. A. Andrews has been appointed lecturer on applied chemistry at the Merchant Venturers' Technical College in succession to Capt. H. Stanley. Mr. Andrews is at present a member of the staff of the Cardiff Technical College.

CAMBRIDGE.—The alternative scheme drawn up by one-half of the Syndicate on the relation of women students to the University will be submitted to the Senate for approval on February 12. A grace is proposed expressing the approval of the Senate of the incorporation of Girton and Newnham Colleges into a University, which Cambridge University would assist and co-operate with in various ways. The women's colleges have given notice that they will not take any steps towards the formation of a separate University even if the report is approved, so that the question will not apparently be much affected whichever way the voting goes.

Prof. Burkitt has offered the University, on behalf of a number of people interested in Oriental archæology, a sum of 20*l.* annually to enable the University to become "a subscribing learned society" to the British School of Archæology in Jerusalem. This will give the University the power to nominate one student at the school.

WE have received a copy of the annual report and statement of accounts of Livingstone College, E.10, for the year 1919–20. For more than three years during the war the buildings were used as a hospital for wounded soldiers, but they have now reverted to their proper function of training missionaries in the elements of practical medicine and surgery. The usefulness of the college has been extended by the decision to admit women as students. It is also announced that a special residential vacation course will be held in July this year on the care of health in the tropics with practical clinical work. In spite of the strictest economy the debit balance increased by 360*l.* during the year, and the deficit now amounts to 931*l.* Donations towards the financial needs of the college are earnestly solicited.

FROM the *Pioneer Mail* for December 24 we learn that the Raja of Mahmudabad inaugurated the Muslim University of Aligarh on the morning of December 17. The proceedings began with a recitation from the Koran, after which the Raja Sahib, who is the first Vice-Chancellor of the new University, read his inaugural address. He gave some account of the history of various Islamic universities, and expressed the hope that the new institution would cause a revival of old Islamic arts and sciences as well as bring modern science within the reach of Muslim youths. The same evening, at the dinner given by the Vice-Chancellor, the latter suggested that the new University should endeavour to raise funds to render it independent of Government assistance; to start this fund he himself promised to give a lakh of rupees (6666*l.*).

THE *Daily Mail* is offering four scholarships, each of the total value of 250*l.*, for students who intend to study for the degree of Bachelor of Commerce at London University. Candidates must be British-born, and they must be engaged, or about to engage, in whole-time business employment. The qualifying examination will be the London Matriculation Examination of June, 1921, and candidates must enter for this in addition to applying for the scholarships. Application forms for candidates living within the 20-mile radius of London will be available at the Efficiency Exhibition, which will open at Olympia on February 10; those living outside this radius can obtain the forms after that date by applying for the catalogue of the exhibition, price 1*s.* 3*d.*, to "Efficiency Catalogue," *Daily Mail,* Carmelite House, London, E.C.4. Candidates must show that they are engaged, and intend to continue to be engaged, in whole-time employment in business and that they propose to pursue a regular course of study for the degree in commerce. The scholarships will be tenable for four years, and payments of the grant will be subject to the student's progress.

THE second Congress of Universities of the Empire will be held at Oxford on July 5–8 of this year. As at the first congress, which met in London in 1912, it is expected that there will be a large attendance of representatives of the universities of the United Kingdom and of the King's Dominions overseas. For a month all delegates from overseas will be the guests of the home universities; the latter will be visited in turn either before or after the full meeting of the congress. In August last letters were addressed to all the universities overseas, and in October a similar circular was sent to all the universities of the United Kingdom, asking for suggestions for the agenda for the coming congress. A sub-committee consisting of the officers of the Bureau and the Vice-Chancellors of Oxford and Cambridge sat to consider the answers received, and it was decided that the second congress should be devoted to considerations of the chief fields of university activity, particularly to those which are new and likely to be viewed from diverse points of view. The agenda therefore consists of subjects dealing with the position of the universities with regard to secondary, adult, technological, and commercial education; with university curricula, research, and finance; and with the problems of the interchange of teachers and students between different universities. Lord Curzon, Mr. A. J. Balfour, Lord Haldane, Lord Crewe, Lord Balfour of Burleigh, Lord Shaftesbury, Lord Robert Cecil, and Lord Kenyon will preside at successive meetings of the congress.

IN March of last year a Royal Commission was appointed to inquire into the financial resources and working of the University of Dublin and of Trinity College, Dublin, and to consider the application made by the University for State financial assistance. The report of the Commission, of which Sir Archibald Geikie was chairman, has been issued as a Parliamentary Paper (Cmd. 1078). The Commissioners estimate that the annual cost over and above the present expenditure of the college of carrying into effect various recommendations will be 49,000*l.*, and that a further sum of 113,000*l.* will be required to provide for new buildings and equipment, reconstruction, and necessary repairs. They are unanimously of opinion that the existing resources of the University of Dublin should be augmented from public funds by an immediate non-recurrent grant of 113,000*l.* and an annual subsidy of 49,000*l.* The following are some of the annual grants recommended:—Physics, 1350*l.*; Dunsink Observatory, 900*l.*; chemistry, 2228*l.*; botany, 2050*l.*; geology, 1400*l.*; zoology, 2150*l.*; medicine, 5692*l.*; engineering, 4270*l.*; agriculture, 2000*l.*; the library, 1588*l.*; research or travelling exhibitions, 2400*l.* Of the capital expenditure 31,500*l.* is recommended for new construction and renovation for the School of Chemistry; 2000*l.* for gardens for the School of Botany; 7000*l.* for a new building for the School of Zoology; 16,000*l.* for a new building for bacteriological research; 19,500*l.* for the Department of Physiology; 25,000*l.* for the extension of premises and equipment of the Department of Engineering; and 12,400*l.* for a new library building and equipment.

ENGINEERING education in the United States is carried on in two types of institution: universities and independent institutes (Higher Education Circular, No. 20, of the Bureau of Education, 1920). The American university differs in its organisation from the universities both of Latin America and of Europe. Typically, it contains a number of "schools" to which students are admitted direct from the secondary schools, and one or more divisions, such as medical and law schools, to which students are admitted only after they have completed two years' training in one of the schools mentioned above. Engineering is a school which offers professional training leading to engineering degrees to students straight from the secondary schools; generally, engineering schools are administered as separate units. The independent institutes are usually devoted solely to engineering, and, academically, the training they provide is of the same standard as that offered by the universities. Both provide a course lasting four years which leads to the degree of B.S. in some branch of engineering; it is at the same time, in spirit and in tendency, a professional course fitting young men for the immediate practice of their professions. In consequence, the curriculum is determined by the requirements of the profession, and, therefore, somewhat rigidly prescribed. Recently the tendency has been to lengthen the training, and several universities are now offering five- and six-year courses. The expenses of foreign students attending American institutions vary; tuition fees range from 150 to 300 dollars per annum in the privately endowed schools, and in State-supported institutions from 20 to 125 dollars a year. Living expenses are assessed at 500 to 700 dollars per annum, and further allowance must be made for travelling expenses when the institution is some distance from ports of entry. A list is given of 127 schools providing four-year courses in engineering which show an enrolment of 51,400 students; one school alone, the Massachusetts Institute of Technology, has accepted 2201 students, while fourteen others have each more than 1000 pupils.

Calendar of Scientific Pioneers.

January 20, 1907. Agnes Mary Clerke died.—Widely known for her astronomical writings, Miss Clerke, like Mary Somerville, Caroline Herschel, Ann Sheepshanks, and Lady Huggins, was an honorary member of the Royal Astronomical Society.

January 21, 1892. John Couch Adams died.—Few scientific achievements have aroused more interest or more controversy than the discovery of Neptune, and the careers of few astronomers have opened so brilliantly as that of Adams, who simultaneously with Leverrier worked out the calculations demonstrating the existence of this planet. After working at the problem for two years Adams in September, 1845, communicated his results to Challis, and in October to Airy. Leverrier's papers were published shortly afterwards, and Neptune was first seen by Galle at Berlin on September 23, 1846. Adams, who was born in Cornwall on June 5, 1819, became Lowndean professor in the University of Cambridge in 1858, and in 1861 succeeded Challis as director of Cambridge Observatory.

January 22, 1799. Horace Bénédict de Saussure died.—Saussure was the first great explorer of the Alps. A naturalist and a physicist, he has been called "the founder of experimental geology," and he is said to have been the first to place meteorology on a reasonable basis.

January 22, 1840. Johann Friedrich Blumenbach died.—For more than fifty years Blumenbach held the chair of anatomy at Göttingen, and wrote works on physiology, anatomy, embryology, and ethnology which became European text-books.

January 22, 1867. Sir William Snow Harris died.—A prominent worker in electricity, Harris by his new form of lightning conductor added greatly to the safety of ships at sea.

January 22, 1900. David Edward Hughes died.—Son of a bootmaker who emigrated to America, Hughes in 1855 patented his type-printing telegraph, and in 1857 came to England. In 1878 he patented his microphone. Recognised as one of the greatest scientific inventors of the age, he amassed a fortune of nearly half a million sterling, which was given mainly to London hospitals and scientific societies.

January 24, 1877. Johann Christian Poggendorf died.—Poggendorf was for fifty years editor of the *Annalen der Physik und Chemie.*

January 24, 1914. Sir David Gill died.—Astronomer-Royal at the Cape of Good Hope, Gill was one of the best known astronomers of his day. He is especially remembered for his great geodetical operations, his determination of the solar parallax, and his pioneering work in connection with the photographic survey of the heavens.

January 26, 1631. Henry Briggs died.—On the foundation of Gresham College, London, Briggs was appointed to the chair of geometry, the first of its kind in England. He was also the first to hold the Savilian chair of geometry at Oxford.

January 26, 1823. Edward Jenner died.—After twenty years' experimenting, Jenner on May 14, 1796, made his first vaccination. Three years later seventy London doctors declared their confidence in his discovery, which was soon promulgated throughout the world. Parliament acknowledged the country's indebtedness to him by voting him sums totalling 30,000*l.*

January 26, 1895. Arthur Cayley died.—Senior wrangler in 1842, Cayley for many years was a law conveyancer, but in 1863 became first Sadlerian professor of mathematics at Cambridge. E. C. S.

Societies and Academies.

LONDON.

Aristotelian Society, January 3.—The Very Rev. Dean W. R. Inge, president, in the chair.—C. A. **Richardson**: The new materialism. The new materialism takes the form of a denial of anything corresponding to the idea of "mind" or "subject." Unlike the old doctrine, it does not affirm the reality of atoms; its ultimate stuff is sense-material. It reduces the subject of experience to a series of sense-data, and the sense-data are conceived as ontologically independent of the subject. Against this it was argued that the subject of experience is a real metaphysical existence. Experience consists in spiritual activity, and one type of this activity is sense-experience. The content, sense-data, is the particular form the activity assumes, and the form is determined by the interaction of individual subjects. The most pressing philosophical need of the day is to come to an agreement on this point. Until we are agreed as to whether there exists the subject or mind there must be disagreement on the fundamental matter of philosophy, namely, the entities in terms of which theories may be formulated. Without a common platform philosophy will be left behind, a curious relic, by the intuitive wisdom of the vast mass of humanity.

DUBLIN.

Royal Dublin Society, December 21.—Dr. F. E. Hackett in the chair.—J. J. **Dowling** and D. **Donnelly**: The measurement of very short intervals of time by the condenser-charging method. An investigation of the degree of accuracy obtainable in the measurement of short time intervals by a method in which the time interval is determined by observing the charge taken up by a condenser connected to a source of steady electromotive force through a known resistance during the interval in question. It was found possible to measure intervals of thirty millionths of a second with an accuracy of one millionth of a second.—J. J. **Dowling** and J. T. **Harris**: An apparatus is described whereby a spark-gap, included in the secondary circuit of a high-tension transformer, is rendered conducting during one-half of each cycle, thus permitting a current to flow in one direction only. The primary current energises an electromagnet which sets into vibration the diaphragm of a König manometric flame, situated in the spark-gap. A subsidiary winding allows the magnet to be polarised by a steady current so as to cut out each alternate flame oscillation. Various tests of the apparatus are described which indicate that very complete rectification is obtainable.—J. J. **Dowling**: A sensitive valve method for measuring capacities, with some important applications. A steady source of alternating e.m.f. is connected to a circuit consisting of a high resistance in series with a condenser. The drop of potential across the resistance is proportional to the capacity of the condenser. The filament and grid of a three-electrode valve respectively are connected to the ends of the resistance, and variations of the capacity of the condenser thus bring about corresponding variations in the plate current. The greater part of this is balanced by an opposed steady current derived from a battery connected through an adjustable resistance to the galvanometer terminals. Using a galvanometer of high sensitivity, very small variations can be detected. The application of this principle to the construction of an ultra-micrometer and of a micro-pressure gauge are described. Displacements of the order of 10^{-7} cm. are easily measurable. Further work is in progress.

PARIS.

Academy of Sciences, December 27.—M. Henri Deslandres in the chair.—H. **Douvillé**: The Eocene of Peru. From the examination of a number of fossils sent by Prof. Lisson (of Lima) it is concluded that the views of Grzybowski, published in 1899, must be modified. Only the upper portion of the Payta strata can still be attributed to the Pliocene; the remainder of the Tertiary Peruvian layers reproduces very closely the constitution of the Californian Eocene, and, like the latter, contains lignite and oil. —P. **Termier** and W. **Kilian**: The age of the glistening schists of the Western Alps. The age of these deposits has been much discussed with widely varying deductions. The authors, after a survey of the existing data, conclude that there is certainly Lias in these strata, and very probably some of the Upper Trias.—C. **Richet** and H. **Cardot**: The hereditary transmission of acquired characters in micro-organisms. A study of the influence of toxic substances (antiseptics) on the lactic bacillus, of the immunity acquired by successive generations, and of the transmission of this acquired immunity to antiseptics.—G. **Charpy** and J. **Durand**: The melting point of coal. It is well known that with certain coals a rise of temperature produces a softening, sometimes called the melting point. This agglomeration point is very important from the point of view of coke manufacture, but it would appear that no exact measurements of this temperature have been made. A description is given of the method devised to give definite readings, with results for eight coals. The "melting point" is characteristic for a given coal, and is independent of the amount of volatile matter present.—L. E. **Dickson**: Polynomials equivalent to determinants.—S. **Bays**: Cyclic systems of Steiner.—G. **Giraud**: Reply to a note by M. Fubini on automorph functions.—P. **Humbert**: Hypertoroidal functions and their connection with hyperspherical functions.—T. **Varapoulos**: The zeros of the integrals of a class of differential equations.—R. **Birkeland**: Resolution of the general algebraical equation by hypergeometrical functions of several variables.—B. **de Fontviolant**: Calculation of the strengths of circular bridges.—H. **Godard**: Observation of the Skjellerup comet made at the Bordeaux Observatory (38-cm. equatorial). Position given for December 17. The comet is a nebulosity of about 1′ diameter without visible nucleus: 11th magnitude.—M. **Michkovitch**: Observation of the Skjellerup comet made at the Marseilles Observatory (26-cm. Eichens equatorial). Position given for December 20.—A. **Hansson** and H. **Jelstrup**: Spectrum of Nova Aquilæ III. in July, 1920. The two photographs, one of two hours' and the other of one hour's exposure, showed a large number of bright lines on a background of continuous spectrum, and, consequently, the identification of the bright lines proved to be difficult. A table of the wave-lengths of the lines identified is given, and includes lines attributed to calcium, helium, iron, hydrogen, and to the element characteristic of nebulæ.—L. **Bloch**: Comparison of the theories of Lorentz and Mie.—P. **Vaillant**: The variations in the electrical conductivity of calcium sulphide with temperature. When a thin layer of calcium sulphide previously exposed to sunlight is heated its electrical conductivity rapidly increases, passes through a very marked maximum, and then decreases almost to zero. The phenomenon is closely connected with the state of phosphorescence.—G. **Contremoulins** and E. **Puthomme**: The determination of the time of exposure in radiography.—P. **Lebeau** and A. **Damiens**: The composition of some coke-oven gases. Analyses of four samples of coke-oven gas made by a method described in an earlier publication. Compared with coal-gas, the main differences are the lower percentage of hydrogen and the high proportion (20 per cent.) of nitrogen.—H. **Le Chatelier**: Remarks on the preceding paper.—M. **Godchot**: The catalytic addition of hydrogen to suberone. By the action of reduced nickel and hydrogen at 175° C. suberone is converted into suberol. Attempts to form a six-carbon ring from suberone by the action of active nickel at 240° C. were unsuccessful, differing in this respect from *cyclo*-heptane.—P. H. **Fritel**: The presence of the genera Phragmites and Nephrodium in the Pleistocene clays of Benenitra (Madagascar).—A. **Nodon**: Solar action and the recent atmospheric disturbances.—P. **Mazé**: Researches on the assimilation of carbon dioxide by green plants. The fresh leaves were heated to 60° C. under reduced pressure and the distillate was received in an ice-cooled receiver. In no case could formaldehyde be detected, but nearly all plants gave ethyl alcohol, acetaldehyde, and nitrous acid. Beans and maize collected in fine weather gave acetylmethylcarbinol, elder leaves gave hydrocyanic acid and glycollic aldehyde, whilst lactaldehyde was obtained from poplar leaves.—A. **Desgrez** and H. **Bierry**: Nitrogen equilibrium and carbohydrates in the food ration. Below a certain limit no other food can replace carbohydrates.—A. **Mayer**, M. **Plantefol**, and F. **Vlès**: Poisoning by the nitrohalogen methanes. Chloropicrin has the most powerful toxic effect; bromopicrin and dichlorodinitromethane are from eight to ten times less active.—R. **Anthony**: Tubular pseudo-hermaphroditism in male Cetaceans.—A. **Dehorne**: The spermatogenesis of *Corethra plumicornis* and eupyrene chromosomes.—M. **Doyon**: Participation of the cellular nuclei in the phenomena of secretion. The anti-coagulating properties of the nucleinic acid of the intestine.—A. **Malaquin**: Sexual and asexual reproduction.—L. **Cavel**: The purification of sewage by the activated-sludge method.

SYDNEY.

Royal Society of New South Wales, December 1.—Mr. J. Nangle, president, in the chair.—Dr. J. A. **Pollock**: The stethoscope, with a reference to a function of the auricle. Various forms of stethoscope are considered; the acoustic determination of surface vibrations has a definite dynamical aspect when the disturbances are very small. Detection in all the instances described depends on the movements of the surface relative to a steady mass elastically connected with it. In detecting small movements with the old-fashioned stethoscope, or after the manner of the tracker, the mechanism is supplied by the head and ear, the auricle having the very definite function of acting as the elastic connection between the mass and the surface. In other cases where the air disturbances are led by tubes directly into the ear passages the mechanical action is recognisable as associated with the instruments.—A. R. **Penfold**: The essential oils of *Leptospermum odoratum* and *L. grandiflorum*. The principal constituents of the former are eudesmene and aromadendrene (sesquiterpenes), eudesmol (sesquiterpene alcohol), α- and β-pinene, with smaller amounts of a rose-odour alcohol, esters, and phenols. This is the first time that eudesmene has been found occurring in Nature. *Leptospermum grandiflorum* consists principally of the same two sesquiterpenes with an unidentified sesquiterpene alcohol.—M. B. **Welch**: Eucalyptus oil-glands. The oil was formerly considered to be present as a single globule contained in a small cavity, but it would now appear that it is rather in the form of an emulsion in cavities which usually approach the surface. Oil occurs also in the stems, buds, fruit, and, in rare species, in the barks. The glands are often more or less devoid of contents, and in the different species show decided variation in arrangement and number. Their origin is evidently due to the separation of certain cell-tissues and their later disintegration.—Dr. G. Harker: The temperature of the vapour arising from boiling saline solutions. It is shown that the temperature of the vapour can be obtained well over 100° C. by boiling the solution in a hypsometer, either by a Bunsen flame or by admission of steam from water boiled in a separate vessel. With a solution of calcium chloride boiling normally at 115° C. a temperature of 106° C. was obtained for the vapour at a point 10 in. above the boiling solution. It is claimed that under the conditions of the experiment superheating could not take place.—J. H. Maiden: Notes on two Acacias. (1) The first is a spreading shrub, which may, however, assume an erect habit and become 10 ft. high. Its affinities are shown in that it was formerly known as *Acacia doratoxylon* var. *angustifolia*. It differs from that species in its habit, in its smaller size, in the short sessile flower-spikes, which are axillary and not racemose, and in the hairy ovary. It is found chiefly in the New England granite country from Howell, near Tingha, as far north as Stanthorpe and the Toowoomba district in Queensland. (2) The second wattle is submitted as a form or race of *Acacia pycnantha*, Benth., or a new species. In its ordinary morphological characters it resembles closely the species named, but there are important differences in the seedlings, the percentage of tannin in the bark, and other characters which lead the author to propose it as a new species. The type comes from Jerrabomberra, in the Federal Territory, near Queanbeyan.—E. Cheel: A native tea-tree, *Leptospermum flavescens* var. *grandiflorum*. This plant occurs in the deep creeks and river-beds from Penrith, extending to the Blue Mountains on the western line, and from Douglas Park to Braidwood on the southern line and tablelands. It was suggested that the plants were quite different from any other species, and the oil obtained from the leaves by Mr. A. R. Penfold tends to confirm this view.

Books Received.

The Foundations of Chemical Theory. By Prof. R. M. Caven. Pp. viii+266. (London: Blackie and Son, Ltd.) 12*s*. 6*d*. net.

A Physician's Anthology of English and American Poetry. Selected and arranged by Dr. C. A. Wood and Dr. F. H. Garrison. Pp. xxiii+346. (London: Oxford University Press.) 8*s*. 6*d*. net.

Les Hommes Fossiles: Eléments de Paléontologie Humaine. By Prof. M. Boule. Pp. xi+491. (Paris: Masson et Cie.) 40 francs.

Penrose's Annual. Volume 23 of the Process Year Book and Review of the Graphic Arts. 1921. Edited by W. Gamble. (London: P. Lund, Humphries and Co., Ltd.; Bradford: The Country Press.) 10*s*. 6*d*. net.

Personal Beauty and Racial Betterment. By Prof. K. Dunlap. Pp. 95. (London: H. Kimpton.) 6*s*. net.

Practical Dental Metallurgy. By Prof. J. D. Hodgen. Fifth edition, completely revised. Pp. 436. (London: H. Kimpton.) 15*s*. net.

Lubricating and Allied Oils: A Handbook for Chemists, Engineers, and Students. By E. A. Evans. (The Directly-Useful Technical Series.) Pp. xv+128. (London: Chapman and Hall, Ltd.) 9*s*. 6*d*. net.

Science Masters' Association: Oxford Meeting, January 5–6, 1921. Practical Suggestions towards the Study of Crystals in Schools. By T. V. Barker. (Oxford: The Holywell Press.) 1*s*. net.

Paläontologie und Abstammungslehre. By Prof. K. Diener. Zweite auflage. Pp. 137. (Berlin and Leipzig: W. de Gruyter and Co.) 1*s*. 9*d*.

The Theory of Direct-Current Dynamos and Motors. By J. Case. Pp. xiii+196. (Cambridge: W. Heffer and Sons, Ltd.) 15*s*. net.

An Introduction to the Chemistry of Plant Products. By Dr. P. Haas and T. G. Hill. Vol. i.: On the Nature and Significance of the Commoner Organic Compounds of Plants. Third edition. Pp. xiii+414. (London: Longmans, Green and Co.) 16*s*. net.

A Text-Book of Physics. By Dr. W. Watson. Seventh edition, revised by H. Moss. Pp. xxvi+976. (London: Longmans, Green and Co.) 21*s*. net.

Department of Applied Statistics (Computing Section), University of London, University College. Tracts for Computers. Edited by Karl Pearson. No. ii.: On the Construction of Tables and on Interpolation. Part i.: Uni-variate Tables. By Karl Pearson. Pp. 70. 3*s*. 9*d*. net. No. iii.: On the Construction of Tables and on Interpolation. Part ii.: Bi-variate Tables. By Karl Pearson. Pp. 54. 3*s*. 9*d*. net. (London: Cambridge University Press.)

General Practice and X-Rays: A Handbook for the General Practitioner and Student. By Alice V. Knox. Pp. xiv+214+xxxii plates. (London: A. and C. Black.) 15*s*. net.

The New Hazell Annual and Almanack for the Year 1921. Thirty-sixth Year of Issue. Pp. lvi+823. (London: H. Frowde and Hodder and Stoughton.) 7*s*. 6*d*. net.

Clouds: A Descriptive Illustrated Guide-Book to the Observation and Classification of Clouds. By G. A. Clarke. Pp. xvi+136+40 plates. (London: Constable and Co., Ltd.) 21*s*. net.

The Raw Materials of Perfumery: Their Nature, Occurrence, and Employment. By E. J. Perry. Pp. ix+112. (London: Sir I. Pitman and Sons, Ltd.) 3*s*. net.

Diary of Societies.

THURSDAY, JANUARY 20.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. A. Harden: Biochemistry (Vitamines).

ROYAL SOCIETY, at 4.30.—Sir Robert Hadfield, Bart., S. R. Williams, and I. S. Bowen: The Magnetic Mechanical Analysis of Manganese Steel.—Dr. W. S. Tucker and E. T. Paris: A Selective Hot-wire Microphone.—E. A. Milne and R. H. Fowler: Siren Harmonics and a Pure Tone Siren.—Prof. L. V. King: The Design of Diaphragms capable of Continuous Tuning.

LINNEAN SOCIETY, at 5.—Prof. E. H. C. Walsh: Lhasa and Central Tibet.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.—Lord Montagu of Beaulieu: The Cost of Air Ton-miles compared with Other Forms of Transport.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—R. E. Palmer: Some Observations on Mining by the Opencast or Stripping Method.—E. A. Wraight: The Standardisation of Materials Employed in Mining and Milling Plant.—A. M. Pontie: Notes on the High-level Diamond Deposits of Brazil.

INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates' Meeting), at 8.—W. H. Wardall: Cylinder and Piston Wear.

CHEMICAL SOCIETY, at 8.—J. V. Backes, R. W. West, and M. A. Whiteley: Quantitative Reduction by Hydriodic Acid of Halogenated Malonyl Derivatives. Part I., The Amides of Sym. Dialkyl and Aryl Substituted Amides of Mono- and Di-bromomalonic Acid.—B. M. Gupta: An Investigation on the Influence of Negative Groups of Different Character on the Reactivity of Hydrogen Atoms Carried by the Same Carbon Atom. Part I.—J. Brönsted: The Influence of Salts upon the Chemical Equilibria in Solution.—H. Hepworth: The Action of the Grignard Reagent on Certain Nitric Esters.—G. T. Morgan and H. D. K. Drew:

Researches on Residual Affinity and Co-ordination. Part III., Reactions of Selenium and Tellurium Acetylacetones.—G. T. Morgan and D. C. Vining: Dihydroxynaphthaldehydes.—G. T. Morgan: Ortho-chlorodinitrotoluenes. Part II.—C. K. Ingold: The Conditions Underlying the Formation of Unsaturated and of Cyclic Compounds from Halogenated Open-chain Derivatives. Part I., Products Derived from α-Halogenated Glutaric Acids.—A. Findlay and W. Thomas: Influence of Colloids on the Rate of Reactions involving Gases. I., Decomposition of Hydroxylamine in Presence of Colloidal Platinum.—M. Nierenstein: The Constitution of Catechin. Part III., Synthesis of *aca*Catechin.—K. G. Naik: The Formation and Properties of Dithioketones ($R_2C=S=S$) and Dithioethers ($R_2S=S$). Part I., The Preparation of Certain Dithioketones and Dithioethers.—W. N. Haworth and E. L. Hirst: The Constitution of the Disaccharides. Part V., Cellobiose (Cellose).—S. H. C. Briggs: The Elements Regarded as Compounds of the First Order.—J. D. Morgan and R. V. Wheeler: Phenomena of the Ignition of Gaseous Mixtures by Induction Coil Sparks.—E. J. Williams: Chloroform Solutions of Hydrogen Chloride.—L. J. Hudleston and H. Bassett: Equilibria of Hydrofluosilicic Acid.—E. Newbery: Chlorine Overvoltages.—P. Râу and P. V. Sarkar: Compounds of Hexamethylenetetramine with Complex Metallic Salts and Acids.

RÖNTGEN SOCIETY (in Physics Laboratory, University College), at 8.15.—M. A. Codd: Increasing the Efficiency of X-ray Tubes by an Improved Design of Coil and Interrupter.

FRIDAY, JANUARY 21.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Prof. R. S. Troup: Indian Timbers.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 5.—T. R. Rodger: Cavernous Sinus Thrombosis.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. Keith: The Principles of Craniology applied to Clinical and Racial Problems.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—H. J. Smith: The Mechanical Loading of Ships.

INSTITUTION OF ELECTRICAL ENGINEERS (at Faraday House, Southampton Row), at 6.30.—H. J. Howard: Electric Welding.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—G. Barrow: The Origin and Age of Post-Eocene Brick-earths near London.

JUNIOR INSTITUTION OF ENGINEERS (at Caxton Hall), at 8.—B. H. Joy: Motor Yachts.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Dr. W. J. Turrell: The Therapeutic Activity of the Galvanic Current.

SATURDAY, JANUARY 22.

BRITISH MYCOLOGICAL SOCIETY (in Botanical Department, University College, Gower Street), at 11 a.m.—F. T. Brooks: Some Tomato Fruit Diseases.—Dr. E. J. Butler: The Imperial Bureau of Mycology.—Miss G. Lister: A New Genus of the Mycetozoa from Japan.—T. Petch: Thread Blights.—Dr. H. Wager: The Action of Gravity on the Fungi.—J. Ramsbottom: Exhibit of Lantern Slides showing Fungal Infection of Orchid Seeds.

PHYSIOLOGICAL SOCIETY (at King's College), at 4.

MONDAY, JANUARY 24.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. Keith: The Principles of Craniology applied to Clinical and Racial Problems.

ROYAL SOCIETY OF ARTS, at 8.—A. E. L. Chorlton: Aero Engines (Howard Lectures).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—Sir Frank Colyer: Old Dental Instruments.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—F. C. Cornell: The Lower Reaches of the Orange River.

MEDICAL SOCIETY OF LONDON, at 8.30.—Dr. A. Feiling: Multiple Neuritis.

TUESDAY, JANUARY 25.

ROYAL HORTICULTURAL SOCIETY, at 3.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Gerald P. Lenox-Conyngham: The Progress of Geodesy in India.

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—Resumption of Discussion on paper by Prof. T. B. Abell on Reinforced Concrete for Ship-Construction.—G. Ellson: Cannon Street Bridge Strengthening.—F. W. A. Handman: Reconstruction of a Viaduct.

ROYAL SOCIETY OF MEDICINE (Medicine Section), at 5.30.—Dr. P. J. Cammidge: Some Observations Bearing on the Etiological Classification of Diabetes Mellitus.—Dr. E. P. Poulton: The Treatment of Peptic Ulcer by Means of Gastric and Gastro-duodenal Tubes.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Dr. F. M. D. Berry: Serbia and Jugo-Slavia Before the War and After.

ROYAL ANTHROPOLOGICAL INSTITUTE (Annual General Meeting), at 8.15.

WEDNESDAY, JANUARY 26.

ROYAL SOCIETY OF ARTS, at 4.30.—A. Abbott: The Origin and Development of the Research Associations Established by the Department for Scientific and Industrial Research.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. Keith: The Principles of Craniology applied to Clinical and Racial Problems.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.—F. E. Wentworth-Sheilds: The Lay-out and Equipment of Docks (Vernon-Harcourt Lecture).

THURSDAY, JANUARY 27.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. A. Harden: Biochemistry (Vitamines).

ROYAL SOCIETY, at 4.30.—*Probable Papers*.—K. Sassa and Prof. C. S. Sherrington: The Myogram of the Flexor-reflex evolved by a Single Break-shock.—Sir Almroth Wright: "Interaction" Between Albuminous Substances and Saline Solutions.—Dr. S. Russ, Dr. Helen Chambers, and Gladwys M. Scott: The Local and Generalised Action of Radium and X-rays upon Tumour Growth.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.30.—Dr. G. L. Pardington: Advancing Years and Balneotherapy (Presidential Address).

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—G. A. Juhlin: Temperature Limits of Large Alternators.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—T. Walker: Obstruction After Suprapubic Prostatectomy and an Open Operation for its Prevention.

FRIDAY, JANUARY 28.

ASSOCIATION OF ECONOMIC BIOLOGISTS (at Imperial College of Science), at 2.30.—Dr. L. Lloyd: Greenhouse White Fly and its Control.—W. B. Brierley: Personal Impressions of Some American Biologists and their Problems.

ROYAL SOCIETY OF MEDICINE (Study of Disease in Children), at 5.—Dr. P. Parkinson: A Case of Patent Ductus Arteriosus.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. Keith: The Principles of Craniology applied to Clinical and Racial Problems.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—Prof. H. Nagaoka: The Magnetic Separation of the Neon Lines and Runge's Rule.—Capt. E. V. Appleton: A Method of Demonstrating the Retro-active Property of a Triode Oscillator.—Dr. D. Owen and R. M. Archer: The Quickness of Response of Current to Voltage in a Thermionic Tube.

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section), at 8.30.—Dr. A. S. M. MacGregor: Some Features of Current Small-pox in Glasgow.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir James Dewar: Cloudland Studies

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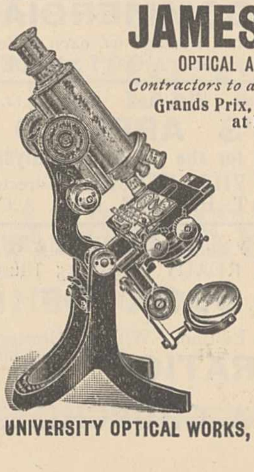

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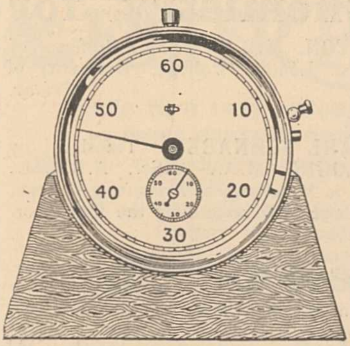

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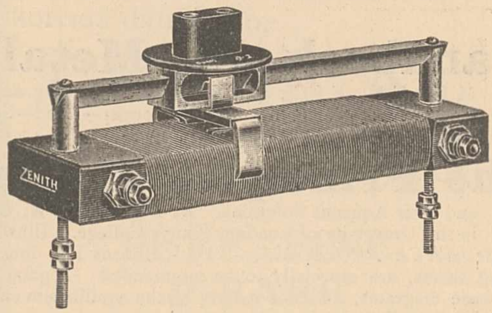

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