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Children and Museums.

THE direct educational work accomplished by museums in the United States is a perpetual source of shame to us in this country. We are well aware that much is being done in some of our own museums, often at the self-sacrifice of their officials; but have we anything to compare with what is described in a recent number of *Natural History* (March-April 1922)—the journal of the American Museum of Natural History? Consider lantern-slides, for example. Our own Natural History Museum has recently started one or two loan collections, comprising in all some few dozen slides. Those of the American Museum number many thousands. They are stored in a room accessible to teachers, who can thus select precisely what they want for their class-room lectures. Last year more than two hundred thousand slides were circulated. It is not long since a fair collection of slides made by an assistant in our own museum was handed over to another institution because there were no facilities for keeping it in the museum itself. Needless to say, the American Museum has a lecture theatre. It has 869 nature-study collections to be lent to any public school in greater New York. There are two motor cars and a motor cycle to deliver slides and collections. Each messenger visits from twenty to forty schools a day. The American Museum is about to erect a special School Service building of five storeys where from three to five thousand children daily may be taken care of properly. The blind are also provided for.

Of course, all this cannot be done by the ordinary officers of the museum, and that is a fact which must be recognised in this country. The American Museum has its own Department of Education, with Mr. George H. Sherwood at the head. In the same way the Brooklyn Botanical Garden has its Curator of Elementary Education, who contributes to the same issue of *Natural History* an interesting article on "Gardening and the City Child." But the work which starts in the museums and public gardens of New York and Brooklyn is taken up by other outside bodies, as the School Nature League of New York City, the president of which, Mrs. John I. Northrop, here tells us how in one of the elementary schools in the middle of the slums a wonderful nature-room has been installed. It is visited by from eight hundred to one thousand children every week. Here is a place for all those miscellaneous curiosities so frequently rejected by the staid museums. They can be placed in the hands of the children and many a fascinating lesson drawn from them. The love of nature thus begun is carried out into the open by means of summer camps, and so becomes linked up with the Boy Scout camps with their travelling museums.

Well, why is it that the Americans have got so far ahead of us on these lines? They have no doubt a new field to cultivate, and they do not have to contend against the terrible weight of inertia inevitable to some of our royal and ancient establishments. But to a large extent it is because Americans are not ashamed of having an ideal and of talking about it. They do not mind saying what they are going to do, and they make the utmost of everything that they have done. This is not the Englishman's way, but it is a way that interests the public both rich and poor. It brings money from the former and enthusiasm from the latter. If we want to achieve the same results we must not be above following somewhat similar methods. Here, during the summer holidays, are the children crowding our museums at South Kensington day after day. Cannot something more be done for them, even if we shed a little dignity in the process?

Ninety Years of British Science.

The British Association for the Advancement of Science: A Retrospect, 1831–1921. By O. J. R. Howarth. Pp. vii + 318. (London: British Association, Burlington House, 1922.) 7*s*. 6*d*.

MR. HOWARTH is to be congratulated on the manner in which he has used his opportunity, while the record he has produced is a most ample justification of the title of the Association—the British Association for the Advancement of Science—British in that its meetings have been held in nearly every part of the Empire, India excepted; and perhaps, as the part India can play in advancing science is more fully recognised, we may in the years to come have a meeting at Delhi, the centre of a civilisation dating back centuries before the Association.

The work is due to a suggestion made by Sir Charles Parsons when president in 1919–20, and owes much to his generous support, while the author has been helped in his task by many friends whose assistance is gratefully acknowledged in the preface. Commencing with the history of the foundation of the Association in 1831, the work deals with its relation to the advancement of science, its organisation and meetings, its aid to research, its connexion with the State, and its work overseas. The author states that his aim has been "to provide a summary review of its activities, with examples," and this he has done with conspicuous success.

Founded in 1831, the Association's life of ninety years has been full of stirring events. Sir David Brewster was its founder; in the *Edinburgh Journal of Science* (vol. 5, 1831) he wrote: "Some months ago it occurred to the editor of this work [himself] that the general interests of science might be greatly promoted by the establishment of a Society of British Cultivators of Science which should meet annually in some central town in England." In writing this Brewster had in mind the work of the *Deutscher Naturforscher Versammlung*, about which an article had appeared in the preceding volume of the journal. The objects of the meeting of this society were, as the author of this article stated, to promote "acquaintance and friendly personal intercourse among men of science; but other great and more important benefits grow out of them." "Might not," he continued, "similar results in our older country be looked for from a similar institution." This statement sums up the work of the Association. Similar results have followed, but to an extent undreamt of by Brewster and his colleagues. The first meeting was held at York. Dalton was there—"old Dalton, atomic Dalton, reading," as Murchison wrote later, "his own memoir, and replying with straightforward pertinacity to every objection in the highly instructive conversations which followed each paper."

Ninety years later the atom has been resolved into its constituent electrons, and Thomson, Rutherford, and Bohr have stated in no uncertain terms the laws which govern the planetary system of the atom, atom no longer when subject to the bombardment of the swift-moving electrons of the cathode rays.

The second meeting of the Association was held at Oxford, and the third at Cambridge. Sedgwick was president, and Mr. Howarth has printed an interesting selection of autographs of members present—Brewster Airy, Babbage, Faraday, Forbes, Herschel, Buckland, Harcourt, Murchison, Phillips, Peacock, Rigaud, Sedgwick, Whewell, Houston, etc., all great names; the physical sciences predominate. Biology was not, or rather it was represented by a little natural history, with some botany and geology. Of the Oxford meeting Murchison, afterwards general secretary and (1846) president, wrote that "under the presidency of Buckland, the body was licked into shape and divided into six sections."

Started thus under brilliant auspices, the Association has been a potent factor in the advancement of science; in its earlier years, it is true, it met with criticism and ridicule in some quarters—Dickens's "Mudfog Papers" may be mentioned; these it has outlived, and the striking success of the Edinburgh Meeting of 1921 showed that even in the altered conditions of the twentieth century there is still ample work for it to undertake.

Turning now to a brief reference to its numerous activities, from the commencement these have not been confined to the period of its annual meetings, and its main contributions to the advancement of science have been through the work of its various committees, aided by grants from its funds, and through the reports on the state of some special science drawn up by a member deputed for this work. "We repudiate," wrote Murchison in 1845, "that the chief aim of our existence is to stir up a few embers of scientific warmth in the provinces," and Owen, president in 1858, claimed that the association was realising the dream of Francis Bacon recounted in his "New Atlantis." Whewell in 1862 wrote: "The Association wants money and ought to get it for it spends a great deal;" he might have added, on objects of the utmost importance to the welfare and progress of mankind.

Mr. Howarth has given in an Appendix a complete list of the grants for research.

The following is a summary of these:

Section.	*l.*	*s.*	*d.*
A (Mathematics and Physics)	34,977	18	7
B (Chemistry)	4,178	17	8
C (Geology)	6,956	3	11
D (Zoology) and K (Botany) jointly	1,579	1	10
D (Zoology)	12,093	15	5
E (Geography)	3,695	13	4
F (Economics)	1,322	4	3
G (Engineering)	4,164	7	6
H (Anthropology)	7,226	16	11
I (Physiology)	3,115	13	7
K (Botany)	1,952	15	1
L (Education: founded in 1901)	538	18	6
M (Agriculture: founded in 1912)	5	0	0

The total sum expended since 1834 has been about 83,000*l.*, somewhat less than 1000*l.* a year it is true, but no inconsiderable sum when it is remembered it has been raised almost entirely from the subscriptions of its members, in the main men and women of science themselves.

The attempt to give details of the researches promoted by these grants would occupy far too much space. An interesting account will be found in Mr. Howarth's pages. Reference may, however, be permitted to a few taken from the list for Section A. Between the years 1862 and 1910 about 1100*l.* was spent in establishing electrical standards, which are now adopted throughout the world and have formed the foundation on which the whole edifice of applied electricity is reared. The observatory at Kew was supported from 1843 to 1872 in great measure by grants of more than 12,000*l.*, and for many years, by the issue of accurate standards and in other ways, promoted in a marked degree meteorological science. Under the subject Heat we find "Remeasurement of dynamical equivalent, 1870–80, 106*l.* 0*s.* 6*d.*"; Joule's work was thus supported by the Association. Seismology has been aided to the extent of more than 2500*l.*, while grants to tidal observations have reached about the same sum. Similarly, from the other Sections examples might be given, showing the influence the Association has exerted on progress and the value and wide scope of its work. For ninety years the Association has laboured, a union of voluntary workers for the advancement of science. In the words of Rayleigh, president in 1884, "The work may be hard and the discipline severe, but the interest never fails, and great is the privilege of achievement." Of the achievements of the Association Mr. Howarth's book is a fitting record.

A Standard Treatise on Crystallography.

Crystallography and Practical Crystal Measurement. By Dr. A. E. H. Tutton. Second edition. In 2 vols. Vol. 1: *Form and Structure.* Pp. xvii + 746 + xiv. Vol. 2: *Physical and Chemical.* Pp. viii + 747–1446. (London: Macmillan and Co., Ltd., 1922.) 50*s.* net each.

THE eleven years which have elapsed since the first edition of this work appeared, have witnessed a remarkable and welcome increase in the interest taken in crystals by chemists and physicists. On the chemical side this has been due partly to the efforts made by Pope and Barlow to correlate chemical composition and crystalline form, and partly to the tardy recognition on the part of organic chemists that the crystal form and optical properties of a substance, once accurately determined, form the most valuable means of identifying it that we possess. On the physical side interest has been aroused by the remarkable discovery of Laue and his collaborators that the conception of a crystal as an orderly arrangement of very minute particles arrived at by the experimental study of crystal morphology, and also from purely geometrical considerations, had a solid basis in fact and could be demonstrated by the diffraction of Röntgen rays. In the hands of the Braggs and of others working on similar lines, this discovery has led to a very wonderful increase in our knowledge of crystal structure. It is natural that these advances should be reflected in the work before us, and we find accordingly that Dr. Tutton has found it necessary to employ nearly five hundred additional pages to deal with the wealth of matter the past ten years have provided.

This has necessitated the division of the work into two volumes, each consisting of two sections, and has also led to a certain amount of re-arrangement of the material contained in the first edition. The first section, which occupies nearly one-third of the whole work, deals with crystal measurement by means of the one-circle, horizontal, reflecting goniometer, and follows closely on the lines of the original edition. A useful account of methods of goniometry at low temperatures has been introduced; and the use of the two- and three-circle goniometers, and the methods based on the gnomonic projection and associated with the name of V. Goldschmidt, receive more adequate treatment than before. The student will, however, miss in this chapter the extraordinarily detailed description of every step in experiment and in computation to which Dr. Tutton has accustomed him in what has gone before; and when he finds that three hundred pages are devoted to the discussion of one-circle goniometry the enthusiast for two-circle methods will scarcely perhaps feel content with part of one chapter. Many readers will wish for fuller information as to the methods of drawing crystals devised by Penfield and by Goldschmidt, and would have welcomed some account of the ideas on "complication" developed by the latter.

The second half of the first volume deals with crystal structure and X-ray analysis and contains much new matter. In particular, attention may be directed to the well-illustrated and concise account of the Sohncke point systems and also to the useful table of the 230 space groups, which will be found helpful as an introduction to a somewhat inaccessible part of the subject. Dr. Tutton's treatment arouses the wish that he had used his powers of clear exposition to elucidate still further these difficult but very important matters. The chapter on the application of X-rays to the determination of crystal structure gives an admirable account of the progress that has been made, while the sketch of Fedorov's views on the correct setting of crystals and on the compilation of a dictionary of crystal forms to facilitate the identification of chemical compounds by their morphology alone, whets our curiosity, and leads us to wish that Dr. Tutton had shown us how to work out the reticular density and the correct setting in a few typical cases.

The third section deals in the main with crystal optics, and begins with an introductory chapter which contains readable accounts of matters so diverse as thermionic valves, radio-activity, atomic numbers, isotopes, theories of atomic structure, the Zeeman effect, Aston's positive ray mass spectrograph, the Michelson echelon, and the Lummer-Gehrcke plate. The succeeding chapters are in the main reprinted from the first edition, but the treatment of the modes of production of monochromatic light is fuller and includes a useful description of the mercury vapour lamp. When explaining the colour effects observed when thin crystalline plates are placed between crossed Nicols, Dr. Tutton says: "The Nicol analyser itself introduces, when crossed to the polarising Nicol, a change of phase of half a wave-length, like the act of reflection in the case of thin films, and this $\lambda/2$ requires to be added to the retardation of one ray behind the other brought about in traversing the crystal." Experience has shown that this statement is a source of perplexity to the average student, and it is to be regretted that Dr. Tutton has not followed the more readily intelligible treatment adopted by Groth in the successive editions of his "Physikalische Krystallographie."

The general excellence of the illustrations is so high that the figures explanatory of the use of the mica plate in finding the optical sign of crystals seem scarcely to come up to the standard. A photograph of the phenomenon reproduced as a plate would have been more in keeping with the style of the book. The figures and descriptions of polarimeters for finding the optical rotation of liquids take up valuable space and seem scarcely necessary in a work on crystallography; indeed, the connexion of much of the matter in this section with crystals is somewhat remote, although the reader will perhaps forgive the author its introduction for the sake of its intrinsic interest, a case in point being the account of the use of the barium platinocyanide screen for secret signalling during the war. The last two chapters of this section contain a full description of the various types of microscopes and of the principal methods employed in the microscopic examination of crystals, both when isolated, or when occurring in rock slices.

The concluding portion of the book opens with an excellent discussion of isomorphism, isogonism, polymorphism, and enantiomorphism, which may be especially commended to the notice of chemists, who will find therein much interesting information as to recent work not easily accessible elsewhere. The next chapters are devoted to the thermal and elastic properties of crystals, and in particular to full descriptions of the ingenious and elaborate apparatus devised by Dr. Tutton for measuring them, and to these have been appended somewhat irrelevant accounts of the Interferential Comparator for standards of length, the Michelson Interferometer, and the Etalon of Fabry and Perot. The final chapters of the book are devoted to the consideration of the electric and magnetic properties of crystals, and to a brief but sufficient account of so-called "liquid crystals."

It will be seen, then, that these two volumes are a mine of accurate information on matters belonging to a wide field of knowledge, and testify alike to the learning and industry of the author and to the enterprise of his publishers. The wealth of detail of many of the descriptions, the large number and excellence of the illustrations, and the considerable amount of irrelevant matter introduced have naturally made the book both bulky and expensive to produce. It is to be feared that the consequent high price will place it out of the reach of the ordinary student, to whom, if we may judge by the long section on one-circle goniometry, it would seem mainly to be addressed. Had Dr. Tutton resisted the temptation to figure and describe every piece of elaborate and expensive apparatus which aroused his interest, and had he omitted all the paragraphs which have nothing to do with crystals, the length and cost of the book might have been very considerably reduced, and its accessibility to the student thereby increased, without in the least diminishing its value as a compendium of all that is worth knowing about crystal measurement as practised to-day.

New Editions of Chemical Works.

(1) *A Dictionary of Applied Chemistry.* By Sir Edward Thorpe. Vol. 3. Revised and enlarged edition. Explosives—Kyrofin. Pp. viii + 735. (London: Longmans, Green and Co., 1922.) 3*l*. net.

(2) *Metallography.* By Prof. Cecil H. Desch. (Text-Books of Physical Chemistry.) Third edition. Pp. xi + 440. (London: Longmans, Green and Co., 1922.) 16*s*. net.

(3) *A Concise History of Chemistry.* By Dr. T. P. Hilditch. Second edition, revised. Pp. xi+276. (London: Methuen and Co., Ltd., 1922.) 6*s*.

(4) *An Introduction to the Principles of Physical Chemistry from the Standpoint of Modern Atomistics and Thermodynamics.* By Prof. E. W. Washburn. Second edition, revised, enlarged, and reset. Pp. xxviii+518. (New York and London: McGraw-Hill Book Co., Inc., 1921.) 20*s*. net.

(5) *Die Wasserstoffionen-Konzentration: ihre Bedeutung für die Biologie und die Methoden ihrer Messung.* Von Prof. Dr. Leonor Michaelis. (Monographien aus dem Gesamtgebiet der Physiologie der Pflanzen und der Tiere, Band I.) Zweite, völlig umgearbeitete Auflage. Teil 1: Die theoretischen Grundlagen. Pp. xi+262. (Berlin: J. Springer, 1922.) Germany, 69 marks; England, 8*s*. 6*d*.

THE reviewing of new editions is a difficult and somewhat thankless task, if only on account of the detailed comparison which is needed in order to discover the novel features which alone call for comment or criticism. The four works in English of which new editions are here noted are all well known, and it would be superfluous to refer to their obvious merits, except in so far as they have been enhanced by the revision which they have undergone.

(1) The first two volumes of the new edition of the "Dictionary of Applied Chemistry" have received adequate notice in these columns. The third volume covers the letters F to K, but begins with an article on "Explosives," which has obviously been carried over from the preceding volume on account of its length and importance. In revising this article Mr. Perry has expanded it to nearly 100 pages by including notes on a large number of new explosives which have come into use during the last few years. The article thus continues to fulfil in its own field the main purpose for which a dictionary exists, namely, to provide some information in reference to every topic which may give rise to inquiry. The main lines of development of the manufacture on a very large scale of a few principal explosives during the war are, however, also adequately dealt with, and useful information is given on points such as the preparation, purification, and properties of T.N.T., and its use in the manufacture of amatol. The portion of the dictionary which is included in the present volume has been expanded by nearly one-quarter from 602 to 735 pages, and a somewhat careful comparison of the old and new editions has shown that, almost without exception, each of the important articles has contributed to this expansion. Fresh features of the new edition include an article on the interferometer by H. H. Robinson, and an article on hardened or hydrogenated oils by C. A. Mitchell, while gas warfare forms the subject of a short unsigned article. A completely new article on glass, by Prof. W. E. S. Turner of Sheffield, has replaced the article on the same subject which appeared in the old edition; the illustrations given in the new article of the automatic machines used for the manufacture of bottles are remarkable as suggesting something even more complex than the engine-room of a submarine. Throughout the volume there is evidence of adequate revision, which fully justifies the issue of the new edition.

(2) The third edition of Prof. C. H. Desch's "Metallography" retains all the valuable features on which the reputation of the book has been built. Substantial additions have been made in the chapter on the physical properties of alloys, where important developments which had taken place since 1913, especially in the study of magnetic and electrical properties, are described. Additions have also been made to the chapter on corrosion, in which the recent work by Dr. J. N. Friend in the Journal of the Chemical Society, is now incorporated, together with other work which has appeared in the Journal of the Institute of Metals and the Transactions of the Faraday Society, where a general discussion on this subject is reported. The chapter on the metallography of iron and steel has also been revised, one important new feature being an equilibrium diagram for iron and nickel, in which the changes that take place in the solid metal as it passes

from the non-magnetic into the magnetic condition are represented by lines, which show the formation of a definite series of solid solutions, instead of by blurred areas. The appendix, in which the various binary, ternary, and quaternary systems which have been studied are classified and summarised, has been revised to include publications received down to the time of going to press. The new edition incorporates the results of nine years of work in metallography, and it can be heartily commended for its up-to-date presentation of this important subject.

(3) The first edition of Dr. Hilditch's "Concise History of Chemistry" was reviewed in NATURE of October 19, 1911, p. 510. The new edition has been expanded from 263 to 276 pages, and, in view of the number of additional topics that have come into prominence during the past ten years, it is clear that the conciseness of the old edition has been at least fully maintained in the new. It will thus be found that the nucleus atom, X-ray analysis of crystals, Moseley's atomic numbers, the octet theory of Langmuir and the discovery of isotopes, are all described in the course of three pages in the chapter on the "Ultimate Constitution of Matter," although another page is given later on to some of these subjects. Gas warfare is described in a paragraph of eleven lines, and "anti-gas" is summed up in a paragraph of four lines. In a few details only the revision is perhaps incomplete, *e.g.* the list of the metals of the rare earths is still that of 1909, with holmium omitted, and the atomic weights (which are of the same date) might well have been supplemented by giving also the atomic numbers; moreover, the new matter is by no means fully represented in the subject index, although the author-index appears to have been revised. The value of the book as an index of chemical discoveries is preserved in the new edition, although it would obviously be useless to look for detailed descriptions in so compact a volume.

(4) Prof. Washburn's "Principles of Physical Chemistry" was reviewed in these columns on June 1, 1916, p. 277, and has established a wide reputation in this country as well as in the country of its origin. As the first edition appeared but seven years ago, only those subjects which have developed since the war have called for further elaboration. These include, however, the work of Aston on isotopes and all the recent work on atomic and molecular structure. It is, indeed, remarkable evidence of the rapid progress which has been made in this field that, while the first edition stops with an account of the qualitative aspects of the periodic classification, and of the models which Soddy and Harkins put forward in order to explain the sequence of properties, these two figures have disappeared in the second edition in favour of a large chart illustrating the Lewis-Langmuir theory; and this chart in turn is probably already obsolete in view of the suggestions put forward by Bohr for making use of the quantum-orbits of the electrons as a basis for the periodic classification of the elements. The work on the X-ray analysis of crystal-structure, which was briefly mentioned in the first edition, claims eight pages in the second edition. Anisotropic liquids are, however, inadequately (and perhaps incorrectly) dealt with, especially in view of recent French work on this subject.

(5) Dr. Michaelis's book on "Hydrogen Ion Concentration" was first issued in 1914. The present volume is a new edition of the first and theoretical part of the book, and covers two main topics, namely, the chemical equilibrium of ions and ions as sources of differences of electrical potential. The subject has attracted even more attention from physiologists than from chemists, and Dr. Michaelis's book is actually issued as the first volume of the series of monographs on physiology; but this does not detract from its value to physical chemists, and especially to those who are liable to be called upon to answer the conundrums of their biochemical colleagues.

Phosphatic Fertilisers.

Basic Slags and Rock Phosphates. By Dr. G. Scott Robertson. (Cambridge Agricultural Monographs.) Pp. xvi+120. (Cambridge: At the University Press, 1922.) 14*s*. net.

DURING and since the war the position in this country with regard to the supply of basic phosphatic fertilisers has undergone a radical change. On one hand, the ousting of the older Bessemer process by the modern open hearth process of steel-making has led to the virtual disappearance from the market of the high grade basic slag to which the agriculturist was accustomed, and its replacement by a totally different material of much lower phosphorus content and frequently of low "citric-solubility." On the other hand, the development of the extensive deposits of rock phosphate in the Pacific Islands has rendered available greatly increased amounts of this material. The field experiments at Cockle Park, from which most of our knowledge of the value of basic slag in agriculture was derived, were carried out with the now obsolete high grade Bessemer material, and prior to Dr. Robertson's experiments practically nothing was known as to the fertilising value of the new open hearth slags; the experiments in this country on raw rock phosphate were also few in number and not very conclusive in result.

Dr. Scott Robertson's experiments were carried out on several different farms in various parts of Essex during the years 1915–20, and were designed to test the relative fertilising value of Bessemer and open hearth basic slag, and of mineral phosphates, on permanent grassland cut for hay. The results of these experiments form one of the most important contributions which have been made in recent years to the literature of phosphatic manures, and their publication in book form is thus very welcome. It was found that on heavy soils of the London Clay and Boulder Clay the improvement effected by rock phosphates compared favourably with that due to high-soluble basic slags, especially in a wet season when the hay harvest was late, and on sour soils. The low-soluble fluorspar slags were definitely inferior, though still effecting a considerable improvement. At two of the centres where the experiments were carried out there was no response to phosphatic manuring, and the author produces evidence that this is due to the operation of another limiting factor, probably deficiency of potash. This point is of interest in connexion with the fact, well known to agriculturists, that basic slag is not invariably effective on all grassland. It is quite likely that some, at least, of these failures are due to a similar cause.

Dr. Robertson did not restrict his work to the determination of the yields of hay on his plots. He presents interesting data on the botanical composition of the herbage, and on the effect of the phosphatic manures on such soil factors as moisture content, temperature, total nitrogen and nitrate content, bacterial numbers, and acidity, all of which, together with climate conditions, are considered in relation to their possible influence on the yields obtained.

Needless to say, the book is well printed and produced, but the price is high for a small volume and will certainly react unfavourably on its sale. This is regrettable, for it deserves a wide circulation among all interested in the improvement of our grasslands and in the country's agricultural production.

H. J. P.

Our Bookshelf.

(1) *Potash.* By Sydney J. Johnstone. New edition revised and enlarged. (Imperial Institute. Monographs on Mineral Resources, with special reference to the British Empire.) Pp. x+122. (London: John Murray, 1922.) 6*s.* net.

(2) *Oil Shales.* By Dr. H. B. Cronshaw. (*Ibid.*) Pp. x+80. (London: John Murray, 1921.) 5*s.* net.

(1) MR. S. J. JOHNSTONE'S monograph on sources of potash is the most useful summary that has been produced since that written by Messrs. H. S. Gale and W. B. Hicks for the Geological Survey of the United States ("Potash in 1917," published 1919). It has no index, but ends with an excellent bibliography, arranged in the sequence of references to the papers in the text. The author deals with all commercial sources of potash, including (p. 112) the product styled Karroo ash, a residue from the ignition of the sheep-dung used as fuel in the Karroo region of S. Africa. The attention now given to alunite is well reflected in the summaries on pp. 51 to 60. The methods of treatment are described, and it may be remembered that a research by W. T. Schaller, the mineralogist, led to the suggestion of the simultaneous extraction from alunite of potash and alumina for commercial purposes. The nomenclature in the analyses of products from the Alsatian mines on p. 12 does not agree with that adopted elsewhere in the text, and the use of "kainite," here and on p. 5, as a synonym for "sylvinite" is an obvious error. "Sylvinite" is, of course, a trade-name for a mixture of sylvine and rock-salt. It is surely time that "muriate of potash," as a name for a substance containing no potash, disappeared. On p. 5 the potassium-content of various products is given, calculated as potash, and the German and other salts are quoted as yielding 100 per cent. We believe that 12·4 per cent. was the official figure adopted by the German Potash Syndicate in 1921. The account of the occurrences of the ordinary soluble potassium salts seems the least satisfactory part of the present memoir. What, for instance, is meant (p. 11) by "the amount of potash averages 30 per cent. of potassium chloride" in the description of an Alsatian deposit?

(2) Dr. Cronshaw's review of oil-shale resources is valuable as a record of attempts to locate such shales by boring in England. Something seems to have gone astray in the account of the Ballycastle coalfield (p. 28), where the Scottish "Broxburn shale" and a place called "Newlygen" are introduced. The description of explorations and results in other countries shows how comparatively successful the industry has been in south-eastern Scotland, though even here the refineries are now to be supplied with imported oil. The author provides a good general and local bibliography.

G. A. J. C.

Town Theory and Practice. By W. R. Lethaby, G. L. Pepler, Sir T. G. Chambers, R. Unwin, and R. L. Reiss. Edited, with an Introduction, by C. B. Purdom. Pp. 139. (London: Benn Bros., Ltd., 1921.) 5*s.* net.

MR. PURDOM points out that, notwithstanding the frequent mention of "garden-cities" in the popular press, it is not generally understood that it is a technical term denoting a self-contained area set out upon a definite plan and including within its boundaries all the requisite elements for the life of an independent community, and that Letchworth and Welwyn alone conform to this definition. This little book on the theory and practice of the garden-city contains five essays which deal with various aspects of the question. Mr. W. R. Lethaby deals with the town itself in an essay of a general character; Mr. G. L. Pepler describes the town plan, showing how the garden-city endeavours to combine practical utility, the convenience of the workers and business undertakings, and æsthetic and hygienic considerations, and Mr. Raymond Unwin, in discussing the best size of the town for good social life, considers, among other matters, the bearing of the number of the population upon the question of educational facilities and artistic development, such as music and the drama. Mr. Reiss raises some interesting points in connexion with land values and the possibility of co-operation with local authorities in the matter of rating and the development of municipal activities. For the use of those who wish to pursue the subject further, a bibliography is appended.

Land and Sea Speed Reckoner. Designed by Capt. W. N. McClean. (London: Constructed by C. T. Cooper and Sons, Ltd.) 1*l.* 12*s.* 6*d.*

THIS is an instrument of the slide-rule type, which has of late years met with considerable favour among navigators for dealing with that class of problem in which an approximate solution is sufficient. By means of the instrument it is possible to obtain (1) speed, when distance and elapsed time are known; (2) elapsed time, when speed and distance are known; (3) distance, when elapsed time and speed are known. The slide-rule consists of two scales, namely, (*a*) a time scale, styled the "Slider," and (*b*) a distance scale, and by setting these in correct mutual relation any of the above problems can be dealt with in one simple operation. Thus, if elapsed time is 8^m 40^s, while distance steamed is 3·2 miles, all that is necessary is to bring the graduations denoting these two values vertically opposite to each other, when the required speed, in this case 22·2 miles per hour, is read off on the distance scale, opposite the division on the time scale marked one hour.

A modification of the instrument, known as the "Air Speed Reckoner," has a specially adapted distance scale to meet the case of high speeds in the navigation of the air.

The manipulation of the scales is simple, and easy to grasp, and the invention seems well adapted to the purpose of dispensing with troublesome arithmetical calculations which the designer appears to have had in view.

Diet and Race: Anthropological Essays. By F. P. Armitage. Pp. vi + 144. (London: Longmans, Green and Co., 1922.) 7*s.* 6*d.* net.

MR. ARMITAGE discusses the relation of diet to stature, pigmentation, and head form. In reference to stature, after an analysis of the food values of staple articles of food in different parts of the world, he suggests that each is associated with a particular type of physique, and shows that scarcity of food is a concomitant of diminutive stature, and *vice versa.* In dealing with pigmentation, he shows that pigmentation varies with the amount of salt which enters directly or indirectly into the diet, the greatest quantity being consumed by the fairer races. The question of pigmentation is obscure, and although it is generally regarded as due to environment, it is not clear how variation has been brought about. It is not impossible that the chemical action set up by salt may be one of the factors involved. In regard to head form, the author suggests that the difference between long and broad heads may be due to the difference of muscular effort requisite in masticating soft and hard foods. The author does not appear to be aware that a similar suggestion, both as to the effect of muscular action and as to the character of food, was put forward by Prof. Arthur Thomson some years ago.

Introduction à l'étude des fonctions elliptiques à l'usage des étudiants des facultés des sciences. Par Prof. P. Humbert. Pp. 38. (Paris: J. Hermann, 1922.) 3 francs.

ELLIPTIC functions are not studied by mathematical students unless they are specialists in mathematical analysis, yet a knowledge of the most important elementary facts about these functions is essential for advanced work in many branches of pure and applied mathematics. Prof. Humbert's object is to supply this information in a conveniently brief form. Starting with the elementary theory of residues and contour integrals, the author introduces the notion of periodic functions defined by integrals: doubly periodic functions then follow, leading to the $\wp$ function and some of its most useful properties. We then get the ζ and σ functions, and finally modular functions are touched upon. The book forms a clearly written introduction which cannot but encourage the student to seek for further and more detailed information in standard treatises. S. B.

On the Edge of the Primeval Forest: Experiences and Observations of a Doctor in Equatorial Africa. By Prof. A. Schweitzer. Translated by Ch. Th. Campion. (London: A. and C. Black, Ltd., 1922.) 6*s.* net.

THE author resigned his professorship in the University of Strasbourg in order to qualify in medicine with the view of working among the natives of the French Congo. His work is an account of five years' experience at Lambarene on the Ogowe River. Prof. Schweitzer is evidently a close observer, and he succeeds in giving a vivid picture of the monotony of life in the oppressive luxuriance of the tropical forest. The considerable attention devoted to medical and surgical matters does not lighten the gloom. There are a few interesting reflections on some urgent tropical problems, such as the labour question and the relation between blacks and whites, which, in view of the author's experience, might with advantages have been expanded. The book is a short one, but not without value as a contribution to the study of the negro and his relations with the trader and missionary.

Evolution of the Essex Rivers and of the Lower Thames. By Prof. J. W. Gregory. Pp. 68. (Colchester: Benham and Co., Ltd., 1922.) 2*s.* 6*d.* net.

As this book's geological contents occupy not quite sixty pages, and as "Bibliography and References" occupy three pages, and refer to fifty-nine different memoirs, or papers, on various points in Essex geology, it is obvious that no brief view of its conclusions is possible here. The views expressed as to the "Evolution of the Essex Rivers" and "The Relations of Essex and Midland River Systems," etc., are not antagonistic to those of previous writers, but are mainly occupied by matters more or less outside those treated by Essex geologists of an earlier date. In short, it is a brief work of much value to all students of Essex geology. T. V. HOLMES.

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.*]

Spectrum Lines of Neutral Helium.

DR. SILBERSTEIN'S letter in NATURE of August 19, p. 247, induces me to write to say that some time ago I found the key for unravelling the constitution of the secondary spectrum of hydrogen to be of a kind similar to, though more generalised than, that used by him for helium. Practically the whole of this spectrum depends on the sequence of the Balmer series. If $f(m)$ denote the mth sequent, the wave number of any line is of the form $\Sigma k_m f(m)$, where the k_m are positive or negative integers; *e.g.* the line $n = 16892{\cdot}72$ is $f(2)-f(3)+f(4)-f(5)-f(6)+f(7) = H_\alpha + (H_\gamma - H\ ) - (H_\delta - H_\epsilon)$ within an observation error $d\lambda = 0{\cdot}01$. In fact the spectrum is a kind of linkage spectrum in which the usual links are replaced by the separations between the successive lines of the primary, namely, 5331·57, 2467·75, etc. The same machinery of analysis used for linkage spectra is then directly applicable, but as the total number of observed lines is about 1600 it may be understood that a considerable time is required for the completion, arrangement, and discussion of the various physical effects in different groups of lines. The preliminary work of forming the linkage maps is practically completed. The results so clearly suggested that Curtis's helium spectrum was built in the same way that I was on the point of writing to him to suggest his testing them, and now Dr. Silberstein's very interesting letter comes to show independently that this is the case.

It has always seemed to me that the existence of these linkage spectra forms a difficulty in the orbital theory of spectral lines. This difficulty Dr. Silberstein's theory does not meet. According to his theory, and apparently in any orbit theory, the two electrons are moving independently, and each passes between two of its corresponding paths. But if the combined change of energy is radiated, these two events must be absolutely simultaneous, and would happen, say, once in an æon.

W. M. HICKS.

August 19.

Micro Methods in the Practical Teaching of Chemistry.

A CHANGE in teaching methods which brings with it simplicity and economy should appeal to all. May I therefore direct attention to methods I have myself begun in Cairo of teaching chemistry from the beginning by "microchemical" methods—that is, by working with very small quantities? (We really need a better word than "microchemical," which seems to suggest the microscope.)

It is strange that even in science we are so conventional. Pieces of apparatus once introduced by some one of repute remain in the shape and form, size and weight in which they were first employed as if they were consecrated objects. The Bunsen burner, for example, although it may be far bigger than required and very expensive in its consumption of gas, is scarcely ever changed. Even where a far less consumption of gas would suffice it seems to be the tradition to burn a large quantity. It is the same with the size of the test tube, beaker, or flask in common use, and the same also with the quantity of material used by the student in carrying out his chemical tests: he will as a rule take a quarter, if not a half, test tubeful of some solution and add as much of the testing reagents as he can get into the test tube. There seems to be no necessity for these large quantities, and most of the tests carried out by students in chemical laboratories could be done with far less material. I propose to describe some of the methods which have been used in the Government Medical School Chemical Department, Cairo, during the past year, feeling that many laboratories would gain much in time, materials, and money by following methods which have proved very successful there.

These methods arose out of necessity. Too many students and too little space is probably a state of things not special to Cairo; the extreme was reached when it became necessary to teach two hundred students without any proper laboratory at all. Rather than refuse admission to the students a solution of the difficulty was sought in microchemical methods, and the result was successful beyond anticipation. Many who visited the laboratory at the time were surprised to see a hundred students seated in perfect silence busily engaged in applying microchemical methods in a hall in which there was neither water nor gas nor any of the appurtenances of a chemical laboratory. The necessity for such an improvisation could scarcely arise under more settled conditions, nor for that reason is it likely that any one would have the opportunity of carrying out such a teaching experiment on so large a scale.

The root idea of the method is economy in its broadest sense: in time, labour, and materials. Clearly if the student uses nothing larger than a drop instead of the habitual inch or half-inch in a test tube the expense in chemicals can be readily reduced one hundredfold. The expense in students' chemicals represented during the year only a few pounds of materials, the consumption of most of which is to be attributed to second-year students doing special work. About 500*l.* has been saved out of chemicals alone, which saving can be applied to the purchase of permanent apparatus.

The economy in apparatus has been even greater than in chemicals. The bottles throughout the laboratory have been reduced to one-tenth of the conventional size. Each student is given at first a small rack, and later another, containing six reagent bottles of one ounce capacity. These bottles are unstoppered but fitted with small dropping-pipettes. The bottles are cheap and the pipettes are made in the laboratory. The racks are easily collected and stored, and it is possible in this way to keep a class constantly supplied with freshly prepared solutions by issuing only those reagents which it is intended to employ at the time, thus avoiding the making up at the beginning of term of large quantities of solutions which may not be required till many months later. No test tubes are used till the student comes to actual separation of the groups, so that for the first half of the course all the expense and annoyance of breakage, difficulties of cleaning, and mess due to test tube work on the benches is avoided.

Indiscriminate test-tubing by students untrained in delicate manipulation and without any quantitative sense is, as it seems to me, a bad influence in their training which it is important to combat. In so many schools has it been the custom to use materials in wastefully large quantities that the name "stinks" only too aptly describes what goes on. But if the student be taught from the outset to regard the drop as a suitable, if not already a large quantity, he will get nearer to the quantitative notion and may acquire some of that delicacy of manipulation so essential to his proper training; and when he comes to use larger quantities of materials and more expensive apparatus he is more likely to do so with economy and care.

In the early part of the work many simple substitutes for the test tube may be used, and there is an advantage in variety, the chief of many considerations being the ease with which such things are washed: a glass slide, as used for the microscope, or any small piece of glass is suitable—for it may be rapidly cleaned after each drop-experiment—and the drop may be studied with the pocket lens, enabling the student to distinguish between crystalline and amorphous precipitates and to note whether the colour is in the precipitate or the solution; indeed the training of the student in the use of the pocket lens from the very outset is highly desirable. Other materials are porcelain tiles or broken china, readily replaced by the student himself. A third class of material, very convenient and possessing certain advantages in chemical tests, is filter-paper or some form of absorbent paper, or in its absence white paper of any kind. When a reaction takes place in a drop on filter-paper, the separation of the precipitate from the solution becomes even more obvious than when the same reaction takes place on a tile or piece of glass. He may learn something also about surface tension, adsorption, and the difference between crystalloid and colloid, and many elementary physical facts which he would never learn by the test tube method.

There are very few reactions commonly carried out in the chemical laboratory which cannot be carried out just as well or better in the microchemical way; for example, the reduction of a copper solution by an aldehyde. Let the student place several separate drops of Fehling's solution on a glass slide and to each add a drop of some different aldehyde solution; let him warm the slide gradually over a small flame and make comparison of the changes in the several drops. This is an example of an experiment of a simple kind where an attempt is made to obtain constant conditions, varying only one factor. Such instructive little tests as these are surely worth far more than mere colour or precipitation tests in test tubes. Many more such tests could be described, but each teacher will probably prefer to devise experiments of his own, suited to the needs of his class.

It is submitted, therefore, that microchemical methods form not only an excellent introductory training for the student but mean a great saving in time, labour, and money. We have saved in one year at least 1,000*l*., enabling us to buy more apparatus of a permanent kind for teaching and research.

EGERTON C. GREY.

Government Medical School,
Cairo, July 1922.

An Atomic Model with Stationary Electrons.

BOHR'S atomic model with its circling electrons appears at first sight quite incompatible with Langmuir's model, in which the electrons are stationary or oscillate about fixed positions of equilibrium. Dr. Langmuir himself, however, has pointed out that a static atom possessing many of the properties of the Bohr atom is possible provided a force of repulsion equal to $F=1/mr^3 . (nh/2\pi)^2$ act between an electron (mass m, charge e) and a nucleus. Here n is an integer and h is Planck's constant. The distance r of the electron from the nucleus in stable equilibrium is the same as the radius of a circular orbit corresponding to a stationary state in Bohr's theory. The total energy of the electron is also the same as that given by Bohr's theory. The frequency of oscillation about the position of equilibrium is identical with the frequency of revolution of the electron in the Bohr atom. Thus the Rydberg constant and the Balmer series can be deduced without assuming moving electrons.

I wish to direct attention to the fact that a force of exactly the type required in Langmuir's theory is provided by the quantum mechanism recently described by Prof. E. T. Whittaker in the Proceedings of the Royal Society of Edinburgh. The mechanism may be pictured as a magnetic wheel consisting of a number of magnetic poles (total strength M) revolving in a circle of radius a. When this magnetic wheel is rotating about its axis with angular velocity ω, it sets up an electric field such that an electron situated at a point on the axis at a distance r, large in comparison with a, is acted on by a force $Mea^2\omega/r^3$ along the axis. Prof. Whittaker has shown that the angular momentum of the magnetic wheel in its steady state (after the passage of an electron completely through it) is determined by $A\omega=2eM$, where A is the moment of inertia of the wheel. We shall assume that, in general, the angular momentum is given by Nicholson's quantum relation, so that

$$A\omega=2eM=nh/2\pi.$$

Substituting the values of Me and ω thus found in the expression for the force on the electron, we find that the "quantum force" is given by

$$\frac{a^2}{2Ar^3}\left(\frac{nh}{2\pi}\right)^2.$$

This agrees precisely with Langmuir's expression for the force of repulsion, provided we make the single additional assumption that $A=\frac{1}{2}ma^2$.

Thus we see that by means of Prof. Whittaker's quantum mechanism it is possible to construct an atomic model which will yield many of the results of Bohr's theory, without employing moving electrons. I have discussed the question more fully in a paper to be published by the Physical Society of London.

H. S. ALLEN.

August 15.

The Variable Depth of Earthquake Foci.

PROF. H. H. TURNER has given reasons (Mon. Not. R.A.S., Geophys. Suppt. No. 1) for believing that the depths of the foci of earthquakes differ among themselves by quantities up to about 300 km. It may be pointed out that this is precisely what may be expected from the theory of a cooling earth. The available information concerning the thermal state of the earth indicates that the rocks in the asthenosphere, at depths of 400 km. and more, must be very much weaker than those at the surface; this is amply confirmed by the geodetic evidence collected by Barrell, which also suggests that the rocks at depths comparable with 100 km. are considerably stronger than those at the surface. Accordingly, whatever may be the cause of crustal deformation in the earth, yield will occur in the asthenosphere for smaller stresses than are necessary to produce it in the upper parts of the crust. Thus the earthquakes arising from fractures below 400 km. would be more numerous but much less violent than those occurring at higher levels, and the greatest earthquakes should have their foci at the depth of greatest strength. We should therefore expect that the depths of earthquake foci may range from zero to 200 or 300 km.

DOROTHY WRINCH.
HAROLD JEFFREYS.

August 21, 1922.

An Electrical Analogue of the Vocal Organs.

IN connexion with correspondence which recently has appeared in the columns of NATURE relating to the physical characteristics of vowel-sounds, the following account may be of interest of an apparatus believed to be novel, which is conveniently capable of the artificial production of many speech-sounds. It is well known that Helmholtz succeeded in imitating vowels by combinations of tuning forks, and Miller by combinations of organ pipes. Others, notably Scripture, have constructed apparatus wherein the transient oscillations of air in resonant cavities were excited by series of puffs of air, in close physical imitation of the action of the human vocal organs. It seems hitherto to have been overlooked that a functional copy of the vocal organs can be devised which depends upon the production of audio-frequency oscillations in electrical circuits.

A schematic diagram of such an apparatus is given in Fig. 1. Periodic interruptions of the electric current, produced by a buzzer or a motor-driven circuit interrupter, corresponded to the periodic inter-

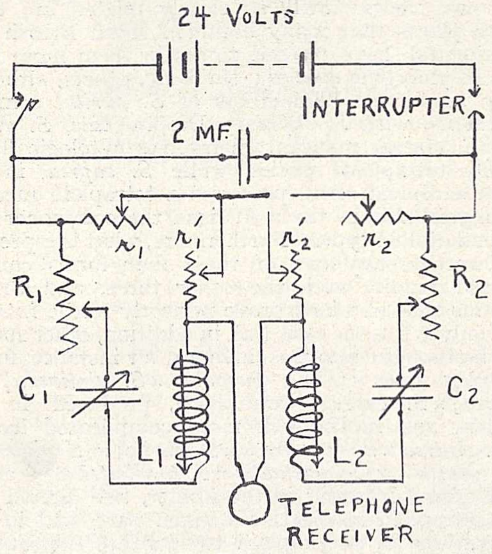


FIG. 1.

ruptions of the air current in the human throat by the vocal cords. The intermittent electric current thus produced excited the natural damped oscillations of the resonant circuits, *1* and *2*. This was confirmed by observation with an oscillograph. In like manner, puffs of air from the vocal cords excite the natural damped oscillations of the air in the mouth cavities. The work of numerous investigators has indicated that the air in the mouth cavities possesses, as a rule, only one or two important modes of vibration. The oscillations of the electric current were transformed to sound-vibrations in the air by a loosely coupled telephone receiver. The distortion introduced by this telephone receiver appeared to be of little importance.

Appropriate adjustments of the resonant circuits *1* and *2* were observed to result in the production of all the various vowels and semi-vowels in turn. Alteration of the frequency or damping of either resonant circuit was observed to result in alteration of the vowel produced. The frequency of interruption, which was the group frequency of the recurrent damped oscillations, was observed to determine the pitch of the vowel; but it did not determine what vowel was produced. Similarly, in the case of the human voice the frequency of vibration of the vocal cords is known to determine the voice-pitch, while the adjustment of the mouth cavities is known to characterise the vowel.

The vowels and semi-vowels produced by the "electrical voice" with regular interruptions, in the manner just described, were equivalent to intoned or sung vowels, or, if the frequency of interruption was made to vary appropriately, to spoken vowels. It was found possible to produce the whispered vowels with interruptions that were non-periodic, which is in accordance with the idea that, in the human voice, whispered speech is due to irregular frictional modulation of the exhaled air. Whether the vowel was whispered, sung, or spoken depended upon the manner of making the interruptions; while what particular vowel was produced depended upon the adjustment of the resonant circuits.

Diphthongs were produced by altering the circuit adjustments rapidly so as to shift from the initial to the final vowel-sound of the diphthong pair. Some of the fricative (hissing) consonants were approximated with irregular interruptions, provided the resonant circuits were set at somewhat higher frequencies than for the vowels and semi-vowels. None of the explosive consonants were satisfactorily imitated. It is believed that lack of success with the explosives was due to obvious difficulties of manipulation.

There was much room for improvement with respect to the naturalness of the "electrical voice." It was too monotonous, as was to have been anticipated. Contrary to expectation, alteration in the wave-form of the exciting current did not materially change the tone, provided the wave-form was sufficiently far from sinusoidal. The intoned vowels, semi-vowels, and diphthongs produced by the "electrical voice" were sufficiently natural to be recognised in at least fifty per cent. of the trials by eight or ten different observers. When arrangements, not indicated in Fig. 1, were made to give the appropriate circuit adjustments in rapid succession, simple words like "mama," "Anna," "wow-wow," "yi-yi," were fairly well imitated. The whispered vowels and fricative consonants were not imitated so well, because (it is thought) of the lack of complete irregularity in the circuit interruptions. In human speech the pitch and vowel quality and intensity are constantly changing in a way difficult to imitate with the crude apparatus of Fig. 1. Probably, also, in the human voice additional weak transient oscillations are excited, due to minor modes of vibration of the air in the cavities of the head, which determine the individuality of the voice without greatly altering the speech-sounds.

Thus these experimental results are sufficient to give a general qualitative description of each of the following four classes of speech-sounds: vowels, semi-vowels, diphthongs, and fricative consonants (but not explosives), whether sung, spoken, or whispered; and these results also make possible quantitative specification of the characteristics of the various speech-sounds themselves. Numerical values of the frequencies and dampings which appear to characterise the various speech-sounds have been calculated from the electrical constants possessed by the resonant circuits of the apparatus when adjusted to produce them.

The analytical expression for a single transient due to one resonant circuit when loosely coupled is, of course,

$$\text{Instantaneous displacement} = Ae^{-at} \sin 2\pi ft,$$

where e is the base of natural logarithms, a the damping constant, f the frequency, and A the amplitude. The displacement in the air-vibration is taken as proportional to the instantaneous current. Also, $f = 1/2\pi\sqrt{LC}$ nearly, and $a = R/2L$. The capacity C of each resonant circuit was variable in steps from 0·001 to 2 microfarads. The inductance L was continuously variable from about 0·3 to 0·7 henry. The resistance R was due largely to a dial box of range 1 to several thousand ohms, and included, in addition, the resistance of the inductometer and the (perhaps 100 ohms) small variable coupling resistances r and r' (Fig. 1).

The nature of the numerical results is indicated in Table I., which gives approximate values of the frequencies and dampings of the recurrent oscillations which characterise six of the more important vowels. Group frequencies (that is, voice pitches) were for each vowel varied over the range 75-300 per second. The first three vowels given in this table are each characterised by a single train of recurrent damped oscillations; the remaining three are characterised by two trains of recurrent damped oscillations. The numerical values are approximate. Indeed, considerable changes in the circuit adjustments in some cases do not materially alter the vowel produced. The problem of determining the permissible range of variation for each speech-sound requires further study. For the latter three vowels the relative values of r_1 and r_2 are of some importance.

TABLE I.

Vowel.	Damping Oscillations. Frequency, *f*.	Damping constant, *a*. (Unit of Time, one second.)
*ru*de	320	small (<50)
law	650	100
*fa*ther	1000	500
m*a*t	750 / 1500	800 / 800
p*e*t	420 / 2300	50 / 50
c*e*de	320 / 2500	50 / 50

These results seem sufficiently interesting to recommend the apparatus of Fig. 1 to the attention of students of speech-sounds. Although simple in construction, this apparatus possesses considerable flexibility and range. The really difficult problem involved in the artificial production of speech-sounds is not the making of a device which shall produce sounds which, in their fundamental physical basis, resemble those of speech, but in the manipulation of the apparatus to imitate the manifold variations in tone which are so important in securing naturalness.

As for the disagreement between the Helmholtz-Miller, or steady state theory of vowels, and the Willis-Hermann-Scripture, or transient, theory, Rayleigh pointed out that the conflict was only apparent. The disagreement concerns methods rather than facts. Which view-point should be adopted is thus a matter of convenience in a given case. When the transmission of speech over telephone circuits is in question, for example, the steady state theory often possesses obvious mathematical advantages. On the other hand, the quantitative data relating to the physical nature of vowels which are given in Prof. Miller's well-known book, "The Science of Musical Sounds," expressed, as they are, in terms of the steady state theory, are less compact and definite than the data of Table I., which are expressed in terms of the transient theory. The general agreement between the two sets of data is, of course, obvious.

The work described in this communication was performed while the writer was associated with the American Telephone and Telegraph Company, and was carried out in the laboratories of that company and of the Western Electric Company, Inc.

JOHN Q. STEWART.

Princeton University, Princeton,
New Jersey, July 8.

Interspecific Sterility.

DR. GATES, in his letter which appears in NATURE for August 5, p. 179, emphasises the importance of tetraploid species in evolution, and with this position I heartily agree. Nevertheless, I do not think that the difficulties in the way of free crossings amongst diploid, tetraploid, and hexaploid species are so great as seems at first sight probable, at any rate in the Salicaceae.

In this order Miss Kathleen B. Blackburn and myself have been conducting cytological researches for some time, and find the fundamental chromosome number, both in Populus and Salix, to be nineteen. Up to the present only diploid species have been encountered in the first-named genus, but in Salix, on the contrary, diploid, tetraploid, and hexaploid forms have revealed themselves. In this communication I wish more particularly to direct attention to that homogeneous assemblage known as the Capreae group, which includes, in the eyes of most salicologists, three genuine species, *Salix caprea*, *S. cinerea*, and *S. aurita*—an arrangement entirely in harmony with my own views. Still, so closely related are these three plants that many botanists, both British and continental, have refused to see in them more than one polymorphic species; similarly, others, although they admit the distinctness of *S. aurita*, combine *S. cinerea* with *S. caprea*. Despite this, *S. aurita* and *S. cinerea* manifest themselves cytologically as purely tetraploid species, while *S. caprea*, in the main a diploid form, possesses a tetraploid race indistinguishable in the field from the commoner and normal diploid type. Furthermore, what is especially noteworthy, any one of these four forms can be crossed readily with the other three, and the F_1 hybrids thus obtained prove perfectly fertile *inter se*. Not only is this the case, but, in addition, other species can be brought into the chain, as, for instance, in the complex cross [(*Salix purpurea* × *S. viminalis*) × *S. cinerea*] × *S. caprea* (tetraploid), produced in my garden, and in the still more complicated hybrid {[(*S. cinerea* × *S. purpurea*) × *S. aurita*] × (*S. viminalis* × *S. caprea*)} × (*S. viminalis* × *S. phylicifolia*), secured by Heribert-Nilsson: in the former, two diploid and two tetraploid species have taken part, and in the latter, three (or two) diploid, two (or three) tetraploid, and one hexaploid form.

As a matter of fact, in the genus Salix, interspecific sterility depends, not on the chromosome complement of the species concerned, but on the physiological divergence of the groups to which they happen to belong. Experiments designed to cross the diploid *S. triandra* with the diploid *S. purpurea* turn out just as fruitless as similar attempts to hybridise it with the tetraploid *S. cinerea* and the hexaploid *S. Andersoniana*; on the other hand, the hybrid combinations between it and the tetraploid *S. alba* and *S. fragilis* can be obtained with the utmost ease.

J. W. H. HARRISON.

Armstrong College, Newcastle-upon-Tyne,
August 8.

The Mass-spectrum of Iron.

I HAVE recently investigated this element by using the vapour of its penta-carbonyl mixed with carbon dioxide. It is even more troublesome to deal with than the corresponding nickel compound, but by employing intense discharges and long exposures fairly satisfactory results have been obtained.

The mass-spectrum of iron is characterised by a strong line, approximately at 56, and it may be concluded with absolute certainty that this line is due to the predominant constituent of the element. Refined measurements indicate a value rather less than this integer. The mean of some sixteen independent and very consistent comparisons with lines due to mercury and compounds of carbon and oxygen works out at $55{\cdot}94 \pm 0{\cdot}05$.

The accepted chemical mean weight, 55·84, suggests the presence of a lighter isotope, and a general consideration of elements already analysed points to the value 54 as the most probable. A very faint line is, indeed, visible in all cases where the 56 line is really strong, but it is impossible to make certain that it is due to iron. Further, if we accept the difference of the above figures as exact and assume 54 to be the only lighter constituent, this line should have about one-twentieth the intensity of the 56 line; actually its intensity appears much less.

Iron may therefore be taken as being almost, if not entirely, a simple element of atomic weight, approximately 56. It may contain a small proportion of an isotope 54, but this is by no means certain.

F. W. ASTON.

Cavendish Laboratory, Cambridge,
August 26.

Density of Adsorbed Films.

WHEN a very small quantity of such a liquid as castor oil is placed upon a clean surface of water dusted with talc, it spreads over the water surface, brushing the talc on one side, and forms an invisible circular spot, the size of which depends upon the amount of oil used. This adsorbed film has the same surface tension as the surrounding water surface, namely, 73 dynes per cm. Hence Devaux, Langmuir, and others regard the film as being only one molecule thick.

If such an invisible film of castor oil be contracted, the surface tension decreases until it falls to about 57·2 dynes per sq. cm. Further contraction does not much reduce the tension. Marcelin was of opinion that as the diameter of the film was decreased, it thickened until it was two molecules thick, and that when this occurred, the film had the same surface tension as castor oil in bulk. But the amount of contraction the surface undergoes in the case of castor oil is only about 40 per cent., and this Devaux points out is not sufficient to make the film two molecules thick, and he suggests that these thicker films are not two molecules thick, but are monomolecular films with *closer packing* of the molecules. On this view the film of limited area surrounded by water is stretched until its tension reaches that of a clean surface of water.

If the above explanation be correct, it is clear that the density of the stretched film of oil having a surface tension of 73 dynes per cm. must be considerably less than that of the same film when its surface tension is only 57·2 dynes per cm.

Now when calculating the dimensions of the molecules of various substances, by the surface tension method, I gather that Devaux and Langmuir regard the oil films, when they are stretched by the surrounding water surface, as having the same density as the liquid in bulk. Would it not be safer to assume that the density of the film, when it has the same surface tension as the oil in bulk, is more nearly equal to that of the oil in bulk? The point is one of considerable interest and importance, and well worthy of consideration.

R. M. DEELEY.

Tintagil, Kew Gardens Road,
Kew, Surrey.

The Pigeon Tick.

WE wish to record the occurrence of the pigeon tick, *Argas reflexus*, in Cambridge, where it is parasitic on the pigeons which breed between the inner and outer roofs of King's College Chapel. On August 4 we found a specimen, which Mr. C. Warburton was kind enough to identify for us. This specimen is now in the collection of the Molteno Institute of Parasitology. On a later date we found six more individuals.

The parasite seems to have been found previously in the British Isles in Canterbury Cathedral only, and not at all since 1908. This new locality, therefore, may indicate that it will be found elsewhere if searched for carefully.

The adult tick is not permanently attached to its host, but hides in crevices in masonry and woodwork, leaving its hiding-places to feed at night.

L. H. MATTHEWS.
A. D. HOBSON.

Zoological Laboratory, Cambridge.

An Ancient Wasp.

I HAVE just received from Mr. John P. Byram a small collection of fossil insects which he obtained at the head of Bear Gulch, 12 miles from Una, Colorado. The formation is Green River Eocene, and Mr. Byram states that the material comes from a lower stratum than the insects previously obtained by us. One of the specimens is a beautifully preserved wasp, with wings outspread, belonging to the modern genus Hoplisus. It is 12 mm. long, with a wing-spread of about 19 mm.; the head and thorax are black; abdomen fusiform with narrow base, and the hind margins of the segments broadly pale-banded, as in living species; the legs are colourless, probably yellow originally; the anterior wing shows a pallid stigma, and a strong dusky cloud including the basal part of the marginal cell and the whole of the second submarginal; the venation is essentially that of the modern *Hoplisus quadrifasciatus*, except that the marginal cell is more slender, and in the hind wing the cubitus practically meets the nervulus.

The only fossorial wasp from the Eocene previously described is Scudder's *Didineis solidescens*, which is evidently quite different from the present species, but is too poorly preserved for the accurate determination of the genus. No older wasps are known.

This Eocene Hoplisus, which may be called *Hoplisus archoryctes*, doubtless preyed on the Homoptera, which are so numerous in the same rocks. It is, I think, the most impressive instance of the persistence of type which I have ever seen, when we consider that it belongs to a highly specialised group of insects, and proves that within this group there has, at least in one line, been no change of form or colour in the many millions of years which we now believe to have elapsed since the Eocene. Even the cloud on the wings is as in living species. Could the species be restored to life, *H. archoryctes* would fall into our system, merely forming another species to be added to the many similar ones existing.

T. D. A. COCKERELL.

University of Colorado, Boulder, Aug. 1.

Black Coral.

PROF. HICKSON'S very interesting article on the therapeutics of Black Coral (NATURE, August 12, p. 217) is sure to stimulate further study, and it is therefore worth while remembering that in alchemical terminology corals are sometimes used as a pseudonym for antimony.

M. NIERENSTEIN.

University of Bristol, August 13.

The Zoological Society.

By E. G. BOULENGER.

BEFORE the foundation of the Zoological Society of London in 1826 there was no organisation in this country devoted solely to zoological science. The Royal Society, as it still does, occasionally published papers of zoological interest, while the Linnean Society, which undertook the discussion of both zoological and botanical subjects, at this time rated the latter science of more importance than the former. As to the exhibition of living animals, during the first quarter of the nineteenth century the only collections in the country were those of the Royal Menageries at Windsor and at the Tower, and the private one of Mr. Cross at Exeter 'Change in the Strand. Hence it came about that a band of enthusiastic zoologists headed by Sir Stamford Raffles, who had just returned from administrative duties in the East Indies, decided on founding a Zoological Society in London. At the first general meeting, held in the rooms of the Horticultural Society in Regent Street, which was attended by more than a hundred persons, Sir Stamford Raffles was elected president. Unfortunately the president and founder died a few months later—some years before the society acquired its charter of incorporation, granted in 1829, in which the Marquis of Lansdowne is named as the first president of the chartered society, and Mr. N. A. Vigors the first secretary.

Twenty acres of ground in Regent's Park having been obtained from the Government at a nominal rent, the gardens were laid out in accordance with the plans of Decimus Burton, and opened in 1828 with a stock consisting of 152 mammals and 475 birds. The first animals to come into the possession of the society were housed at the offices in Bruton Street, where they were kept until suitable accommodation had been provided for them in the gardens. The first animal to be received was a griffon vulture, which lived in the menagerie for forty years. While the menagerie was being formed in Regent's Park the society was engaged in establishing a museum of preserved specimens in Bruton Street. The museum attracted so many donations, becoming in consequence so crowded, that in 1836 more commodious quarters were taken for it in Leicester Square. In 1843 the collections were transferred to the gardens, and housed in a building on a site now occupied by the society's offices. Indeed, in the early days of the society the museum was regarded as the centre of the society's usefulness. When, however, the zoological department of the British Museum developed, the absurdity of endeavouring to maintain an inferior collection in the same city became apparent, and in 1856 it was decided to part with the collection and present the type specimens to the national museum.

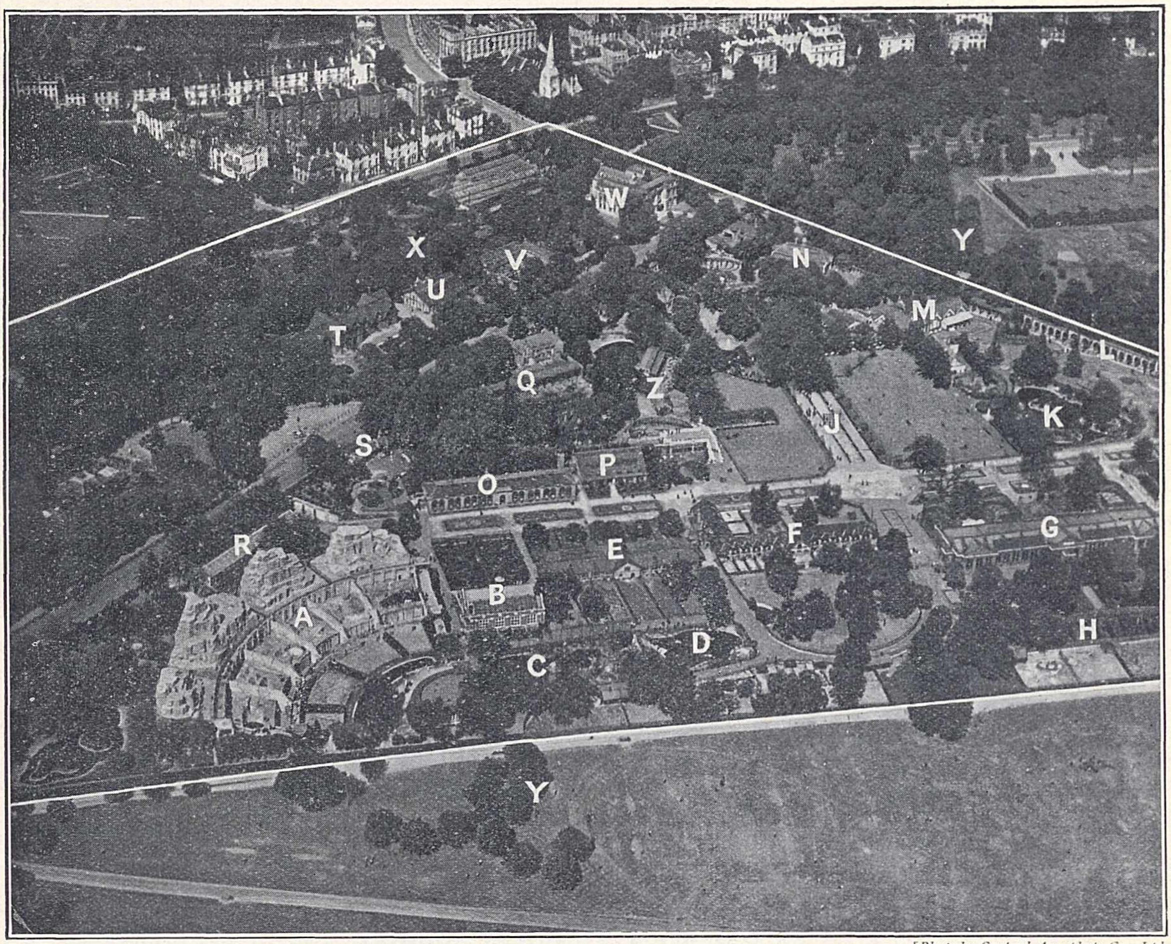
The establishment of a farm at Kingston was another of the society's early enterprises. Its object was to give accommodation to animals requiring a greater range and more quiet than the gardens in Regent's Park could afford. It was also considered necessary for the purpose of breeding, and rearing young animals, and especially for attempting to naturalise such species as were hitherto unknown in this country. This experiment was a costly failure, and was abandoned in 1836.

In the infancy of the society there were no scientific meetings, communications on subjects of zoological interest being submitted at the general meetings. In 1829 a special committee of science and correspondence was formed, at the meetings of which zoological subjects were discussed. The committee met until 1832, when an alteration was made in the by-laws by which the committee meetings were replaced by general meetings for the discussion of scientific business. These were held first at Bruton Street, but in 1843 the society moved to No. 11 Hanover Square, where it remained for forty years. In 1884 more commodious premises at No. 3 of the same square were acquired, and the meetings were held there until 1909, when the society moved to its present premises in the gardens.

The principal features of the gardens at its opening consisted of a lodge on approximately the site of the present main entrance, where visitors provided with a fellow's order paid a shilling for admission; a bear pit which still existed fifteen years ago on the site of the terrace, built in 1843; a yard for kangaroos on the site of the present eland paddock; sheds for deer and goats, and dens for large "quadrupeds"—tenanted by a lion, a tigress, a pair of leopards, a puma, a hyæna and a pair of polar bears on the site of the Lion House; a Monkey House with poles outside to which the monkeys were fastened during the summer months, on the site of the recently demolished otter pond; an enclosure for emus where the pelican enclosure now stands; paddocks for cranes and other large birds on the site of the present Eastern Aviary; an aviary for small birds, renamed the Crescent Aviary, which was demolished only last year, on the site of the new tea pavilion; and a Llama House with clock tower, the present Camel House, which alone of all the original houses and enclosures stands where it did in 1828. Just north of the Llama House was a yard with cages which housed a hybrid between a jackal and a dog, some bears, dingos, and a sable. On the site of the present Llama House were cattle-sheds containing an American bison. Towards the close of the year 1829 the tunnel connecting the south and the middle gardens (then called north garden, the present north garden being acquired at a much later date) was built, and a repository was constructed on the site of the present offices. The repository served for the reception of the animals on their arrival, and in turn has been converted into a reptile house, a museum, a small cats' house, and a squirrel house.

The gardens soon acquired great popularity, the annual admissions between the years 1830 and 1840 averaging more than 200,000. From the year 1840 the income of the society gradually decreased until in the year 1847 there were only 88,500 visitors. In that year Mr. D. W. Mitchell was appointed the first paid secretary, and with the general change of policy which he introduced matters immediately improved. To Mr. Mitchell, who held office till 1859, when he took up the directorship of the Jardin d'Acclimatation, then just founded in Paris, were due the abolition of the rule which required that all visitors should be provided with a fellow's order, and the policy of admitting the public on Mondays, and children at any time for sixpence each. On Mr. Mitchell's retirement, Dr. Philip Lutley Sclater was elected to the post of secretary, which he held until 1901. During the lengthy period that he held office many changes were effected in the gardens, the most important being the erection of the Antelope House (1861), the Eastern Aviary (1862), the Monkey House (1864), the Elephant House (1868), the Lion House (1876), the old Insect House (now the Rodent House) (1881), the Reptile House (1887), the Ostrich House (1897), the Llama House (1898), the Zebra House (1899), and the Ape House (1901), all of which are still standing and are to be distinguished on the accompanying aero-photograph. Towards the end of the year 1901 Dr. Sclater retired after serving the society for forty-three years, a period during which the society occupied a very high position in the scientific world. On his retirement his son, Mr. W. L. Sclater, held the office of secretary for a short period, but at the following annual meeting, on a vote of the fellows, the present secretary, Dr. P. Chalmers Mitchell, was elected to the post. Just prior to the retirement of Dr. Sclater some dissatisfaction had been expressed by a number of fellows with the housing conditions in the gardens, and the new secretary was soon at work, carrying out various improvements which gave immediate satisfaction to the fellows and public.

Apart from realising the necessity of doing away with various small cages, and giving their inmates more exercise, Dr. Chalmers Mitchell, in spite of some opposition, insisted that many of the animals, which hitherto had been confined all the year round in very hot cages, should be given access to the open air. It was then the general belief that most of the creatures coming from the tropics should be kept very warm, and consequently their housing conditions were determined almost solely by considerations of temperature. Now visitors to the gardens in winter may see a host of tropical animals in the open, a change of policy which has had the effect of improving greatly the



[*Photo by Central Aerophoto Co., Ltd.*

THE ZOOLOGICAL GARDENS, REGENT'S PARK, LONDON.

A=MAPPIN TERRACES. B=ANTHROPOID APE HOUSE. C=SOUTHERN AVIARY. D=SEA LIONS' POND. E=OSTRICH HOUSE. F=ANTELOPE HOUSE. G=LION HOUSE. H=WOLVES' AND FOXES' DENS. J=ELEPHANT RIDE. K=THREE ISLAND POND. L=BIRDS OF PREY AVIARIES. M=REFRESHMENT ROOMS. N=SMALL CATS' HOUSE. O=MONKEY HOUSE. P=SMALL BIRDS' HOUSE. Q=EASTERN AVIARY. R=WESTERN AVIARY. S=MAIN ENTRANCE. T=ELEPHANT HOUSE. U=PARROTS' HOUSE. V=CAIRD INSECT HOUSE. W=OFFICES AND LIBRARY. X=REGENT'S CANAL. Y=REGENT'S PARK. Z=CLOCK TOWER AND CAMEL HOUSE.

general health of the exhibits. The secretary also realised that in the past, when new buildings and enclosures were erected, in most cases immediate convenience took precedence of any general scheme. In 1909 he induced the council to consider the condition of the gardens with regard to existing buildings of a permanent character, and recommended that in the future, as buildings and enclosures were erected, they should be arranged in conformity with a general plan. The matter was temporarily shelved, but in 1912 the garden committee drew up a list of the animals the society could expect to exhibit under suitable conditions at any time, considered the existing accommodation, deciding how far it was to be regarded as satisfactory, and what areas should be reserved for the supply of further accommodation as it could be provided. It is in conformity with the plan then drawn up that the various buildings and open spaces provided in recent years have been erected and set out.

In 1906 and in 1907 the society obtained additional grants of land from H.M. Commissioner of Works. The 20 acres of land granted to the society in 1826 lay on both sides of the Outer Circle, corresponding roughly with the existing middle and south gardens, but only a portion to the south of the circle was laid out. In 1834 an additional plot of ten acres on the south-west border of the gardens was obtained at an annual rental, on the condition that it was to be used as pasturage. In 1839, use of the land north of the Regent's Park Canal, corresponding to the existing north gardens, was granted.

In 1841 the ground in the occupation of the society was rearranged. The strip on the north bank of the canal was surrendered, and a portion at the east end of the middle garden was exchanged for a corresponding area at the west end, and permission was given to extend the works over the ten acres granted in 1834. In 1869 the land on the north bank of the canal was again taken over by the society. A considerable portion of the north garden was, however, not made use of until after 1903, when the policy of increasing open-air facilities for the animals was put into operation. Complete use of the north garden was, however, not possible until 1906, when the right-of-way was obtained over two unoccupied portions of ground on both sides of the canal, and H.M. Commissioner of Works agreed to allow half of the new bridge over the canal to be used by the society on payment of its proportion of the cost of reconstruction. A communication between the north and the middle gardens was thus obtained. In 1907 a strip of ground was obtained along the south-west boundary of the south garden, which ends in a large triangular area at the west end, now occupied by a pond for water-fowl, and goose paddocks. The condition attached to the grant of the new piece of land was that the animals placed on it should be visible to the public in Regent's Park. The paddocks erected on this site now contain deer, llamas, emus, and rheas.

Of the buildings erected and designed under supervision of the present secretary, the Small Cats' House (1903), the Sea-Lions' Pond (1905), the Small Birds' House (1905), the Cattle and Deer Sheds (1906), the Society's New Offices and Library (1909), the Sanatorium (1909), the New Prosectorium (1909), the Mappin Terraces for the open-air display of mountain goats and bears, with its tea-pavilion (1913), the Small Mammal and Caird Insect House (1913), and the New Tea Pavilion facing the broad walk (1922), are the most important. The transfer of the offices, library, and meeting room to the gardens, apart from providing adequate accommodation for the library, which had outgrown the rooms in Hanover Square, has greatly facilitated the work of the staff. At the time there was some opposition to the transfer, a few fellows being of opinion that there would be a falling off in the attendances at the scientific meetings. Such, however, has not been the case, as at the present day they are attended far better than in the past.

How all the great improvements which have gradually been effected during the past twenty years have popularised the gardens may be best realised when we consider that the admissions, which in 1902 amounted to less than 700,000, last year exceeded 1,500,000. When the new fresh-water and marine aquarium, which the council has decided to build under the Mappin Terraces, is completed, the latter figure will no doubt be exceeded.

The Resonance Theory of Audition.

By Prof. E. H. Barton, F.R.S.

THE resonance theory of audition continues to excite considerable interest and must be regarded as being still in the controversial stage. The very name is somewhat unfortunate and may have led some into the mistaken view that some sympathetic vibrators in the ear are postulated as capable of actual resonance or resounding like a tuning-fork set in audible vibration by another which was first sounded. Of course it should be understood, on the resonance theory, that the vibrator in question merely vibrates when a sound of nearly its own proper pitch is received by the ear, such vibration, though effecting audition by its possessor, being quite inaudible to others. Some through misunderstandings on this or other points have failed to grasp the essentials of the resonance theory of audition, and have in consequence levelled at it criticisms which clearer knowledge on their part would have obviated. No attempt will be made here to locate in the ear those mechanisms, if any, which play the part of sympathetic vibrators, responders, or resonators. That is left to the anatomists to discover. But we may note briefly the essentials of the resonance theory, the salient facts of audition and what power the theory has of meeting the demand which those facts make upon it. In the latter we may derive help from the consideration of a simple working model which any one may set up and experiment with for himself.

Essentials of the Resonance Theory.—This theory postulates the existence within the ear of some set of mechanisms, each of which has its own proper rate of vibration and rate of dying away when left to itself. Each such vibrator can accordingly be set in vigorous vibration by very feeble forces, provided they occur at or very nearly at the rate in question. These sympathetic vibrations would quickly die away when their stimulating cause ceased. Each such vibrator is supposed to have nervous connexion with the brain so that the fact and amplitude of its vibrations may be transmitted thence and duly noted.

The theory is not primarily concerned with the exact nature or details of structure of these vibrators provided only that they fulfil the foregoing conditions for mathematical theory shows that the response of one such vibrator to the forces exerted upon it by another vibration obeys the same general laws quite independently of the details and nature of the vibratory responder under consideration.

Facts of Audition.—For normal ears the following may be regarded as the chief facts of audition with which we are here concerned:

(i.) The range of audition is limited at the upper and lower ends, such limit varying with individuals, but about eleven octaves are usually audible.

(ii.) Before either limit of audition is reached the notes may be recognised to be very high or low, but the distinct location of pitch fails, so that only about seven octaves are musically available.

(iii.) At about the middle of the range the discrimination of pitch between near notes when sounded successively is, for a keen ear, about the twentieth of an equal-tempered semitone or $\frac{1}{240}$th of an octave.

(iv.) When two very near notes of almost equal intensities are sounded simultaneously, the difference of their frequencies may be recognised by any one as the number of beats per second. This may serve to discriminate a pitch-difference of the fortieth of a semitone or half that just named.

(v.) When two different notes at a considerable interval (say C and G) are sounded together, both notes can be heard and their interval estimated, they are not mistaken for a single note of intermediate pitch (E or E♭). (This deserves special notice as being the direct opposite of colour vision for some parts of the spectrum, and will be dealt with in another article.)

(vi.) When several simple vibrations occur simultaneously, being produced in association from the same vibrating source, string or wind, the resulting character of the compound tone or note is recognised and spoken of as its quality, quality of tone, or tone simply.

(vii.) A musical shake of about ten notes per second on a note of frequency about a hundred and ten per second can be heard distinctly.

Power of Theory to meet the Facts.—Having briefly reviewed the chief facts of audition we may now naturally ask what power the resonance theory has to meet the demands thus made upon it. In other words, can the physicist imagine a set of vibratory responders the behaviour of which under vibratory stimuli would give results which correspond to those of human audition? In trying to arrive at a right or possible solution, obviously many variables are at our disposal. They may be stated thus:

(*a*) The total range of pitches of the set of responders.
(*b*) The musical intervals between adjacent responders.
(*c*) The damping (or rate of dying away) of the vibrations natural to these responders when started and then left to themselves.
(*d*) The constancy or otherwise of the intervals and of the dampings throughout the range.
(*e*) The fineness of discrimination of relative amplitudes of vibrations of adjacent or other responders by means of the nerves attached to them.

These variables are more than are needed to make a solution possible; they leave a choice between a variety of possibilities which may be imagined by the physicist and suggested to the anatomist for examination and rejection or acceptance. Thus, for example, the less the damping natural to a set of responders the easier is the location of pitch by them. But the presence of objectionable damping could be balanced by an enhanced fineness in the nervous discrimination of relative amplitudes of adjacent responders. A word or two of explanation may be desirable as to the relation between the damping natural to a vibratory responder and the nature of its responses to various alternating forces of nearly its own frequency. Without entering here into the niceties of the mathematical theory it may be said broadly that the best response follows only with the best tuning between the frequency natural to a responder and that of the forces acting upon it. But the actual value of this response and its falling off consequent upon mistuning both depend on the damping natural to the responder. If the damping is very slight, then the response is very vigorous for precise tuning, but for quite small mistunings the response is almost negligible. This is often summed up by saying that for slightly damped responders the resonance is *sharp*. On the other hand, for highly damped responders the response is not so good for best tuning as in the former case, but this response is only slightly impaired by moderate mistuning of the forces. In other words, for strongly damped responders the resonance is *spread*.

Bearing these facts in mind we have to make a choice among the possibilities open to us so as best to meet the facts of the case. The facts (iii.) and (v.) show that the damping must not be too large, because that would involve spread resonance instead of the sharpness needed for the actual fineness of location of pitch experienced. On the other hand, fact (vii.) shows that the damping must not be too small, as in that case the sound heard from one note of the shake would run into that of the next and give a blurred effect contrary to experience. We have thus found limits between which the damping should lie.

In view of these considerations we may submit the following suggestions. Let it be supposed that in the ear there is a set of vibratory responders which—

1. Cover a range of seven or more octaves,
2. Are about twelve to the octave in the middle of the range and have a suitable damping,
3. Are in total number about a hundred.

Simple Model and its Behaviour.—To test the adequacy of the arrangement just postulated let the following simple model be set up as shown in the diagram, Fig. 1.

This responsive model consists essentially of a stout cord stretched across a room between the fixed points H and J, with a pendulum KL with heavy bob L to act as driver, and a number of light graduated responders lettered C to C′. The latter have small paper cones about 2 cm. high as bobs, with the addition of split rings of copper wire resting on them to prevent the damping being too great. The driving pendulum has a "tightener" at M to adjust its length, which must be reckoned from L up to N, since when the heavy bob L swings the bridle HKJ swings about the line HNJ. The lengths of the light responders, on the other hand, must be reckoned only up to their suspension point on the cord HK. These light responders have suspensions of thread which are passed through the cord HK and may then be cut off and the adjustment to place made so that the line of the bobs CD—C′ passes through H. This is essential in order that each responder receives an equal inclination by a given displacement of the heavy bob L. In the diagram just one octave of responders is shown, the number being thirteen and the lengths such as to make their relative frequencies those of the consecutive notes on the piano or organ. This allows a fineness of discrimination of pitch in agreement with experience. Of course to represent the whole set of aural mechanisms, seven or more octaves would be needed, but a single octave on the model enables one to carry out a number of interesting tests, though for some, two octaves are necessary, as shown by dotted lines in the figure. For the latter the lengths of the responders (and also the distances from H of their points of suspension) may be as follows: 57·05, 50·8, 45·25, 40·3, 35·9, 32·0, 28·5, 25·4, 22·6, 20·16, 18·0, 16·0, 14·25, 12·7, 11·3, 10·1, 9·0, 8·0, 7·13, 6·35, 5·65, 5·04, 4·49, 4·0, 3·55 cm. Any consecutive thirteen values will do for a single octave.

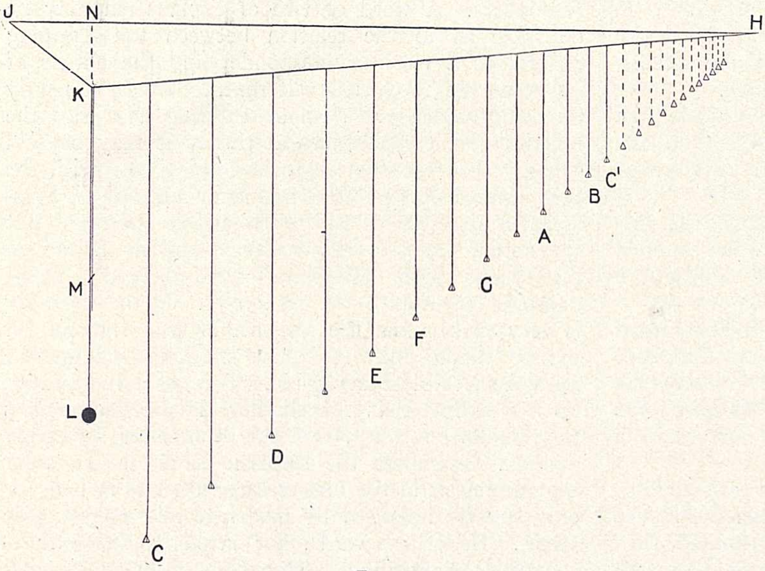


FIG. 1.

We may now test the behaviour of such a model and ascertain if in essential features it typifies the mechanism in the ear, although of course it is not for a moment imagined that any pendulums exist in the ear. If vibratory responders exist there they must be of an elastic nature.

If the seven octaves or more of responders were provided we should have the musical range of seven octaves accounted for. Further, the lack of precise discrimination of pitch for very high notes and for very low notes is explained also. Thus, for any note well within the range of the responders, when the pendulum bob L is swung, thus representing by its frequency a certain note, the responders vibrate in response, the one best in tune vibrating most, the others near it, *both above and below*, showing a rather less response. Hence the pitch is recognised and located by this behaviour. But if the pendulum LN is made shorter than the shortest or longer than the longest responder provided, then we have the responders near the end in question responding best but no maximum response with a *return to quiescence beyond it.* Thus the exact pitch cannot be located, and this agrees with experience. Consider next the discrimination of pitch between notes very near in pitch, and let us ascertain what is possible when the adjacent responders differ in pitch by a semitone or one-twelfth of an octave. It will be easily ascertained that a discrimination of pitch of about the twentieth of this semitone is possible. For by adjusting the tightener M on the suspension KL, we can make the response of two adjacent pendulums equal, and then by repeatedly lengthening the heavy or driving pendulum the response of the lower of the two light pendulums may be increased and that of the higher one decreased till the lower one just shows a maximum, the adjacent ones above and below being alike in their response. We should then have passed over the half of a semitone only and ten steps are susceptible of discrimination in this range. Without any wire rings on the paper cones the responders would not succeed in this test, but with the rings to weight the cones there is less damping, sharper resonance, and adequate discrimination.

If two octaves of responders are provided very striking experiments can be shown as to the recognition of the overtones essential to notes of a certain quality of tone. Thus, setting the pendulum NL to the pitch of a low responder, say the third from the bottom, if the pendulum swings freely we have a responsive maximum at that responder. But if the bob L is grasped in the hand and swung to and fro in the same period as before, but with a "dimple" at one end of the swing, it is really executing tone and octave, and the responders will promptly show the corresponding two resonance humps. Again, if the bob L is swung to and fro, with a "dimple" at each end, it is really executing tone and twelfth (frequencies 1 and 3), and the responders give the corresponding two resonances. Lastly, if the bob L is moved smoothly from end to end in one direction, but returns with two kinks or dimples, we have really a vibration consisting of tone, octave and twelfth (frequencies as 1, 2 and 3), and the three appropriate resonance humps are shown by the set of responders.

Thus, without overstraining or even exhausting the possibilities of the resonance theory it seems easy by its use to account for the main facts of audition, none of which seem in conflict with the theory. This, of course, does not suffice to establish the hypothesis, as it is conceivable that some other might be equally successful. But, pending the advent of such a rival, perhaps the disciples of Helmholtz may be pardoned for what others might style their inexplicable interest in an old and unproved theory.

The Lesser Whitethroat's Fanfare.

(To J. S. H.)

THOUGH lyrics mingled with tattoos
Of melodrama savour,
The Lesser Whitethroat dares to use
Both avenues to favour.
Behind a screen
Of leaves unseen
He'll croon with tenderest passion,
Then loudly reel
A clarion peal
Of notes in fanfare fashion:
(*Sotto voce, pp.*) *Chi'ddy-choo-ee'cheo,-Wee'jo-choo-ee'chey,*
Wee'-chiddy-wee'chey,-Choo-i'ddy, Choo-ee'!
Then changing time,
And reckless of rhyme:
(*Vivace, ff.*) JIP-JIP-JIP-JIP,
JIP-JIP-JIP-JIP,
JIP-JIP!

But can we give this Warbler praise
When art he compromises,—
In secret hums his native lays,
And flash-notes advertises?
Sing, Warbler, sing!
These cries you fling
Too soon all tune will smother;
And then you'll flit
A ribald Tit,
And Whitethroats lose their brother!

W. GARSTANG.

Obituary.

W. H. HUDSON.

THE death of Mr. William Henry Hudson at his residence in London on August 18, in his eighty-first year, removes from our midst a remarkable personality, a great writer of English prose, and a keen interpreter of Nature.

Mr. Hudson's father emigrated to the Argentine in the early part of the last century and settled on the pampas, and it was there that his childhood and early life was spent. We get a vivid idea of the conditions under which he grew to manhood in the pages of "Far Away and Long Ago," a volume of autobiographical recollections which he published in 1918—the vast treeless plains, the solitary estancia with a few trees around it, the semi-savage gauchos, and above all the teeming bird life along the strand of a lonely mere.

In his early days Mr. Hudson entered into correspondence with the late Dr. P. L. Sclater and sent him collections of birds and mammals. Accounts of these, first appearing in the Proceedings of the Zoological Society, formed the foundation of a joint work, "Argentine Ornithology," published in two volumes in 1888-1889, to which Mr. Hudson contributed the notes and observations on the habits of the birds, while Dr. Sclater was responsible for the technical descriptions and general arrangement. This work was recently re-issued by Mr. Hudson alone, but without the technical descriptions, under the title of "Birds of La Plata." Two other volumes, well known to lovers of good writing dealing with South American Natural History, were "The Naturalist in La Plata," 1892, and "Idle Days in Patagonia," 1893.

About this time Mr. Hudson came to England and began a long series of works dealing with the study of Nature in England. "Birds of a Village," "Nature in Downland," "Hampshire Days," "The Land's End," and the more strictly ornithological "British Birds," "Birds and Man," and "Birds in London," followed one another in quick succession. Though always in feeble health and of a delicate constitution, he tramped over southern England from the New Forest to Penzance throughout the summer, spending the winter partly in London and partly at Penzance, where he made his second home.

Recognition of his talent came late to him. In his early days in England he was unable to earn a livelihood with his pen and he was awarded in 1901 a Civil List Pension of 150*l.* in "recognition of the originality of his writings on natural history." This he resigned in August last year on the ground that he needed it no longer. "Publishers," he told an intimate friend, "threw money at him with both hands."

A man of extremely sensitive temperament, Hudson could not endure to take the life of any animal or bird, and was an ardent supporter of the Society for the Protection of Birds, to which he devoted much of his energy during recent years. He was thus out of sympathy with any form of collecting. He had, however, a wonderful power of observation, and his sense of hearing was extremely acute. His writing is simple, lucid, and descriptive, and he never gave to his observations on bird or animal psychology that anthropomorphic tendency which so often characterises the writers of popular works on natural history subjects. Though he can never be reckoned among the ranks of scientific ornithologists, his writings will undoubtedly endure as monuments of accurate observation and of limpid, lucid, English prose.

Current Topics and Events.

In an address to the Rothamsted branch of the National Union of Scientific Workers, reported in the *Scientific Worker* for June, Prof. A. L. Bowley pleaded, as so many have done, for an "interpreter" to mediate between science and the laity. He suggests that "one test of greatness in works of art is that they should make a direct appeal to those whose powers of appreciation are not specialised," and, by analogy, that the greatest science should be the most easily interpreted. But what does the analogy really prove? The "art" which is appreciated without *any* specialisation is that of the Merry Widow waltz or Poems of Cheer; the appreciation of a Bach fugue or a Shakespeare sonnet *does* require some "specialisation"; it requires, not practice of the art, but some deliberate self-education. If the laity would (or could) educate themselves in science as they do in art, interpreters might be forthcoming who would do for science what in our generation Berenson and Mr. Roger Fry have done for painting or Sir Henry Wood and Mr. Ernest Newman for music. The difficulty now is that the wholly "unspecialised" laity demand "interpretation" in terms of concepts of which science denies the validity, just as they demand sensual prettiness in painting and catchiness of tune in music. Before interpretation can begin there must be an effort to understand; men of Prof. Bowley's eminence in other branches of learning must not pronounce *ex cathedra* that "science is not beautiful"; men must know that science is beautiful—to those who will train themselves to appreciate its beauty.

The *Museums Journal* for July 1922 criticises the announcement of the Board of Education that in future local authorities will be charged with half the actual cost of transporting the collections sent on loan from the Victoria and Albert Museum to provincial museums and art galleries. Hitherto there has been a uniform charge of *2l. 10s.* The change will make little difference to places near London, but will be prohibitive for the less wealthy distant towns. The collections of the Victoria and Albert Museum were originally intended to help museums and students throughout the country. Gradually there arose a division between the objects retained in the museum and those put into circulation; but the Circulation Department remained an important section of the museum. Now it is contended that the two are "in hopeless competition in regard to purchase of objects." This, if true, is absurd, and we agree that something should be done to co-ordinate the work of the various national museums *inter se* and with the work of the provincial museums.

While the *Museums Journal* seems to be of the opinion that the national museums do not do enough for those in the provinces, Mr. Lawrence Haward, in a lecture to the Royal Society of Arts (published in the Journal of the Royal Society of Arts for July 28, and in the *Museums Journal* for July and August 1922), says: "If more has not been done to make the National Collections available to the nation, as distinct from the inhabitants of London, it is largely, I think, because the provincial galleries have not always realised how ungrudgingly those in authority in the great National Galleries and Museums will impart their knowledge and render assistance in a variety of ways to their provincial colleagues out of the abundance of their own treasures." And again, he says of provincial museums: "If only they know how to use their opportunities, and are given a fair chance of putting their knowledge into practice, they can become a really vital influence in the town . . . acting as cultural centres for the whole community." Without attempting to decide whether it is the national museums or the provincial museums that are most to blame, such acquaintance as we have with the work of both has forced us to the conclusion that the provincial public does not sufficiently appreciate the advantages of its own local museums, and frequently worries the officials of metropolitan institutions with questions that would have been much more conveniently dealt with nearer home.

In commemoration of the bi-centenary of the appointment of Bernard de Jussieu as demonstrator of botany at the Paris Jardin des Plantes, the Abbé L. Parcot in *La Nature* (July 1) gives an interesting account of his work, especially the foundation of the Botanic Garden at the Petit Trianon at Versailles. The latter was of supreme interest as the birth-place of the natural system of classification of plants. De Jussieu was commissioned in 1750 by Louis XV. to lay out a botanic garden at Petit Trianon. Sixteen years before, Linnaeus had published his artificial system of classification which was enthusiastically adopted by botanists owing to its simplicity of working, as it was based on obvious characters of the sexual organs. Linnaeus had, however, also published some "Fragmenta" of a natural system; that is, one in which plants were arranged according to the sum of relationships of all their characters. Starting with these "Fragmenta," de Jussieu developed a system according to which he arranged the plants in his new garden, and prepared a manuscript catalogue indicating the grouping of the genera in families, and also the list of species included under the genera. This catalogue was published by his nephew, Antoine Laurent de Jussieu, in 1789, twelve years after the death of Jussieu himself. The system was further elaborated by Antoine, and later by Augustin Pyrame de Candolle, and attained its modern development in the classic work of Bentham and Hooker. The famous botanical school and garden of the Trianon were dispersed after the death of Louis XV., and for a long time the site of the garden was uncertain. L'Abbé Parcot has, however, reproduced in *La Nature* some original plans in which the position of the garden is indicated, to the right of the chateau: a cedar of Lebanon and other conifers remain where they were planted by de Jussieu, and a few other of his trees which were replanted in the lawns and flower garden are still standing.

AN imposing scientific expedition set out from San Diego on July 9 last for a two months' cruise among the islands off the west coast of Lower California. According to *Science*, the chief object of the expedition is to make investigations into the present abundance and condition of the southern fur seal, the southern sea otter, and the elephant seal in the localities visited. It had been thought that these valuable animals were extinct, but recent discoveries have shown that a few still exist, and combined action of the United States and the Mexican Governments is necessary for their preservation and exploitation. Advantage will be taken of the opportunity for making surveys of the flora, fauna, and geology of the islands, which hitherto have been but little explored. The expedition has been under consideration by the California Academy of Sciences for some time past, and its realisation has been made possible by the co-operation of the Government of Mexico and a number of American institutions, including the San Diego Museum of Natural History, the Scripps Institution for Biological Research, the National Geographic Society, and the Pacific Division of the American Association for the Advancement of Science. The Mexican Government has loaned the fishery guard boat *Tecate* for the expedition and has accepted as its guests all members of the expedition sent by American institutions. Sen. Carlos Cuesta Terron, professor of herpetology and biology in the National Museum of Natural History of Mexico and a Government representative on the expedition, is director, but the scientific investigations will be in the immediate charge of Dr. G. Dallas Hanna, of the California Academy of Sciences, and A. W. Anthony, of the San Diego Museum of Natural History.

MR. ERNEST A. SMITH has resigned his position as secretary of the British Non-Ferrous Metals Research Association and accepted an appointment as research metallurgist to the Sheffield Smelting Company, Ltd.

MRS. KAPP writes to correct a statement respecting her late husband's parentage that appeared in the obituary notice in NATURE of August 19. She informs us that Prof. Gisbert Kapp's father was not German but a native of Trieste and the governing civil councillor of that city.

ENGINEER VICE-ADMIRAL SIR GEORGE GOODWIN, late Engineer-in-Chief of the Fleet, and Dr. James Colquhoun Irvine, vice-chancellor and principal of the University of St. Andrews, have been appointed members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

THE *Times* of August 28 announces that a special Press telegram from Prof. J. W. Gregory, of Glasgow University, reports his safe arrival at Talifu, Yunnan, after a successful journey in Tibet. It will be remembered that Prof. Gregory and his son, Mr. C. J. Gregory, left England for Rangoon at the end of March last with the object of investigating some features in the mountain structure of north-western Yunnan and western Szechuan (see NATURE, January 12, 1922, vol. 109, p. 51).

A NOVEL feature of the forthcoming Swansea meeting of the Institute of Metals will be the inauguration of a series of annual public lectures on subjects of practical interest to those engaged in the non-ferrous metals industry. Dr. R. S. Hutton, director of the British Non-Ferrous Metals Research Association, is to deliver the first, which will be entitled "The Science of Human Effort (Motion Study and Vocational Training)," on September 19. Further particulars of the meeting, which will be held on September 19-22, can be obtained from the Secretary, Mr. G. Shaw Scott, 36 Victoria Street, London, S.W.1.

A NOTE on *The Pan-American Geologist*, published in NATURE on July 1, has brought from the office of *Economic Geology* a letter (unsigned) stating that *The American Geologist* still remains incorporated with that journal, and that the names of some geologists given as associate editors of *The Pan-American Geologist* were used without permission. If we have repeated erroneous statements we regret it; but those statements had been in our hands for some months, and were not published by us until we saw actual parts of *The Pan-American Geologist*, which appeared to confirm them.

THE Cleveland Technical Institute at Middlesbrough has issued for nearly a year a monthly Bulletin containing abstracts of the most important scientific and technical articles which have appeared in home and foreign periodicals during the month. The Bulletin is printed on one side of the page only, and each issue consists of about 60 pages. Each abstract is on the average about half a page in length, and the intention is that those of interest to the reader shall be cut out by him, pasted on cards, and placed in their proper position in a card catalogue. They are classified under the headings: chemistry and physics of iron and steel, mechanical and electrical engineering, fuel and fuel technology, shipbuilding and marine engineering, foundry practice, non-ferrous alloys, industrial chemistry, blast-furnace practice, and steel-making. A few pages are devoted occasionally to short accounts of recent home and foreign patents, and a list of recent technical publications is generally given each month. As a means of keeping those engaged in industry well up-to-date the Bulletin deserves every support.

AMONG the autumn announcements of Messrs. Chapman and Hall, Ltd., we notice the following: "Practical Applications of X-rays," by Dr. G. W. C. Kaye, in which will be described the various uses to which the rays can be put in commerce; and Vol. 2 of "Mechanical Testing," by R. G. Batson and J. H. Hyde, entitled "Testing of Apparatus, Machines, and Structures." The work will deal with the methods of testing Dynamometers, Gear Boxes, Girders, Reinforced Concrete Structures, Pumps, Springs, Ball-bearings, etc. In the "Directly-useful Technical Series," "Electrical Measuring Instruments and Supply Meters," by D. J. Bolton, will be issued.

Research Items.

CHILD SACRIFICE AT CARTHAGE.—Historical evidence goes to show that the sacrifice of children to the Mother Goddess was not infrequent. Two French archæologists, M. Pouissote and M. Lautier, engaged in exploring the ruins of ancient Carthage, have unearthed in front of an altar near a temple of Tanit three vaults containing the charred bones of new-born babies and children from two to three years of age. The archæologists believe that to the left of the altar was a stone slab with a bronze grill, under which burnt a fierce fire, and here the naked bodies of the first-born were offered in accordance with the ancient rites which were regularly practised from the sixth or seventh centuries before the Christian era until the destruction of Carthage by the Romans. Others, however, believe that it was customary for the parents to reclaim the remains of sacrificed children, and that the bones now found, a gruesome pile 15 feet high, are the remains of sacrificed children placed by their parents under the protection of the all-powerful Tanit.

A POLYNESIAN MUSEUM.—The Bernice Pauahi Bishop Museum at Honolulu, Hawaii, was founded in 1889, by her husband, Charles Reed Bishop, as a memorial of Princess Pauahi, the last of the Kamchamcha family of the chiefs of Hawaii. It is devoted to the study of Polynesian and kindred antiquities, ethnology, and natural history. Besides the material from Polynesia and other Pacific islands, that from Hawaii is the largest and most important. A large staff of experts is employed in research and the collection of specimens, which are of large and increasing value. The Museum has recently published a useful collection of proverbial sayings of the Tongans, compiled by Messrs. E. E. V. Collocott and J. Havea, which, in addition to its value to students of proverbs and linguists, contains a number of useful notes on the folk-lore and customs of the people.

HEAD-HUNTING IN ASSAM.—Mr. L. H. Hutton, the author of two important works on the Angami and Sema Nagas, contributes a paper to the August issue of *Man* on the method in which the heads of victims are decorated and divided. In addition to complete skulls adorned with mithan or buffalo horns, or with wooden imitations of these, many houses had trophies hung up in which the skull was only partly human, the taker having got only a share of the head. In such cases the rest of the head is made of wood, or the skull of an animal, such as a pig, while in another the missing half was ingeniously fabricated from two skulls of the black gibbon (*Hylobates huluk*), making the skull look as if it had three eyes. The object of the horns is said to be to prevent the dead man hearing the call of his friends searching for him, as, if his soul were to go to them, it would instigate them to revenge, whereas if it remain with the taker of the head, it lures its late relations to put themselves within reach of the possessor of the head, and lose their own to him as well. Some Ao villages used to attain the same end by stringing the skull of one of their own dogs above the skull of their enemy. The soul of the dog made such a barking whenever the strange relations of the dead man came within call of him that he never heard them imploring his soul to return.

HUMPBACK WHALE FROM THE MIOCENE OF CALIFORNIA.—How often does it happen that what proves to be a valuable fossil becomes irretrievably damaged before its importance is recognised. This appears to have been the case with a specimen of Megaptera from the Miocene Diatomaceous earth of Lompoc, California. The remaining incomplete skull has been studied by R. Kellogg (Proc. U.S. Nat. Mus., vol. lxi., art. 14), who points out that the discovery of this Miocene member of the Mystacoceti gives additional force to the views of those who have advocated the great antiquity of the Cetacea, for so highly specialised a form occurring in strata of this age affords further evidence for assuming that the evolution of the Cetacea has taken a longer period than heretofore considered plausible. A careful detailed description, illustrated by plates and text figures, completes this paper on *Megaptera miocæna*, n. sp.

PHYLOGENY OF OCHETOCERAS.—The Ammonite genus Ochetoceras, belonging to the family Harpoceratidæ, is confined to the Lusitanian, Kimmeridgian, and Portlandian divisions of the Upper Jurassic and was derived from the Middle Jurassic Oppelia. The numerous species, according to Marjorie O'Connell (Bull. Amer. Mus. Nat. Hist., vol. xlvi.), are found to fall into three phyletic series: those of (1) *Ochetoceras arolicum*, (2) *O. hispidum*, and (3) *O. caniculatum*. The relations of the European species of the first series and the Mexican and Cuban of the other two are here set forth for the first time. These relationships are shown in a series of tables and the various species discussed and described. In all three series the same orthogenetic trends in development are traceable and consist in: (*a*) A progressive diminution in the ratio of width to height of whorl and width of whorl to diameter; (*b*) a progressive diminution in the coarseness of the costæ; (*c*) the branching of the primary costæ at their ventral ends, and finally, (*d*), the branching of the intercalated costæ, or striæ.

EOCENE MOLLUSCA AND FORAMINIFERA FROM NIGERIA.—For some years past scattered information has been obtained concerning the Tertiary fossils of Nigeria, and some of the Vertebrata have been described, but there yet existed a considerable amount of unpublished material. This through the auspices of the Geological Survey of Nigeria (established in 1919) is now being collected for publication, and the Survey's third Bulletin is devoted to the Eocene Mollusca, described by R. Bullen Newton, with an appendix on the Foraminifera by E. Heron-Allen and A. Earland. It is no slight on the eminent authors of the Appendix to say that it is necessarily mainly a list of species, since the sample submitted to them was small. It is of interest, however, to note the almost complete absence of the characteristic Eocene genus Nummulites. The bulk of the paper is devoted to the description of the Mollusca, and great credit is due to Mr. Bullen Newton for the excellent way in which this is done. In all, seventy-three species are described and of these more than half are definitely new and worthy of better illustration than seemingly could be given them. The results of Mr. Newton's study of these Nigerian Mollusca are exceedingly interesting; for he is able to show that the fauna is of Middle Eocene or Lutetian origin, and that some of the forms are closely allied to, if not identical with, British examples from the same geological horizon; that others agree with species occurring in the Upper Mokattam Beds of Egypt; while yet others have affinities with fossils from the Middle Eocenes of Alabama. Among these last is a representative of the genus Bulbifusus, hitherto known only from America. Truly a strange linking together in past ages of remote parts of the globe, still more emphasised by the recent discovery of one of the species, *Cardita* [= *Venericadia*] *planicosta*, in Peru (NATURE, April 29, 1922, p. 561).

THE ORIGIN OF IGNEOUS ROCKS RICH IN ALKALIES.—Dr. S. J. Shand ("The Nepeline Rocks of Sekukuniland," Trans. Geol. Soc., S. Africa, vol. xxiv. p. 111, 1921), discusses an occurrence of the so-called alkaline igneous rocks in and around the farm Spitzkop in the Transvaal. Following the work of N. L. Bowen, he holds that the original magma separated during cooling into a norite and a mass rich in alkalies. The latter rose towards the surface through the well-known dolomite formation, and floated up a huge mass of limestone, which has a visible area of half a square mile. By reaction with the limestone, as R. A. Daly has urged in other cases, a nepheline-syenite (foyaite) magma was produced, which becomes much more calcareous in the neighbourhood of the limestone. The author furnishes a good review of the whole question in "The Problem of the Alkaline Rocks" (Proc. Geol. Soc., S. Africa, 1922, p. xix). He defines an alkaline rock by pointing out that in common igneous rocks the alkali-metals [does he not mean their oxides ?] "are combined with alumina and silica in the molecular proportion of 1 : 1 : 6 (in felspars) or 1 : 3 : 6 (in micas). An alkaline rock, if names are to mean anything, should be one in which the alkalies are in excess of the 1 : 1 : 6 ratio, either alumina or silica or both being deficient." He then discusses the work of N. L. Bowen, who, since the publication of Shand's paper, and in association with G. W. Morey, has shown that orthoclase, at about 1200°, does not melt as a whole, but yields leucite and a glass (Am. Journ. Sci., vol. cciv. p. 1, 1922). Bowen and Morey point out that leucite may thus arise as a temporary mineral in cooling granite magmas; since it breaks up into orthoclase and nepheline, the characteristic minerals of the nepheline-syenites may arise in association through this intermediate phase.

BIRDS MARKED IN EUROPE RECOVERED IN SOUTH AFRICA.—In the August number of *British Birds* Mr. H. F. Witherby records the recovery at Jansenville, Cape Province, on January 8, 1922, of a swallow ringed as a nestling in Berkshire on August 20, 1921. Details of the five previous records of the kind are recapitulated, with a useful map, but these have already been quoted in NATURE in Dr. Thomson's recent article (March 16, vol. 109, p. 346) on the migrations of British swallows. In the same publication Mr. W. L. Sclater directs attention to a record of a common tern marked in East Prussia and recovered in Natal; another common tern marked in Sweden has been recovered in Cape Province, while there is also a remarkable record of one marked in Maine, U.S.A., and recovered in West Africa. Apart from these six swallows and two terns, the only birds which appear to have been recorded by the marking method as travelling from Europe to South Africa are white storks: there are many such records of this species, which has been largely marked in Hungary, Germany, and Denmark, and there are also several very valuable records from intermediate localities such as Central Africa. The records of European marked birds recovered in Northern Africa are less restricted as to species and include cases of the lapwing, lesser black-backed gull, starling, swallow, and white stork.

ATTACK ON A MOTH BY A WASP.—Miss M. M. Buchanan sends us from Penrith a specimen of a moth which was caught while fluttering near the ground with a wasp attached to its thorax. The wasp escaped, but one from a nest a couple of yards away was *Vespa vulgaris*, Linn., and the moth was a small Emerald moth (*Geometra vernaria*, Hübn.). Wasps, which, as is well known, are almost omnivorous, are in the habit of seizing and carrying off other insects as food for their larvæ, but their chief victims belong to the order Diptera (two-winged flies). Major E. E. Austen, of the Natural History Museum, informs us that he has personally witnessed an attack by a wasp on a Drone-Fly (*Eristalis tenax*, Linn.). In this case, in spite of the fact that the victim was the bulkier insect of the two, the wasp flew away with the body of the fly in a very few moments, after first ruthlessly cutting off by means of its powerful mandibles the right wing, the head, and lastly the left wing, all of which from the wasp's point of view were evidently useless encumbrances. Since wasps are diurnal in habit, and moths, speaking generally, are the reverse, attacks by the former upon the latter can scarcely be of common occurrence, and the incident described by Miss Buchanan, if not unique, is certainly unusual.

NIGERIAN PLANTS OF ECONOMIC VALUE.—Part IV. of "The Useful Plants of Nigeria," published as Additional Series IX. of the Kew Bulletin, completes the work begun in 1908 by Mr. J. H. Holland in collating the information of plants of economic importance in Upper Guinea. The remainder of the dicotyledons and the monocotyledons are considered, and a brief note is given on the ferns and fungi. Bound with this part is an appendix containing a list of books of general interest on West Africa, a complete index to all four parts, an introduction, and a preface. Sir David Prain, in the introduction, states briefly the reasons which led to the work being undertaken and the selection of Mr. Holland, from his experience of Nigeria, as compiler. In the preface, Mr. Holland outlines the arrangement and scope of the work. Among the natural families reviewed in this part, the Euphorbiaceæ and Moraceæ provide many plants of economic importance. Under the monocotyledons, valuable information is brought together concerning, among others, the banana, pineapple, sisal hemp, yams, cocoyams, piassava, oil palm, and coconuts. The pages on the Gramineæ and the information on fodder grasses are particularly welcome at a time when stock-raising is receiving so much consideration on the Coast. The list of references to special works and monographs given at the end of each species will be found very useful, but in the illustrations cited, reference to a typical example, easily accessible, would have saved much space and rendered the work more handy. The increased price of this last part raises the cost of the whole work to *1l. 8s.*, and may prevent it becoming as popular as it should be. Mr. Holland is to be congratulated on bringing this compilation to so successful a conclusion. It has entailed many years of careful research, and it fills an important gap in our reference books on West Africa.

TIDAL INVESTIGATIONS.—The third annual report of the Tidal Institute of the University of Liverpool recounts briefly a number of tidal investigations which have been begun there, but not completed, during the past year. The first two years' work established the existence of important residual fluctuations of sea-level, both periodic and irregular, which remain after all those harmonics directly accountable for by the astronomical forces have been removed. Two hypotheses which give some promise of explaining the periodic part of these residuals have been examined, but it is intended to apply further tests before publishing an account of the work. The main investigations of the year relate, however, to the irregular variations of sea-level due to meteorological causes. The method of intensive tidal analysis adopted at the Institute isolates the unexplained residuals with considerable accuracy, and has already facilitated their reduction to law. The residuals for Newlyn thus obtained, over a period of two months, were shown by Mr. Jolly, of the Ordnance Survey, to be correlated with the local barometric pressure and its gradients in two directions at 7 A.M. on the same day. This work has been modified and extended by Dr. Doodson, who has obtained numerical formulæ, depending on meteorological data, which give corrections for the predicted heights of high and low water at the Port of Liverpool, and there is a prospect of obtaining such corrections on the previous day by forecasting the pressure distribution a day ahead. The report closes with the encouraging statement that a thorough understanding of the effects of meteorological changes is now only a matter of continued effort.

ATLANTIC HURRICANES.—After a period of relative quietness, Atlantic hurricanes are, with the approach of autumn, likely to become a source of danger to vessels traversing the ocean. By the aid of wireless the navigator of the present day has an immense advantage over those of quite recent times, and reports from other vessels as well as from seaports on both sides of the Atlantic can now be received when at sea and charted. The *Monthly Meteorological Chart of the North Atlantic* for September, in addition to its usual information of interest to the sailor, deals with two Atlantic hurricanes experienced in September 1921. The tracks of these hurricanes appeared in the *U.S. Monthly Weather Review*, December 1921, and charts for several days which embraced the storms, as well as descriptive matter, are given in the *Monthly Weather Review*, September 1921. Detailed experiences and observations in the Meteorological Office chart will enable the seaman to see precisely how, when afloat, wireless weather reports may help him. With all the aid he may get, it does not relieve the commander from forming and using his own conclusions, and a knowledge of meteorology is more than ever of use to him. The back of the September chart gives small weather charts for each morning, showing the weather conditions over a large part of the North Atlantic from September 7 to 16. Practically during the whole of this period there were two cyclones travelling first to the north-westward and recurving later to the north-eastward, and some vessels clearly experienced both storms. A study of the various details will facilitate action being taken when in the neighbourhood of similar storms.

MONSOONS AS RAIN MAKERS.—In the *U.S. Geographical Review*, vol. xii., July 1922, is an article by Prof. A. McAdie on monsoon and trade winds as rain makers and desert makers. Naturally there is a large amount of originality in the article, but Prof. McAdie makes it clear that much has been taken from Dr. G. C. Simpson's lecture to the Royal Meteorological Society in March last year. The monsoon is essentially a seasonal wind, and the word is used in this sense all the world over, but those like Dr. Simpson, who with respect to India discuss it from an Indian standpoint, associate the wind with the rainy season from June to September. Prof. McAdie is more especially concerned with the monsoonal influence on the Californian coast, where the seasonal winds in the summer fail to produce rain. The heavy fogs along the Californian coast show that the water vapour is present and yet there is no rain, although the air stream must rise at least 2000 metres, because it is flowing into a region of much higher temperature and the mountains fail to become rain makers. In a midwinter month in California the mountains often rob the air stream of much of the moisture. Instances are given of two consecutive midwinter months showing very different precipitation results. The author states that if the winds can bring rain they can also prevent rain from falling, and can in some cases cause deserts. Although warm moist air may be rising, a strong upper-air current may blow the clouds away and interrupt the process of rain making. At the coming meeting of the British Association at Hull a discussion on monsoons is to be opened by Dr. G. C. Simpson, and some further contributions to the subject may be expected.

SURVEYING INSTRUMENTS.—Messrs. T. Cooke and Sons, Ltd., Buckingham Works, York, have issued a revised Price List of the instruments in their Catalogue No. 256, which includes all the surveying apparatus and instruments in ordinary use among engineers and surveyors. Certain of the less common types of instruments in previous lists have disappeared, and component parts of existing types have been standardised so far as possible to cut down production costs. A great variety of well-designed theodolites are described and illustrated, ranging from the simple type of builder's transit to the "geodetic" and the "universal" micrometer instruments, giving direct readings to single seconds of arc. A full range of surveyors' levels is also listed, including the U.S. Coast and Geodetic Survey pattern, which has been specially designed for precision work and affords an exceptionally high degree of accuracy. Details are given of the various types and sizes of spirit bubbles which are manufactured by the firm and can be supplied to any degree of sensitiveness down to one second of arc per 0·1 inch of run. In addition, a series of instructive notes are given on such subjects as tests of optical properties of telescopes; the application of stadia lines to instruments; diaphragms; circles and verniers; methods of observing with micrometer theodolites. Thus the catalogue forms a useful manual of instruments for the surveyor.

WIRELESS RECEIVING SET.—The Metropolitan Vickers Co., Ltd., is putting on the market a compactly arranged crystal receiving set specially designed for use with the broadcasting services that are soon likely to be started in this country. The set, which is intended for a range of about 15 miles, is priced at 4*l*. 10*s*., and consists of a tuner and crystal detector in a case, with a space to hold the head telephone set when not in use; the set requires only to be connected to the aerial, for the construction of which materials are supplied with the outfit. It is not clear whether the battery is contained in the case, but with this class of apparatus one or two cells only would be necessary. The tuner is conveniently arranged for working by a handle moving over a dial, and has no rubbing contacts, being formed by two coils, the relative angular position of which can be varied. For greater changes of wave-length, alternative condensers can be cut in and out. The crystals are chosen with great care, and a spare crystal is provided with each set. The company is also placing on the market a valve set at 23*l*. 10*s*., including batteries, aerial, insulators, etc. This is designed for ranges up to 50 miles and employs two valves, one detecting and the other amplifying. The batteries are contained in a separate box, and the whole of the leads for the telephone head set and the high-tension and low-tension batteries are brought to one plug, which can easily be detached from the set before the lid is closed. This automatically throws the valves out of operation. A loud-speaking telephone can be substituted for the ordinary head set at a slight extra cost. Both these sets will pick up wave-lengths from 300 to 600 metres, and we are informed that both have been approved by the Postmaster-General.

The Weights and Measures of India.

By C. A. SILBERRAD, President Indian Weights and Measures Committee.

A COMMITTEE was appointed by the Government of India in the autumn of 1913 "to inquire into the whole question of the feasibility of securing the use of uniform weights and measures in India." It submitted its report[1] in July 1914, but further consideration of the matter was delayed by the war and subsequent political developments in India, and it was only in April 1922 that, after consultation with Local Governments, the final resolution on the report was issued. This in brief approved the recommendations of the report and left it to Local Governments to give effect to them so far as and in what way each thought advisable.

Like its inhabitants, the weights and measures of India are extremely diversified; but, like them, they are susceptible of a certain amount of classification. Doubtless originally the systems which came into use at the different centres were entirely independent, but with the centralisation of administration, the unification of the coinage, and the spread of railways a certain degree of systematisation has arisen, and the weight of the tola has been assimilated to that of the rupee (180 grains), and is recognised practically everywhere as a fundamental unit, the relation of which to almost all weights in actual use is known.

The system of weights most widely known is that in force on the railways. This consists of the seer of 80 tolas (of 180 grains each) and the maund of 40 seers, with the chatak of 5 tolas. This system is used almost to the exclusion of any other in the west of the United Provinces, the Panjab, except a tract in the centre and the districts bordering on the North-west Frontier Province, the Hazara district of the latter, Sind, Baluchistan, the north of the Bombay Deccan, and the greater part of the Central Provinces. In the Central Panjab, the southern portions of the United Provinces, Chota Nagpur, and practically all Bengal and Assam this system is in use in combination with various other seers—usually known as *kachchha* (*i.e.* imperfect) seers, consisting of a variable but always smaller number of tolas—usually 40 to 60. In Rohilkhand (United Provinces) and the western Panjab with the trans-Indus portion of the Frontier Province the most usual system is one in which the seer contains about 100 tolas, while in Gujarat that most commonly used contains 40 tolas.

In the eastern parts of the United Provinces and the greater part of Behar proper, with adjoining portions of Chota Nagpur, the popular systems are extraordinarily variable. They are based on some number of *gandas* (sets of four) of the local pice (copper coins). These are of two kinds—Gorakhpuri and Lohiya. The Gorakhpuri pice were coined at Butwal in Nepal, and like Lohiya pice consist of shapeless dumps of copper, the weight of which was variable when they were new, and has become much more so with use. A number of *gandas* of such pice was taken to represent the seer of the place concerned. That number would naturally represent a somewhat different weight when other pice were used, so some would be added or subtracted, and that new number would start a new seer. Matters were further complicated by the adoption of the rupee in some places as unit instead of the local pice, the same numbers being used. The numbers supposed to be equivalent to a definite weight vary considerably, a fair average is 100 Lohiya pice = 92 Gorakhpuri pice = 80 tolas. In the Gorakhpur district seers of 8, $8\frac{1}{2}$, 11, 12, 13, $13\frac{1}{2}$, $13\frac{3}{4}$, 14, 21, 22, $24\frac{3}{4}$, 25, 27, $27\frac{1}{2}$, 28, 32, 36, and 40 *gandas* of such pice are reported, while with other seers the total number reported as in use in various parts of the district amounts to 42, not to mention several *panseris* (literally five seers) weights to which there is no corresponding seer in use. The Lohiya pice are fully as variable; 121 separate *gandas* when weighed were found to give 60 different weights varying from 531 to 675 grains. The result is extraordinary confusion.

The *kachchha* seer of 32 to 36 tolas used in the central Panjab has a somewhat similar origin, this seer being supposed to be the weight of 36 *mansuri* pice, a coin coined in the Maler-Kotla state and of varying weight, the 36 averaging $33\frac{1}{3}$ tolas. Similarly in the north-west Frontier Province the Peshawari seer was supposed to be the weight of 102 Doadzashahi or Nanakshahi rupees, each of which was slightly heavier than the present rupee.

Lastly, there are the tracts where a small seer of 15 to 28 tolas is used to the more or less complete exclusion of any other seers. Thus in Bombay city the ordinarily used seer is of 28 tolas, and small seers of something near this weight are current throughout the southern Bombay Deccan, the Konkan, and west Berar.

Throughout these parts of India the table of weights is very similar. The chatak is always one-sixteenth of the seer; it is, however, known by other names—*e.g.* it is a *kanwa* in parts of Behar and Orissa, a *sharak* in the western Panjab, and an *anna* in Sind; while the sixteenth part of the central Panjab *kachchha* seer is termed a *sirsai*. In some tracts the chatak is divided into four parts; these are termed *kachha* in Bengal and *duko* in Sind.

The maund, though usually containing 40 seers, does not do so by any means always, the variations in this respect being by commodities as well as by localities. Thus in Cawnpore a dozen different maunds, containing from 41 to 63 seers (of 80 tolas), are in use for various kinds of merchandise, and in Bombay city seven maunds and 12 khandis. This latter is a weight supposed normally to contain 20 maunds, those in use in Bombay vary from 11 to 28 Bombay maunds (of 40 seers each of 28 tolas).

So far as they fall into this classification the Madras weights come under this head, as the standard seer for Madras contains 24 tolas and the larger seers are but little used, though the 80-tola seer is known through its use on the railways and by Government. The standard table is 3 tolas = one palam; 8 palams = one seer; 5 seers = one viss; 8 viss = one maund. But the palam is 6 tolas in Madras, varies from $3\frac{3}{8}$ to 15 in Malabar, and is $\frac{1}{7}$th pound avoirdupois in Tinnevelly. The viss too may sometimes be 6 seers, and maunds and khandis (usually 20 maunds) vary as greatly here as elsewhere. Certain places have other peculiar weights—*e.g.* the *thukku*, varying from 100 to 250 tolas, and the *tulam* from 800 to 1350. An interesting survival is the use of the Dutch pound (termed *rathal* and deemed equivalent to $42\frac{1}{2}$ tolas) in Cochin. Similarly the British pound has given rise to a *rathal* of $38\frac{8}{9}$ tolas, and in the parts of Arcot near Pondicherry the half-kilo to one of 42·9 tolas. The Madras weights are the most confused and complicated of all India, this being due possibly to the greater differences between the peoples composing its population, and to the fact that much of the Presidency never formed part of the Mughal Empire, and that consequently the basis of many of the weights was not the rupee but the pagoda or some

[1] Report of the Weights and Measures Committee, published by the Government of India. Government Central Press, Simla. Rs. 2.

other coin, so that the adoption of the rupee tola as a unit was more difficult.

The following table, showing the number of different seers reported to the Weights and Measures Committee in 1913–14 in each province, will give perhaps a clearer idea of the complexity and confusion of Indian weights than anything else :

Province.	Number of Seers equivalent to							Weights in Tolas of smallest and largest Seer.
	Less than 30 Tolas.	30–50.	50–70.	70–90.	90–110.	Above 110.	Total.	
United Provinces . .	4	21	11	24	30	13	106	$18\frac{2}{7}$—130
Bengal	1	..	7	19	10	6	43	16—189
Madras	12	2	..	13	2	..	29	20—105
Behar and Orissa . .	1	18	12	16	8	3	58	28—132
Panjab	..	15	..	4	8	..	27	30—105
Bombay	15	5	1	5	..	2	28	15—130
Central Provinces . .	3	2	1	2	3	..	11	21—100
Assam	..	..	2	6	4	2	14	60—120
N.-W. Frontier Province	..	..	1	3	4	2	10	50—$154\frac{1}{2}$
Baluchistan . . .	..	..	..	1	..	..	1	80

Weights smaller than the tola are used mainly by jewellers and physicians, and the most fundamental unit for these throughout India would appear to have been originally the red and black seed of the *Abrus precatorius*, termed in Northern India the *gunchi*, and assumed to weigh one *ratti*. Other seeds and grains were also used, such as the poppy seed, the seed of the *Cæsalpinia sepiaria* and grains of juar (the greater millet), rice, wheat, and barley. The tola used in this table frequently differs from that of 180 grains, but is now usually connected therewith by being deemed equal to a definite number of rattis more (or less) than the standard tola. A very usual table in Northern India is—8 khaskhas (poppy seeds) = one chawal (grain of unhusked rice) ; 2 chawal = one jau (barleycorn) ; 4 jau = one ratti ; 8 rattis = one masha ; and 12 mashas = one tola. In Bengal, Behar, and Assam the *dhan* (grain of husked rice) takes the place of the *jau*. In Bombay and the Central Provinces 2 rattis make a *val*, which is held to be represented by the seed of the *Cæsalpinia sepiaria*, while in part of the Chanda district a grain of wheat serves this purpose. Throughout Behar, Bengal, Assam, and the greater part of the Central Provinces the jewellers' tola is usually 180 grains. In Northern India it is usually greater by from one to twelve rattis, the most usual values being two, three, or four rattis in excess. Occasionally, however, the gold tola is less than 180 grains. In Bombay it varies from 172 to 192 grains. In Madras jewellers' weights seem to vary almost from district to district, and the complications are innumerable. The seed of the *Abrus precatorius*, held to represent the weight *gundumani* or *guruginja*, is a frequent unit, but various obsolete coins (*e.g.* the fanam and the pagoda) and their fractions are in use, and the relations of these weights to the 180-grain tola usually but little known. As an example of the result of these multifarious measures it may be mentioned that silver is occasionally weighed in Madras by a table which is connected with the standard tola by the fact that 3399 of the *rattis* thereof are equal to 64 tolas ! As a matter of fact, throughout India current silver coins are largely used as weights, though the larger jewellers frequently have well-made sets of weights representing the locally current table.

There remains Burma. The weights of this province though showing some connexion with those of Madras, are fundamentally different. The universally current unit is the *peiktha*, usually known to Europeans by its Madras name of *viss*, which has been fixed by Government as 140 tolas (3·60 lbs. avoirdupois), though as a matter of fact this "fixation" has had but little effect outside a few of the municipalities. It varies slightly, having apparently originally been really about $142\frac{6}{7}$ tolas, and was formerly held to be equivalent to 3·65 lbs. avoirdupois (or $141\frac{17}{18}$ tolas). The *peiktha* is divided into 100 *kyat* or *gyat*, known to Europeans as *tikal*. This, it may be mentioned, is, so far as I know, the only truly decimal subdivision current anywhere in the Indian Empire.

For weights below the *tikal* the original table appears to have been 2 small ywès = one large ywè ; 2 large ywès = one pè ; 2 pès = one mú ; 5 pès = one mat ; 2 mats or 5 mús = one ngá-mú ("five-mú") ; 2 ngá-mú = one tikal. Various seeds are used to represent some of these weights ; thus, that of the *Abrus precatorius* is held to be equal to the small, and that of the *Adenanthera pavonina* to the large *ywè*, while the seed of the *Garcinia pedunculata* is occasionally deemed equal to 8 large *ywès*. This table was complicated by the fact that, owing to intercourse with India, the *tikal* was divided also into 16 parts, equally known as *pè*, and then four of these went to the *mat*. Further complications were introduced by the application of the same series of subdivisions to the tola of 180 grains, as fundamental unit, in place of the *tikal*, while in the Ruby Mines district the *ratti* is thus subdivided. The result, needless to say, is extreme confusion.

British (avoirdupois) weights are a good deal used in Bombay city and some of the big towns of Bombay, Berar, and the west of the Central Provinces, and in a considerable number of places in Madras, but practically only in large places and by the larger establishments. Not infrequently the nearness of the pound weight ($39\frac{3}{8}$ tolas) to the half of the 80 or the whole of the 40 tola seer leads to mistakes, or even to deliberate fraud. Any knowledge of the metric system is confined practically to the neighbourhood of Pondicherry.

Only the more important variations have been discussed ; to give anything like a complete list would be far beyond the limits of space admissible. The Weights and Measures Committee of 1913–14 prepared a complete list showing for each district in India and Burma all weights and measures reported to them as in use. It forms a volume of some 500 pages. Enough has, however, been said to show the extreme confusion in weights that exists in many parts of India.

Apart from the use of seeds to represent weights there are few items of special interest. In Upper Burma before the annexation, weights based on the system sanctioned by the King were always made in the form of the *hentha* (known in India as the Brahmini duck). Although in many parts of India well or fairly well made metal weights are in use, often the actual weights consist of lumps of metal or stone, while smaller weights are made out of buttons, etc. Even where cast-iron weights are in use it will frequently happen that there is no indication as to the precise seer, etc., which is deemed to be represented. Thus two or more iron seers of identical appearance but different weights may be found in use in the same town, and sometimes even in the same shop.

In a few places, and these by no means the more advanced, locally made steelyards are used ; thus in Cuttack the *bisa* is a steelyard with movable fulcrum used to weigh articles up to 4 or 5 pounds. Similar steelyards, called *tul* or *tulachoni*, are in use in several districts in the Brahmaputra valley. In Burma, steelyards with fixed fulcrum (known as *le-dan* or *taing-tzu*) are regularly used by the Chinese, but looked askance at by the Burmans, who sometimes find themselves outwitted by the Chinaman when it is used. This instrument, frequently well made of bone or ivory, has one movable weight and two or three points of support, with scales marked on the rod corresponding to each point of support.

Measures of Length.—As almost throughout the world the cubit, or distance from the elbow to the tip of the middle-finger, was the original fundamental unit. This is subdivided into spans, fist-breadths, and digits, and also into sixteenths. A very usual table in Northern India is: 3 jau (barleycorns) = one angul (digit); 3 angul = one girha; 4 angul = one mushti (fist-breadth); 4 girha or 3 mushti = one balisht (span); 2 balisht = one hath (cubit); 2 hath = one gaz (yard).

The names of the various measures of length naturally vary in different parts of the country; thus the yard is a *val*, *var*, or *war* in Bombay and the Central Provinces, and a *gaik* in Burma; the cubit, known as *hath* throughout Northern India, is a *mura* or *mulam* in parts of Madras and a *taung* in Burma. The *girha* is a *visam* in Madras, but corresponds to no measure in Burma. The *balisht* of Northern India is the *bighat* of Bengal, the *jana* of parts of Madras, and the *htwa* of Burma; but the general table is very similar throughout the whole country. The *gaz* (*gaj*, *var*, or *gaik*) varies considerably from place to place, and for different articles, and altogether the number of variants is great; the great majority, however, are within three inches of the British yard, but there are yards in use as long as 48 in. and as short as 19 in., but such are exceptional. To a greater or less extent all are being assimilated to the British yard of 36 in., and in fact many are known by their length in sixteenths (*girha*) of that measure. The foot and inch are but little known, the yard being almost always subdivided, for practical purposes, into 16 *girha*.

The most important of other yards are:

(i.) That based on the *murwan* or *morni* (crooked) *hath* of approximately 24 in. This cubit was arrived at by measuring from the elbow round the tip of the outstretched middle-finger and back to the knuckle; it gives rise to a yard of 40 in. to 48 in., and the British yard is deemed equal to $1\frac{1}{2}$ *morni hath*. It is in use in several districts of the Panjab near the Indus and the adjacent parts of the Frontier Province. It is divided into sixteenths (known as *sharak* or *tasu*) and also into twentieths, which are called *girha*.

(ii.) The Peshawari yard of 38 in. to $38\frac{3}{4}$ in., of which the British yard is deemed to be 15 *girhas* (*i.e.* $\frac{15}{16}$ths). It is used throughout most of the Frontier Province.

(iii.) The *Imarati* or *Mi'mari gaz* (masons' or carpenters' yard). It is still used fairly widely in the north-western part of the United Provinces and the adjacent parts of the Panjab. Its usual length is 33 in., and it varies from $32\frac{1}{2}$ in. to 34 in. It forms part of a special table used in the building and carpentry trades. This is: 4 pain (or 2 sole) = one sut; 4 sut = one pan; 4 pan = 1 tasu; 24 tasu = one imarati gaz. This table is however sometimes applied to the British yard, giving rise to a *tasu* of exactly $1\frac{1}{2}$ in. This yard is probably identical with the *tachumulam* of the southern districts of Madras, which is 33 in. in length and used by carpenters and masons only. In the South Arcot district there is also a special "architectural inch" of $1\frac{1}{4}$ in. British, 24 of which make the "architectural yard." In Bombay city yards of 32 and 24 *tasu* are occasionally used for measuring cloth, this *tasu* is $1\frac{1}{8}$ in. British measure. Beyond the similarity of names of the subdivisions there would appear to be no connection.

(iv.) The *Ilahi* or *Akbari gaz*, originated by Akbar to represent one pace for purposes of land measurement, and at first $33\frac{1}{2}$ in. in length, but now varying from $31\frac{1}{2}$ in. to 40 in. It is over much of Northern India the basis of many indigenous systems of land measurement.

On the Malabar coast the yard is to some extent replaced by the *kole*, a measure of similar length, which consists of 24, or in places of $26\frac{1}{2}$, *angulams* (or *virals*), which appear to be the length instead of the breadth of a finger joint, inasmuch as one *angulam* is held exactly to equal the diameter of a rupee or $1\frac{1}{6}$ in.

Apart from the measures used for measuring land and distance there are practically no measures of any importance larger than the yard. Those for land measurement are closely connected with measures of area and will be considered therewith. Measurements of distance are usually vague. The normal indigenous unit is the *kos* (or in Madras the *kros*). Though supposed to be 4000 cubits it really has little, if any, connexion with that unit and varies from $1\frac{1}{2}$ to 3 miles. The corresponding unit in Burma is the *daing* or *taing*, supposed to contain 7000 cubits, but in reality equally vague. With the construction of roads and railways and the indication of miles and furlongs thereupon, these measures are now almost universally known and used. A somewhat unfortunate complication has, however, been introduced into the Panjab by the invention of a Canal "mile" of 5000 feet divided into five equal parts, each of which (from the shape of the "$\frac{1}{5}$th-milestone" or *burj*) is termed a *burji*. Somewhat interesting is the introduction of new measures of length by reason of the way in which land is subdivided in the Canal colonies into *marabbas* (squares) and *killas* of 1100 ft. and 220 ft. square respectively. The lengths of the sides of these square areas are becoming known as measures of length under the names of the areas.

Most frequently however distances are referred to by the average villager as "the length of a field," "a gunshot," "the distance to which a man's voice will carry," etc.

Measures of Area.—There can be little doubt that the first measures of area depended on the amount of work involved in cultivating the area concerned, or the amount of seed required to sow, or produced by it. Thus the bigah, the most widespread unit of area, is said to have originally represented the area a pair of bullocks could plough in a day. Other units are defined as the area a pair of animals could maintain under cultivation throughout a year, or that they can harrow or sow in a day, or that a man can weed in a day. Many units are based on the area sown with some stated quantity of seed; in rice-growing areas by the number of paddy plants required for planting it, or as the area which a man (or sometimes a woman) can plant in a day, and so on. Another measure used in some parts is the area which can be guarded from the depredations of wild animals by one watchman on a raised platform. In Baluchistan a common measure of land is the area which can be irrigated in 24 hours.

These methods of estimating areas are still widely used by the cultivators themselves in the less thickly populated areas, such as most of the Central Provinces, Burma and Chota Nagpur, and parts of Bombay, Madras and Assam and the Himalayan tracts.

In the more densely populated parts of the country, where the value of the land is greater, a more definite method has been evolved. This throughout almost the whole of both India and Burma seems to have been based on a square each side of which is a certain number of paces, but which is now always expressed in terms of cubits. The length of this unit is extremely variable, but it would appear that in selecting a length the simplest that could be expressed conveniently in both cubits and paces was originally taken. Thus many of these units are near to 5 cubits, which, taking the cubit at 18 in., is equal to three paces of 33 in. each. This unit length has many names: in the United Provinces it is termed a *latta* or *gatha*, and the standard (so far as there was one) was three *Akbari gaz* (of $33\frac{1}{2}$ in. each). The standard most often recognised by Government, however, is of 99 in., so that 20 equal a chain of 55 yards. In the Panjab, the Frontier Province, and Sind the corresponding unit is the *karam*, the most important one being 66 in. in length. In Behar and Orissa it is known as the *bans, lagga, padika*, or *nal*, and usually varies between 6 ft. and 12 ft. In Bengal it is a *dhau, danda, nal*, or *katha*. In Assam a *nal, tar*, or *bes*. In Bombay proper a *kathi*, and in Sind a *kano*; in Madras a *nolo* (Ganjam) or *badda* (Nellore), and in Burma a *ta* (=seven cubits or $10\frac{1}{2}$ ft.). The actual area arrived at by this method is, however, most variable, and though the unit length seems to have originally been about three paces it may, as a matter of fact, be apparently anything from one to five. The more valuable the land and the more powerful the landowner the smaller is the *laggi*. A not infrequent method of raising rents was to shorten the length of the *laggi*, the "rent per bigah" remaining nominally the same for the smaller resultant bigah. Many riots have been caused by differences of opinion between landlord and tenant as to the correct length of the *laggi*. The square *laggi* has many names: in the United Provinces it is usually a *biswansi*, in the Panjab a *sirsahi*, in Behar a *dhur*, in Bombay a *kathi*, Assam a *rekh*, Burma a *palagwet*, and so on. Though it is almost always the four-hundredth part of the bigah (or corresponding unit), the intermediate subdivisions vary. The most general intervening unit is one consisting of 20 square *laggis*, known most widely as a *biswa* or *katha* ("*cotta*"). But in Orissa 16 of the smallest units make a *guntha*, and 25 *gunthas* go to the *man* (which corresponds to the bigah elsewhere). In the Panjab, where the square *karam* is known as the *sirsahi*, 9 of them go to the *marla*, 20 *marlas* equal one *kanál*, and 4 *kanáls* one bigah. Here two bigahs make a *ghumaon*, which has been standardised as one acre. This table holds over the western Panjab, Sind, and the Frontier Province. In Burma there are two large units—the *pègadi* (or "public" *pè*) containing 625 square *ta* (or *palagwet*), and the min-pè of 35 *ta* $2\frac{1}{2}$ *taung* square or 1250 $\frac{25}{196}$ *palagwet*, treated for practical purposes as exactly equal to two *pègadi*.

In eastern Bengal the unit length is often used somewhat differently, the unit area being sometimes rectangular. Thus in Dacca and Maimansingh a common unit is the *káni*, a variable rectangle, but most frequently one the sides of which are 12 and 10 *nal*. The *pakhi*, another frequently used unit, appears to be practically only another name for the *káni*.

Though the system is so similar throughout the country it has not resulted in any uniformity; in fact, the bigah and connected measures are almost as indefinite as the older measures previously mentioned. Thus in the United Provinces no less than 58 bigahs, varying from $\frac{1}{16}$th to one acre, are reported. In Champaran district (Behar and Orissa) the *laggi* varies from 10 ft. $10\frac{1}{2}$ in. to 17 ft. $5\frac{1}{2}$ in. In Dacca the Settlement Officer had to prepare more than 100 conversion tables to reduce the local measures of area to the acre. In much of Madras the indigenous systems appear to have had other origins; thus in Madras city the *cawnie* of 1·32 acres is still used—this is equal to 20 *manai* or "grounds," the *manai* having originally been defined as the area sufficient for a small Indian house. Elsewhere the *gorru*, a measure based on the area a pair of bullocks can plough, is used; it is about $3\frac{1}{3}$ to 4 acres.

There are numerous other units of area in use in various parts of the country, and the variations of those bearing the same name are almost innumerable, but there would seem to be little purpose in giving further details.

When precision is necessary in dealing with areas which are of such vital importance to rent law and the land revenue, two methods have been adopted. Either the bigah has been standardised over a certain area or else the British acre (divided either into roods and poles, or more usually into one-hundredths) has been used. The number of different "standardised" bigahs actually adopted in the Settlement records is very great; thus in the Gorakhpur district of the United Provinces no less than nine were used. In many parts of the country the acre and its hundredth parts (generally termed "decimals," or in Burma "dathama") are becoming well known. In the Panjab Canal colonies two new units have been introduced—the *killa* of 220 ft. square and the *marabba* (square) of 1100 ft. square, equal to 25 *killa*, being respectively equivalent to 10 and 250 acres. In short, for all purposes where exactness is required either the acre and its subdivisions or some standardised indigenous measure is now used.

Measures of Capacity.—Contrary to what is sometimes alleged, measures of capacity for grain and such like articles are very widely used throughout India, the only tracts where they are practically non-existent being the greater part of the United Provinces (excluding the extreme east and south-west), most of Behar proper, and the eastern Panjab. It is true that in much of the rest of India they are mainly used in rural areas and the smaller towns and for retail and local transactions, but even so their use is widespread and certainly affects the great bulk of the people. In Burma, and to a less extent in Madras, they are of universal importance, forming the basis of large transactions. For some reason, or possibly by pure coincidence, their use is more widespread in the rice-growing areas, though by no means excluded from the rest of the country.

The unit measure of the series in use is usually defined as a measure containing a certain number of the chief current local unit of weight of the predominant grain. Sometimes a definite weight of a mixture of several (8 or 9) kinds of grain was used to fix the size. A picturesque variant to this rule occurs in the Khasia and Jaintia hills (the inhabitants of which were head hunters), where the size of the standard measure was fixed as being convenient to hold a man's head. Measures are generally used "heaped," rarely (though occasionally) "struck." As there is no uniformity in the cross-section of measures supposed to contain equal quantities this increases the variations. The measures themselves are made sometimes of wicker-work, at others of wood or metal, and may be cylindrical, rectangular, prismoidal, hemispherical, or more or less globular—*i.e.* in the shape of a sphere with considerably less than the upper hemisphere removed. The wicker measures especially are liable to increase in size with age. Save in Burma, Madras, and a few of the larger municipalities in the Central Provinces and Berar, no attempt has ever been made to standardise them, and there has never been anything corresponding to the unifying influence of the railway seer to assimilate the measures of different places.

The chief measure of a place is generally one containing from one to five local seers of some grain, and there are various multiples and submultiples of this, the larger ones being merely measures of account. It has already been seen how numerous are the local units of weight—the reasons just given make those of capacity even more variable. The units themselves, and the names and mutual relations of their multiples and submultiples, vary from district to district, and, indeed, are very far from being uniform throughout a district. As their use is largely confined to local transactions this variation is of less importance, for the normal customers of each market are fully aware of the measures in use there. It would be of little interest to give the innumerable names of these measures; one example of their variability will suffice. The *gauni* is a widely used measure in Orissa; the Balasore district reports the use of 18 different *gaunis*, said to contain anything from 1 to over 8 seers of paddy. In Cuttack its limits are somewhat closer—1¾ to 7 seers—while in Puri they are said to be from 2 to 8, and 9 different *gaunis* are reported as in use. The actual measure is made of wicker.

The standardised measures of Madras and Burma call for more detailed comment. In Madras there are two, known respectively as the Madras type measure or *padi* and the Madras type seer; they are defined as holding respectively 120 and 80 tolas of second sort rice when "struck" or 132 and 88 when "heaped." Of water they contain 62·5 and 41·7 oz. One or other is used throughout a considerable portion of the Madras Presidency, but by no means to the exclusion of numerous other measures which may or may not bear a definite relationship to them.

It is, however, in Burma that capacity measures are of greatest importance, as it is by the *tin* or "basket" that rice is almost universally bought and sold wholesale, and by its submultiple measures retail. The table of measures most frequently used is: 2 lamè = 1 zalè; 2 zalè = 1 hkwet; 2 hkwet = 1 pyi or byi (or with the initial particle ta—ta-byi, whence "tubby"); 2 pyi = 1 sayat; 2 sayat = 1 seik; 2 seik = 1 hkwe; and 2 hkwe = 1 tin or basket. It is an interesting comment on the desire for a standard measure that the tin of "Milkmaid" brand condensed milk has become universally recognised as representing one *lamè*; the Nestlé's tin as one *zalè*, and the tin containing preserved lichis as 3½ *lamè*. In origin the *lamè* is said to have been two handfuls, and the basket to have come into existence as being the amount of unhusked rice a man could conveniently carry at one time. The Burmese Government appears to have made some attempt at standardising it, and the British Government has more or less recognised as the standard basket one containing 9 gallons, other baskets being defined in Government reports in terms thereof. The baskets in ordinary use throughout the country vary a good deal, being usually somewhat smaller than 9 gallons. Most, however, contain between 8 and 9 gallons. The basket used by the rice-millers of Rangoon, Bassein, and Moulmein is as a rule a cylindrical wooden vessel, 24½ in. or 25 in. in height and 14½ in. or 15 in. in diameter. One of these measures is taken to measure a consignment of paddy, and every now and then a basket is weighed—usually 5 or 6 per 10,000. The price is fixed at so much per 100 baskets of 46 lb., with the proviso that 2½ per cent. more be paid for every pound the average basket weighs in excess of 46, while for every pound it weighs less 2 per cent. is deducted. For other produce for export, baskets containing definite weights are used, and trade in them is really by weight. But rural trade is almost entirely by measure.

There are practically no true liquid measures anywhere; occasionally one of the dry measures will be used, but the usual way of selling liquids is by weight, a measure containing a definite weight of the specific liquid for which it is used being frequently used for convenience.

We thus find that throughout the country, with the exception of Burma and to a less extent of Madras (here only as regards weights below the tola), the tola of 180 grains or the weight of the rupee is a universally recognised unit, and to an almost equal extent the "railway" seer of 80 such tolas is at least known and over a large extent of the country actually used. The identity of the weight of this tola and of the rupee is a most important point to remember, as it makes it almost compulsory to change the weight of that coin if any system not based on this tola be introduced. This is a proceeding very liable to be viewed with great suspicion by the less educated portion of the community. For a measure of length the British yard is almost universally known and very widely used. As a measure of area the acre is fast becoming the only really definite one. Measures of capacity are various, but dependent on measures of weight.

Accordingly the majority of the Weights and Measures Committee recommended the adoption of the "railway" seer of 80 tolas (each of 180 grains), the British yard and the acre as fundamental units, and suggested the standardisation of suitable measures of capacity at the nearest suitable multiple of the bulk of 1¼ seers of water, this being approximately equivalent to the bulk of a seer of wheat. This conclusion, negativing any approximation to a decimal system, was certainly viewed with regret by myself, but the binary system and the rupee-tola unit are so firmly rooted in the country that it seemed inadvisable to attempt to change a method which was at least equally good for the ordinary transactions of every-day life for one the advantages of which are apparent mainly in foreign trade. The fact that practically no progress towards adopting the metric system in England has been made (*vide* NATURE, vol. 110, p. 29) is of considerable interest in this connexion, for when such is the case in a highly educated and intensely commercial country, where the proportion of foreign trade is probably higher than anywhere in the world, would it have been justifiable to recommend the compulsory adoption of the metric—or, in fact, of any decimal—system for India?

School Instruction in Botany.[1]

It is, we believe, a misfortune that so large a proportion of teachers of botany in schools know little practically of the cultivation of plants. It is, indeed, not unusual for simple laboratory experiments involving the use of growing seedlings and plants to come to an untimely end owing to lack of precautions which would be observed by every practical gardener. The uncertainty of success of even simple experiments in such unskilled hands is no doubt in part responsible for the fact that school botany is still so largely concerned with taxonomy—which only the trained botanist can appreciate fully—and so little with those fundamental aspects of plant biology which should be of interest to all.

A general understanding of the significance of green plants in relation to the food problem, of the conditions controlling the growing of crops, and of the differences between such "artificial" vegetation and the natural vegetation of the countryside, with similar matters of fundamental importance, should be as much a part of general educational equipment as is the knowledge that the earth revolves round the sun, or the ability to use decimal notation.

[1] The Botany Gardens of the James Allen's Girls' School, Dulwich. Board of Education. Educational Pamphlet No. 41. Price 2s.

Those who desire to see biology take its proper place in general education, as also others more directly interested in the teaching of botany in schools, owe a debt of gratitude to Dr. Lilian J. Clarke of the James Allen's Girls' School, Dulwich, for a practical demonstration of how much can be done within the rather narrow limitations of a school curriculum to make botany a "live" subject, and also for the creation of a school botany garden in many respects unique both in design and in the manner in which it is utilised in the teaching work.

In a pamphlet before us, the publication of which has been greatly delayed by post-war conditions, Dr. Clarke gives a stimulating account of the history and organisation of the school botany gardens and the teaching work associated with them. We have no doubt that this report of an interesting experiment in science teaching will serve the purpose intended by the Board and be helpful to other schools which give special attention to the teaching of botany. To quote Dr. Clarke: "Our main object in developing the gardens has been to make the teaching of botany thoroughly practical by closely associating indoor with outdoor work. . . . The gardens have been of great assistance in carrying out the method of studying botany by direct observation and experiment: they are, in fact, outdoor laboratories."

Attention may be directed to two features of special interest in these botany gardens. One is the provision of vegetable plots in sole charge of the pupils themselves. Certain obvious difficulties must be overcome in order to make possible the inclusion of garden work as part of an ordinary school routine, and it is proof of able administration on the part of the science staff, and willing work and co-operation on the part of the girls themselves, that these plots showed a working profit during the period 1912–15. Used in this way, garden work stimulates interest in plant life and affords a reasonable basis for lessons in photosynthesis and the essential features of plant physiology.

A more unusual feature in the gardens, and one of great educational value, has been the construction of a number of special areas, each designed to provide the conditions requisite for a characteristic type of vegetation. Among these are fresh-water and salt-water marshes, a pond 34 ft. by 23 ft., a pebble beach, a peat bog, and soil conditions favourable for the growth of chalk-loving and heath plants, as well as the successful reproduction of natural vegetation units such as an oak wood. No better introduction to the study of plant ecology can be imagined than these attempts to reproduce the essential conditions of special habitats with the subsequent collection, naming, planting, and care of the appropriate plant species.

The value of science teaching in schools would be greatly enhanced were more attention given to linking up different groups of scientific facts and to bringing them into touch with other subjects in the school curriculum and with the facts of ordinary life. Botany teaching as described in this report appears to offer an opportunity of doing this. For example, it is not difficult to link up the recognition of vegetation units such as those referred to above with the teaching of geography and history.

No mention is made in the report of the utilisation of the botany gardens for the observation of animal life, although it is clear that development is possible along these lines also. The phenomena of metamorphosis in frogs and butterflies, and the inter-relations of plant and animal life as shown by the association of certain caterpillars with specific food plants may be cited as examples, as well as the opportunity afforded for observations on the ecology of animals.

University and Educational Intelligence.

DR. KENNETH FISHER, senior science master at Eton College, and formerly assistant master at Clifton College, has been appointed headmaster of Oundle School, in succession to the late Mr. F. W. Sanderson.

THE Council of the City and Guilds of London Institute in their report for 1921 reviews the history of this body's work from its inception in 1876. The report shows that the aggregate amount of the contributions by the City companies to the Institute's funds exceeds one million pounds. Of the several undertakings maintained wholly or in part by the Institute, the most important is the City and Guilds (Engineering) College, now constituting the engineering section of the Imperial College of Science and Technology. Of the degrees in engineering conferred by the University of London in the past twenty years, nearly half, of honours degrees more than half, were won by students of this college. The total number of students in 1920–21 was 609, of whom nearly half were taking electrical engineering. The Finsbury Technical College, which it was proposed to close last year owing to financial difficulties, has now been placed under a delegacy as a grant-aided institution subject to the regulations of the London County Council. Technological examinations conducted by the Institute were in 1921 held in 67 subjects in 316 centres, including many in India and other parts of the Empire overseas. The number of entries was nearly eight thousand.

A PROJECT for an international congress of all universities, both state and independent, of all countries, is to be elaborated by a sub-commission of the commission on intellectual co-operation set up by the League of Nations, consisting of Profs. Gilbert Murray and de Reynolds (Berne); A. de Castro, director of the faculty of medicine in the University of Rio de Janeiro; M. J. Destrée, ex-minister of sciences and arts of Belgium; and Dr. R. A. Millikan, director of the Norman Bridge laboratory of physics at the technological institute of California. This sub-commission will begin by examining, with due regard to the sovereign right of nations to legislate in matters of education and to university autonomy, the questions of exchange of professors and of students, equivalence of university studies and diplomas, the institution of international bursaries and vacation courses, and a central bureau of university information. In making these proposals the council of the League appears to have overlooked those two very efficient existing organs, the Universities Bureau of the British Empire and the American Institute of International Education, which were established by the universities themselves and are actively engaged in furthering these very objects. Another sub-committee, consisting of Madame Curie and M. Destrée and a certain number of specialists to be co-opted by them, is to study the organisation of international bibliography and the question of establishing international libraries on the basis of a convention entitling them to receive copies of all published works.

AT the fifth annual meeting of the American Council on Education reports were presented showing that under the able direction of Dr. S. P. Capen this body has accomplished much useful work and has in hand enterprises of far-reaching importance in connexion with questions of educational policy. It has played a leading part in the recent development of Franco-

American educational relations, both through its management of exchanges of scholarships and fellowships, and through collaborating with the French Ministry of Public Instruction in working out equivalencies of French and American academic records. At present 50 scholarships are offered through the Council by American universities and colleges to French students, while 40 are offered by French universities and lycées to Americans. As regards the establishment of what the French call "équivalences de scolarité," the Council's standing committee on international educational relations prepared a report (published last January) which has been accepted by the Conseil Supérieur de l'Instruction Publique as the basis for the admission of American students to candidacy for the State doctorates. The council has also a standing committee on College Standards which is engaged in devising means for effecting a general unification of procedure on the part of the several national and sectional accrediting bodies, and it has formulated already a list of basic requirements for admission to a list of accredited colleges. Another standing committee is busy with the question of tariffs on educational supplies; another is about to present a first instalment of its report on educational finance; another is investigating how the established principles of "academic freedom" may best be safeguarded and their general application be promoted in the face of threatened restrictions by legislation of the freedom of teaching and investigation; while another is to undertake a registration in the form of a directory, of college and university teaching personnel, to include at the outset at least 25,000 names.

THE programme of lectures and classes for teachers during the session 1922–23, organised by the London County Council, has recently been issued. Teachers from outside the London area are admitted to the lectures on payment of a small additional fee. The handbook is drawn up on similar lines to those of previous years, the lectures being divided into groups according to subject. Among the science lectures there are several interesting courses, among which are the following: Prof. C. Spearman and the Rev. F. Aveling, ten lectures on the experimental investigation of children; Mr. Cyril Burt, three courses of lectures on psychology and education; Prof. O. W. Richardson, ten lectures on modern views of matter and radiation; Prof. F. E. Fritch, five lectures on the vegetation of the London area; Prof. A. Smithells, one lecture on the atom; Sir William Bragg, five lectures on the constitution of matter; Dr. R. S. Clay, ten lectures on science in elementary schools; Mr. A. L. Leach, eight lectures on the geology and geography of the London district; Prof. J. Arthur Thomson, three lectures on the progress of evolution; and Prof. T. P. Nunn, six lectures on Einstein's theory of relativity and its educational bearings. In addition to these courses, there will be four special lectures—on teaching children astronomy, by Sir Frank W. Dyson; on the significance of crystal analysis, by Sir William Bragg; on the relation between the health and character of the school child, by Prof. Karl Pearson; and on the drama of animal life, by Prof. J. Arthur Thomson. The value of these special lectures by recognised authorities on their own subjects can scarcely be over-emphasised. Courses are also being organised in geography and in the teaching of arithmetic and mathematics. Copies of the handbook of the lectures, with application forms, can be obtained from the Education Officer at the County Hall, Westminster Bridge, S.E.1.

Calendar of Industrial Pioneers.

September 3, 1854. Henry Fourdrinier died.—Born in Lombard Street, London, in 1766, Fourdrinier, with his brother Sealy, succeeded to his father's business of paper-making, and at the beginning of last century endeavoured to introduce the continuous paper-making machine invented in 1799 by the Frenchman, Louis Robert. He spent some 60,000*l*. improving and making new machinery, but ultimately became bankrupt. The subsequent success of the paper-making machine was largely due to Bryan Donkin, but Fourdrinier's pioneering work was acknowledged in 1840 by a Parliamentary grant to him of 7000*l*.

September 3, 1874. Sir John Rennie died.—The first British civil engineer since the days of Sir Hugh Myddleton (1560–1631) to receive the honour of knighthood, Rennie was trained under his father, the builder of Waterloo Bridge, and was responsible for the building of London Bridge and the completion of the Plymouth Breakwater. He was engineer to the Admiralty, carried out many important harbour works, and in 1845–1848 was president of the Institution of Civil Engineers.

September 3, 1895. Ralph Hart Tweddell died.—One of the pioneers in the application of hydraulic pressure to machine tools, Tweddell brought out his hydraulic rivetting machine in 1866. His methods reduced the cost of rivetting to one-seventh that of hand work. Used first by Armstrong at Newcastle in 1871, Tweddell's hydraulic machines were extensively adopted three years later in the French dockyard at Toulon.

September 5, 1885. Walter Bentley Woodbury died.—Originally an engineer, Woodbury spent some years in Australia, Java, and Batavia, and became known for his successful work with the collodion process in photography. Returning to England in 1863, he invented the Woodbury-type process and patented many improvements in connexion with photography.

September 6, 1842. Jean Baptiste Van Mons died.—The founder of the *Journal de chemie et de physique*, and a prolific writer, Van Mons at a time when the nations of Europe were at enmity, performed a valuable service by propagating abroad a knowledge of the discoveries of Lavoisier, Volta, Vauquelin, Chenevix and others. He was born in Brussels in 1765, became a pharmacist, and for twenty years was professor of chemistry and agriculture in the University of Louvain.

September 7, 1870. Cowper Phipps Coles died.—Flag-lieutenant to Admiral Lyons during the Crimea War, and in 1855 captain of the paddle sloop *Stromboli*, Coles first became known for his construction of a gun raft. Taking up the study of naval architecture he carried out experiments on mounting guns in cupolas, and he was afterwards responsible for the design of the ill-fated turret vessel H.M.S. *Captain* which capsized off Cape Finisterre on the night of September 7, 1870, Coles being on board at the time.

September 8, 1761. Bernard Forest de Belidor died.—Known principally for his writings on hydraulics, Belidor as a French military engineer made many experiments on the explosive power of gunpowder, became inspector of artillery and held a post in the arsenal at Paris. His "Architecture Hydraulique," long regarded as a standard work, was first published in 1753, while Navier published a new edition with notes in 1819.

E. C. S.

Societies and Academies.

Paris.

Academy of Sciences, August 7.—M. G. Bigourdan in the chair.—B. **Baillaud**: A new transit instrument recently installed at the Paris Observatory.—S. **Winogradsky**: The supposed transformation of the nitrifying ferment into a saprophytic species. A criticism of the views of M. Beijerinck on the nitrifying organism.—M. **Abramesco**: Developments in series with two complex variables following the inverse of given polynomials.—D. **Yovanovitch**: The chemical properties of mesothorium-2. Radioactive barium chloride is precipitated by hydrochloric acid: the precipitate contains mesothorium-1, thorium-X, and radium. The mesothorium-2 is precipitated as hydrate, and freed from thorium B and C by treatment with sulphuretted hydrogen after adding a little lead and bismuth. Its chemical properties resemble those of lanthanum.—J. **Orcel**: The chemical composition of aerinite.—J. **Barthoux**: Minerals of the Oudjda region (Morocco). The following minerals have been found in a lead mine near Oudjda: galena, vanadinite, pyromorphite, wulfenite, cerussite, dolomite, calcite, and aragonite: details of the crystal forms are given.—Aimé **Azam**: The constitution and origin of the sediment of the plain of Caen called *rougeauts* and *fauvets*.—J. **Voicu**: The influence of humus on the sensibility of *Azotobacter Chroococcum* towards boron. In a culture medium without humus the effect of boron on the nitrogen assimilated is insignificant, but if humus is added to the culture the toxic action of boron is marked, and the amount of nitrogen fixed is reduced.—René **Maire** and E. **Chemin**: A new marine pyrenomycete.—F. **Granel**: The structure and development of the pseudobranchia of the teleosteans.—Paul **Portier** and Marcel **Duval**: The variation of the osmotic pressure of the blood of the eel as a function of modifications of the salinity of the external medium. The osmotic pressure of the blood serum of the eel living in fresh water is much higher than in the carp; when the salt in the water is changed from 0 to 39 parts per 1000, with corresponding change in the freezing-point from $-0^{\circ}\cdot 02$ to $-2^{\circ}\cdot 22$, the freezing-point of the serum changes only from $-0^{\circ}\cdot 63$ to $0^{\circ}\cdot 83$, and the fish is not prejudicially affected. In salt solutions of higher concentration than sea water the eel dies.—Mlle. T. **Duboc**: The action of tribromoxylenol on tubercle bacilli.—A. **Trillat**: The influence of humidity and vesicular state on the diffusion in air of drops containing micro-organisms. From 98 per cent. to 99·5 per cent. of the liquid dust produced by an ordinary pulveriser fall within a few metres of the point of origin. But of the remainder, some drops are so small that they remain in suspension, especially if the air is nearly saturated with moisture, and may travel considerable distances. That micro-organisms may be carried in this way has been proved by exposure of Petri dishes, and also by experiments with animals (mice).

Melbourne.

Royal Society of Victoria, June 8.—Mr. F. Wesswould in the chair.—Reuben T. Patton: On the drying of timber. An examination of moisture distribution in oak from winter to autumn seems to indicate that the moisture content of the heartwood is constant. Other trees, however, gave very extraordinary moisture distributions, and these emphasise the need for further investigation. Diffusion constants were obtained for some common timbers, and these show that oak has the lowest constant while pine has the highest. A study of the diffusion of moisture through the wood goes to show that the fibre saturation theory does not hold. Work with cubes of green timber tends to show that drying from the end is about five times as fast as from a radial face. Thickness has no influence on the rate of drying. The curves of loss for a series of thicknesses form an envelope. The maximum temperatures and minimum humidities occurring in this state give very favourable drying conditions. Only at a humidity of 2 per cent. was the rate of drying adversely affected. The more rapid the drying the greater is the amount of shrinkage.—S. R. **Tovey** and P. F. **Morris**: The contributions from the National Herbarium of Victoria, No. 2. The paper contained a description of *Teucrium racemosum*, R.Br., var. *polymorpha*, Tovey and Morris. The variety differs from the type *T. racemosum* in having the stamens inserted in the corolla and the stigma only slightly exserted. Three new records of recent introductions were also given, viz. 1. A deciduous ornamental tree *Paulownia tomentosa*, Steud (*P. imperialis*); 2. *Scorzonera laciniata*, Lt.: this plant is sometimes cultivated for its tapering root; 3. *Solanum triflorum*, Nutt., has made its appearance; it somewhat resembles the common Black Nightshade. The leaves are deeply cut (pinnatifid), the berries are about the size of a small cherry. In America the berries are considered poisonous. The active constituent is Solanin. The plant has been proclaimed under the Thistle Act for the whole State. The remainder of the paper consists of records of additional regional distribution of plants, also corrections in accordance with article 48 of the Vienna Botanical Congress (1905) and other notes of interest.

Cape Town.

Royal Society of South Africa, July 19.—Dr. J. D. F. Gilchrist, president, in the chair.—K. H. **Barnard**: Maps illustrating the zoological aspects of Wegener's disruption hypothesis. Stress was laid on the fact that on this hypothesis the land bridges connecting the southern continents into an enormous more or less equatorial continent were not required; that on the contrary the greater part of the old polar Gondwanaland was still in existence at the present day, and had never been beneath the sea since palæozoic times. Consequently the distance, over which such groups as, *e.g.*, the Acanthodrile Worms, Peripatopsidæ, Acavid Landshells, Cystignathid Frogs had had to travel was minimised. The extremities of these continents, hitherto regarded as peripheral, and containing primitive types driven thither by more specialised rivals, are seen to be really portions of the centre of Gondwanaland. The primitive and generalised types have always been approximately where we find them to-day, and their dispersal has been hindered and restricted, other than by physical causes, by the appearance of higher and more dominant types in other regions; *e.g.* the Acavidæ and Achatinidæ in South Africa and Ortman's classical explanation of the mutual exclusiveness of the Freshwater Crayfishes and Crabs. The concomitant expansion of an arm of the Indo-Pacific Ocean continually further between India and Australia, Africa and Antarctica, and extending eventually between Africa and South America (to form the Atlantic), was shown to have far-reaching consequences in aiding the dispersal of the marine fauna, *e.g.* the Silurid Fishes, Galaxias, and the ancestors of the Freshwater Crayfishes. Difficulties in the way of explaining certain features of the fauna of New Zealand, which has been permanently above the sea only since Tertiary times, were shown to be obviated by the new hypothesis.—W. H. **Logeman**: An easily constructed automatic Toepler vacuum pump.