THURSDAY, AUGUST 28, 1913.

PRACTICAL HYDRAULICS.

The Control of Water as Applied to Irrigation, Power and Town Water Supply Purposes. By P. A. M. Parker. Pp. vii + 1055. (London: G. Routledge & Sons, Ltd., 1913.) Price 21*s.* net.

THIS comprehensive and authoritative work contains a wealth of matter relating to practical hydraulics which one might seek in vain for in any other published book on the subject. In the preface the author tells us that the book is the product of actual engineering experience, and is mainly based on a collection of notes and formulæ accumulated in some eighteen years of professional work, during the major portion of which he was engaged in independent practice, and that therefore it must be regarded not as a text-book, but rather as a manual for engineers in active work. He also remarks that, "although the initial knowledge assumed in the reader may be considered to be somewhat unusual, many portions of the book have stood the test of everyday office requirements in the hands of draughtsmen and assistants." And it is only fair to say that an examination of the work is entirely favourable to the author on these points, although, of course, in a work covering such a wide field, here and there are matters of a controversial character, which might be dealt with if the exigencies of space permitted.

The book contains the following chapters, namely: i., preliminary data; ii., general theory of hydraulics; iii., gauging of streams and rivers; iv., gauging by weirs; v., discharge of orifices; vi., collection of water and flood discharge; vii., dams and reservoirs; viii., pipes; ix., open channels; x., filtration and purification of water; xi., problems connected with town water supply; xii., irrigation; xiii., movable dams; xiv., hydraulic machinery other than turbines; xv., turbines and centrifugal pumps; xvi., concrete, ironwork, and allied hydraulic construction; (*a*) tables; (*b*) graphic diagrams. But these headings scarcely give an adequate idea of the scope of the book, as some of the chapters are divided into important sections. For instance, in chapter xiv. we have: section A, enlargements and contractions in pipes; section B, water hammer; section C, ejectors and syphons; section D, air lift and hydraulic compressor; section E, hydraulic ram; section F, resistance to motion of solid bodies in water; section G, impact of water on moving bodies. All of these are important subdivisions, and they appear to be handled in an entirely satisfactory and convincing way; but having regard to the title of the chapter, one looks in vain for any discussions on the piston-pump and Humphrey's pumps, the most important of all hydraulic machines. However, the hydraulic engineer has other books available in which these machines are fully dealt with, and the author was wise in confining himself to matters that do not so completely come within the province of the mechanical engineer.

Chapter vii., dams and reservoirs, is one of the best in the book; the 130 pages devoted to this important section will be appreciated by both designers and engineering students. A valuable feature of the work is that each chapter is prefaced by a list of its own symbols and a sequential table of an extremely useful character, and many of the chapters have also a summary of the equations and formulæ. The mathematics used in this lucid and most readable work are fairly easy, certainly to those accustomed to read works on hydraulics.

Another exceedingly valuable feature is the bibliography, as the book teems with references to original authorities; indeed, it is a standing testimonial to the author's patient and untiring labours. He is to be congratulated upon producing a work that will in all probability rank as high in connection with applied hydralics as Bellasis's work on hydraulics does in connection with theoretical questions; in fact, Mr. Parker's encyclopædic work is the most notable book of the kind that has appeared for many years, and it will probably become a classic. H. J. S.

SPHERICAL ASTRONOMY.

Lehrbuch der sphärischen Astronomie. By Dr. L. de Ball. Pp. xv + 387. (Leipzig: W. Engelmann, 1912.) Price 20 marks.

DR. L. DE BALL'S excellent treatise shows abundant evidence of a long and careful preparation. From the nature of the subject striking innovations are not to be expected; it is rather in the minute details of the exposition that the merit of the present work is found. In some places the mathematical treatment has been simplified, in others the discussion has been made more rigorous and thorough. The author's long experience as a practical astronomer has led to improvements in all parts of the subject, little in themselves, but when taken together making a notable advance. According to the introduction, the book is intended to be both a text-book for students and a work of reference; it is in the latter respect that we commend it. Spherical astronomy is a rather heterogeneous collection of but distantly related problems, and a minute treatment of isolated questions, many of which are only required in special researches and have no general

interest, makes a very unsuitable course of reading for the student. But for those who are seeking specially full information on any of the subjects dealt with, this work will prove a very useful aid.

The introductory chapters deal very concisely with interpolation formulæ, the chief developments in series, and the method of least squares (without any account of the error-function). A long chapter deals with the theory of the earth's rotation. This part is rather hard reading, owing to the great number of symbols introduced. It would, we think, have been worth while to set out the definition of each symbol on a separate line, in order that it might be more readily referred to; for the reader can scarcely carry in his head the meaning of all the symbols, and their definitions are scattered through a great many pages of the text. Another long chapter deals with refraction, and includes a discussion of the effect of water-vapour on the constant of refraction. The treatment of the great problems of fundamental astronomy, the determination of the equinox, the obliquity of the ecliptic, and the construction of a fundamental catalogue is most thorough and satisfactory. In the chapter on parallax it may be noted that the correction to the ellipticity of the earth is included as an unknown in the determination of the moon's parallax; this small illustration shows the author's practical acquaintance with his subject, for the two quantities are so closely related that it is not improbable that the best determination of the figure of the earth may ultimately be obtained from lunar observations.

We would strongly criticise the absence of all reference to the theory of photographic observations. Thus, whilst the effect of precession, parallax, aberration, and refraction on micrometer measures is fully discussed, the formulæ relating to their effect on photographic measures are ignored. The theory of the projection of the celestial sphere on a photographic plate is eminently a branch of spherical astronomy, and at the present day it is most constantly required by practical astronomers, yet the text-books persist in devoting their whole attention to the obsolescent position angle and distance, instead of to rectangular coordinates. Such an omission is misleading to the student, and it is a defect in a work of reference for the observatory. Much of geometrical astronomy consists in a perfunctory application of three formulæ of spherical trigonometry; but the theory of rectangular coordinates is a more difficult subject, and the observer could not generally work out for himself the necessary formulæ without guidance. A. S. E.

RECENT BOTANICAL PUBLICATIONS.

(1) *An Introduction to Plant Geography.* By Dr. M. E. Hardy. Pp. 192+66 figures. (Oxford: Clarendon Press, 1913.) Price 2*s.* 6*d.*

(2) *The Living Plant: A Description and Interpretation of Its Functions and Structure.* By Prof. W. F. Ganong. Pp. xii+478+178 figures. (London: Constable and Co., Ltd.; New York: Henry Holt and Co., 1913.) Price 15*s.* net.

(3) *Flowerless Plants: How and Where they Grow.* By S. Leonard Bastin. Pp. xi+152+64 plates. (London Cassell and Co., Ltd., 1913.) Price 6*s.* net.

(4) *School and Home Gardens.* By W. H. D. Meier. Pp. iv+319+159 figures. (Boston and London: Ginn and Co., n.d.) Price 4*s.*

(5) *Agronomy: A Course in Practical Gardening for High Schools.* By W. N. Clute. Pp. xvi+296+195 figures. (Boston and London. Ginn and Co., n.d.) Price 4*s.* 6*d.*

(6) *Das botanische Praktikum.* Fünfte Auflage. By the late Dr. E. Strasburger and Dr. M. Koernicke. Pp. xxvi+860+246 figures. (Jena: Gustav Fischer, 1913.) Price 24 marks.

(7) *Paläobotanisches Praktikum.* By Prof. H. Potonié and Dr. W. Gothan. Pp. viii+152+14 figures. (Berlin: Gebrüder Borntraeger, 1913.) Price 4 marks.

(8) *Die palaeobotanische Literatur.* By W. J. Jongmans. Dritter Band: Die Erscheinungen der Jahre 1910 und 1911 und Nachträge für 1909. Pp. 569. (Jena: Gustav Fischer, 1913.) Price 26 marks.

(9) *Icones of the Plants of Formosa, and Materials for a Flora of the Island, based on a Study of the Collections of the Botanical Survey of the Government of Formosa.* By B. Hayata. Fasc. ii. Pp. 156+40 plates. (Taihoku: Bureau of Productive Industries, 1912.)

(1) THE compiler of this introduction to plant geography appears to be somewhat out of touch with the modern development of the subject from the ecological point of view. The work is apparently intended for school use, but one would have thought that the best method of approach would be to deal at some length with the conditions of plant life in general, instead of devoting to this subject only twenty pages towards the end of the book as the author has done, and to lay stress on the idea of plant communities rather than to plunge, after a brief glance at a few types of British vegetation, into the descriptions of the "main vegetations of the globe," which form the greater part of the book. However, these descriptions, though extremely condensed, are thoroughly readable and vivid, but it is very doubtful whether the author's method of

treatment is calculated to give the subject of plant geography much educational value in a school curriculum. Many of the illustrations are extremely poor. However, we may perhaps hope for a more adequate and better illustrated treatment of the subject in the more advanced book promised in the preface.

(2) Prof. Ganong has already laid students and teachers of botany under a debt of gratitude for his valuable and helpful manuals, and in the present work he has produced an attractive and stimulating volume which every botanical teacher would do well to obtain. It presents the clearest and most complete picture of plant life that has appeared for many years, and should do much to popularise the study of plants among that increasing class of readers whose needs are met neither by the standard text-books intended primarily for college students, nor by the unfortunately too common type of "popular" botany book the appeal of which is made by means of coloured plates with incidental letterpress, concerning the character of which the less said the better. Prof. Ganong combines in a particularly happy manner scientific accuracy, clearness of exposition, and literary style, such as make this book delightful reading, whether he is dealing with the deeper problems of physiology or with the most familiar aspects of plant life. The work is marked throughout by freshness and originality of treatment, and the diagrams and generalised drawings which he gives so freely will be of the greatest value to teachers of botany, apart from their primary object of enabling the "general reader" to understand the descriptions which they illustrate.

(3) Mr. Bastin has produced a thoroughly attractive and interesting work, well designed to serve as a first introduction to the study of the flowerless plants, with the aid of the more detailed books on the various groups. Unlike some other writers of popular nature-study books, the author aims solely at arousing the reader's interest by means of excellent photographic illustrations and simple but, so far as they go, accurate descriptions, and takes care to point out that the reader of books of this scope will find in the text-books of the specialist "the best possible friends, incomplete in themselves, but priceless as guides to those things which alone can be truly studied in the open air." Nothing could be more different from the explicit or implicit claims of various other "popular" botanical writers to have presented a full and sufficient treatment of the subject in their books. Mr. Bastin's work is admirably calculated to stimulate interest in the hitherto somewhat neglected groups—from the nature-study point of view—with which he deals, and the reader who wishes to proceed to a more detailed study will, at any rate, have nothing to unlearn, though one rather wishes that the author had included in his excellent work a list of suitable books for the further study to which this forms such an admirable introduction.

(4) Mr. Meier's book, though written primarily for American use, contains scarcely anything that will not be found of interest and value to teachers of school-gardening in this country, as well as to amateur gardeners in general, and this despite the fact that the author does not deal with generalities or with experiments. He has succeeded admirably in his attempt to give definite instructions for the arrangement, planting, and care of a fairly wide range of plants commonly grown in the house and garden, the difficulties met in cultivating each individual plant being considered one at a time, and definite directions given for overcoming them.

(5) The second half of Mr. Clute's book covers much the same ground as the work just noticed, but its scope is somewhat wider, and the first portion constitutes an excellent general introduction to botany. Many of the illustrations of familiar objects have a fresh appearance, owing to the author's very sparing use of figures copied from other works. Nothing could be more suitable as a general introduction to botany and horticulture than the lessons on soil with which the book opens, though this portion might perhaps with advantage have been expanded. The teacher will find much that is useful in the work, despite the fact that American examples and illustrations are largely used.

(6) The late Prof. Strasburger's well-known "Botanische Praktikum" needs no special recommendation to teachers and students of botany, to whom it is well-nigh indispensable, no other single book covering so much ground. In successive editions the book has grown in size until in the present one, the fifth, it has become perhaps unduly large for convenience in laboratory use.

The present edition differs from its predecessors mainly in the addition of a considerable amount of new letterpress and illustrations dealing with micro-technique, the general plan of the work remaining unaltered. It is an open question whether there is not rather too much general descriptive matter that would be more in place in a book intended for the study instead of the laboratory; but still, the tacking-on of more or less theoretical passages to the directions for practical work has decided advantages. The chief drawback to the plan is that it is somewhat

difficult to know where the line should be drawn, and that a book of this kind tends to indefinite expansion in successive editions; this objection is to some extent met by the author's smaller book, the "Kleine botanische Praktikum," but since the student can obtain the necessary theoretical matter in the ordinary descriptive text-books, it would appear better to limit the scope of a practical manual to directions for actual laboratory work. The use of the copious index relating to technique is facilitated by its being printed on coloured paper in this edition, which will be welcomed by teachers and students of botanical microscopy as the best and most comprehensive treatise on the subject in existence.

(7) This little book opens up what is to a large extent a new field, and will be of the utmost value to students of geology and plant ecology, as well as palæobotany. Despite its small size it contains an immense amount of skilfully condensed information, and is mainly occupied by concise and clear directions for the examination of fossil and subfossil plant remains in coal, peat, clay, &c. The names of Prof. Potonié and Dr. Gothan are sufficient guarantee of the excellence of the major part of the work, which is concerned with the preparation and examination of fossil and subfossil plant remains generally, but special attention may be directed to the excellent section by Dr. Stoller dealing with the investigation of peat deposits from the ecological and phytogeographical point of view.

(8) The labour undertaken by Dr. Jongmans in compiling an annual bibliography of palæobotanical literature has evidently secured the approval and support which it deserved, though one may regret the delay in issuing the third volume of this work, containing the titles for the years 1910 and 1911, with a supplementary list of 1909 publications. The mere citation of titles, however, forms a small part of the work, occupying only forty pages of this volume; the remainder (more than 500 pages) is devoted to the indexing of the plants dealt with in some 800 books and papers, a few words being added in each case to indicate the general nature of the communication made concerning the plant named.

(9) The original plan of the "Icones Plantarum Formosanarum" was to publish in a long series of fascicles, extending over some fifteen years, a flora which should contain full descriptions of all plants found in Formosa. However, even in the first fascicle (1911) this plan had to be altered slightly so as not to exceed the grant made by the authorities, and accordingly only the new species were described, with notes on the others; and in the meantime a further reduction of the grant has unfortunately compelled Dr. Hayata to cut out nearly all references to species in this second fascicle. Even in this somewhat truncated form, the work is of the utmost value; the present instalment contains keys to the families, genera, and species, an enumeration of Formosan plants from Saxifragaceæ to Dipsaceæ, with their localities and geographical distribution, descriptions of new plants, and forty very fine plates. The total number of flowering plant species now known from Formosa is a little more than 3000. For the interesting conifer *Taiwania cryptomerioides* a diagnosis is given of the male flowers, which were first discovered in 1911; in its male flowers this genus shows marked general resemblance to Cunninghamia. F. CAVERS.

OUR BOOKSHELF.

Einführung in die Spektrochemie. By Prof. G. Urbain. Uebersetzt von Dr. U. Meyer. Pp. viii+213+9 plates. (Dresden and Leipzig: Theodor Steinkopff, 1913.) Price 9 marks.

THIS book is a translation of the French edition which has already been reviewed in these columns. It is based on a course of spectroscopy given by the author at the Sorbonne, and will be found useful in this country to colleges taking a short course in the subject for advanced students.

The book contains an excellent and up-to-date account of the various methods used in the production of spectra. The descriptions of the methods employed are very clear and well illustrated with diagrams, and contain many laboratory details necessary to know in order to repeat the methods with facility, but which are generally omitted from text-books.

Following this, which occupies nearly half the book, are chapters on phosphorescence and absorption spectra. A final chapter is devoted to the analysis of spectra into series and the laws of series, in which the chief facts of the subject are clearly set forth.

A Galla-English, English-Galla Dictionary. Collected and Compiled by E. C. Foot. (Cambridge University Press, 1913.) Price 6*s.* net.

THE Galla are people living in Abyssinia from Harrar, on the east, to the Sudan frontier on the west, and from Wollo, in the north, down to the southern frontier. Some, too, live in British East Africa, and a detached tribe to the west of Witu, on the north bank of the Tana river. Mr. Foot describes them as "a most industrious, pastoral and agricultural people, who are also keen traders."

Mr. Foot has been studying their language since he went to Abyssinia first, in 1907, and the volume gives the results of his industry. As Sir John Harrington says in his introductory note, the dictionary should be of service not only in Abyssinia, but also on her frontiers with the Sudan, Uganda, and East Africa.

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.*]

Radium-D and the Final Product of the Radium Disintegration Series.

A RECENT discussion in the columns of NATURE has raised the question of the existence of elements chemically and spectroscopically identical but differing from one another by a few units of atomic weight. Should the far-reaching generalisations of Soddy and of Fajans prove correct, the chemical elements will have to be regarded from an entirely different point of view, and the explanation of the periodic nature of their properties will have to be sought for in the recurrent character of the processes of radio-active disintegration. At present, however, some of the evidence on which those views are based is at least open to question. With the exception of radium, niton, and the parent elements—uranium and thorium—none of the thirty-four radio-active bodies have been isolated, and none of their compounds have been obtained in a state approaching purity. Their properties have only been inferred from their behaviour when mixed with very large amounts, comparatively speaking, of known elements, such as lead, thorium, and tellurium, and when it has been found impossible to alter the proportions of these minute traces of radio-active matter by the usual analytical processes, chemical identity has been inferred. Even admitting the extreme delicacy of radio-active methods of analysis, it might be questioned whether much can be deduced from the inseparability of such minute traces when present along with large amounts of closely related elements. More satisfactory evidence would be furnished if the chemical properties of an equilibrium mixture from a pure radio-active parent could be investigated; and since during the last few months some direct observations have been made on the nature of radium-D and its products it may be of interest to give a preliminary account of the investigation.

The source of the radium-D and its products was highly purified niton (radium emanation) which four years ago had been compressed into fine capillary glass tubes, liquefied, and used for the determination of the vapour pressures of the gas by Sir William Ramsay and myself. Each tube originally contained somewhat less than 0·2 of a curie of emanation, which, when liquefied by pressure, filled a volume of approximately 1/5000 cub. mm. at the sealed end of the tube. Three tubes of the precious material were kindly placed at my disposal by Sir William Ramsay. The emanation was allowed to decay under pressure, and subsequent microscopic examination showed that the liquid had transformed itself into a dark-coloured deposit of submetallic lustre, resembling somewhat a dried colloidal metal, and also into a colourless gas, viz. helium. The total mass of the solid deposit was hence of the order of 1/1000 milligram, and since it had decayed for four years it contained, in addition to the equilibrium quantities of radium-E and radium-F, about 15 per cent. of radium-G, the end point of the series, as well as traces of the branch series derived from radium-C_2. The tube was only weakly radio-active, but when laid on a photographic plate the impression produced by the β-radiation of radium-E corresponded exactly with the visible distribution of the deposit in the tube. By a suitable procedure the mercury sealing the open end of the tube was removed as completely as possible, and after pumping off the helium pure chlorine was admitted. At ordinary temperatures the submetallic deposit remained unattacked, but on gently warming it was seen to change completely into a pure white, apparently homogeneous, crystalline chloride. On heating *in vacuo* to 220° C., the chloride did not volatilise perceptibly, and the photographic impression it produced coincided with that obtained from the submetallic deposit. Hence the chlorides of radium-D, -E, and -G are not appreciably volatile under these conditions.

On introducing water into the tube it was seen that the crystalline deposit dissolved without decomposition, but was only slightly soluble. Even after warming in presence of about ten times its own volume of water only a small proportion of the total solid went into solution.

The chief object, however, of this experiment was to determine whether radium-G, the final product of the series, was similar in chemical character to lead, and also to find out if radium-D approximated closely in behaviour to its longer-lived descendant. That radium-G and lead are identical is supported by much indirect evidence, though no direct proof has been advanced. Now lead is an element which can be detected in very minute quantities by the delicate and characteristic microscopic test of Behrens, viz. by the formation of a characteristically crystalline triple nitrite with the nitrites of copper and potassium. The test is so delicate that 1/100,000 milligram of lead can be detected with certainty if the proper conditions are observed, and, moreover, by determining the number and size of the crystals in a drop of known volume the amount present can be approximately estimated. It was proposed, therefore, to apply the test to a known fraction of the radio-active matter in the tube and to see whether the amount of triple nitrite formed corresponded with radium-G alone or with radium-G + radium-D. The application of the test was complicated, however, by the discovery that the glass of the capillary, and, in fact, soda-glass in general, contained about 0·03 per cent. of lead, and that a detectable fraction of this lead could be dissolved out of the glass with nitric acid. By avoiding the use of strong acids and simply extracting the glass with water no perceptible amount of this element could be found in the concentrated extract. To be quite certain that no lead from the glass could find its way into solution by this procedure, the very stringent test was made of extracting 5 grams of finely powdered glass for some hours with water and testing the residue after evaporation to dryness. The glass used had at some previous time been exposed to the action of radium emanation, and was of a deep purple colour. No lead was found in the extract, though analysis proved its presence in the glass.

Other sources of error lay in the possible presence of lead in the mercury sealing the tube, and in the reagents used for the test. No lead could be detected in the mercury and the reagents were carefully purified beforehand. In order to carry out the test the capillary tube containing the radio-active matter was cut into two portions, a longer one containing most of the solution, and a shorter portion in which the undissolved crystals remained. The solution in the longer portion was allowed to evaporate on a silica microscopic slide, and one portion of the drop obtained was tested for lead by the triple nitrite test and another tested with potassium chromate. In both cases the presence of lead was indubitably proved, but the quantity present was small. The short end containing the crystals was then fractured and the fragments extracted with water to which a drop of acetic acid had been added. The evaporated extract

which left a scarcely visible residue was intensely radio-active, and from its solution a minute trace of a dark-coloured sulphide was precipitated by sulphuretted hydrogen. This latter was separated by centrifuging the solution in a capillary tube, dissolved in a drop of nitric acid, and tested by the Behrens method. The drop yielded a copious crop of triple nitrite crystals, and the amount of lead present was estimated at 1/4000 milligram. Now in the whole of the disintegration products in the tube only about 1/7000 milligram of radium-G was contained, and, further, only a fraction of the total matter was used for the test. Hence it seems probable that radium-G and radium-D both form a characteristically crystalline triple nitrite identical with that formed by lead.

An attempt was made to determine what fraction of the whole of the matter originally in the tube was present in the drop tested, by comparing the β-radiation of the various portions, but no great trustworthiness could be placed on the measurements at the time, since the chloride of radium-E has probably a different solubility to the chlorides of D and G. In a few months' time, however, when the β-radiation of E has reached its equilibrium value a repetition of the measurements should lead to a definite conclusion. Hence, excluding the possibility of undetected sources of error, one must conclude that the slow change products of the disintegration of niton contain a body behaving like lead, and, further, that this body is either radium-D alone or a mixture of radium-D and radium-G. Thus the investigation, so far as it has gone at present, tends further to support the theories of Soddy and of Fajans.

R. WHYTLAW-GRAY.

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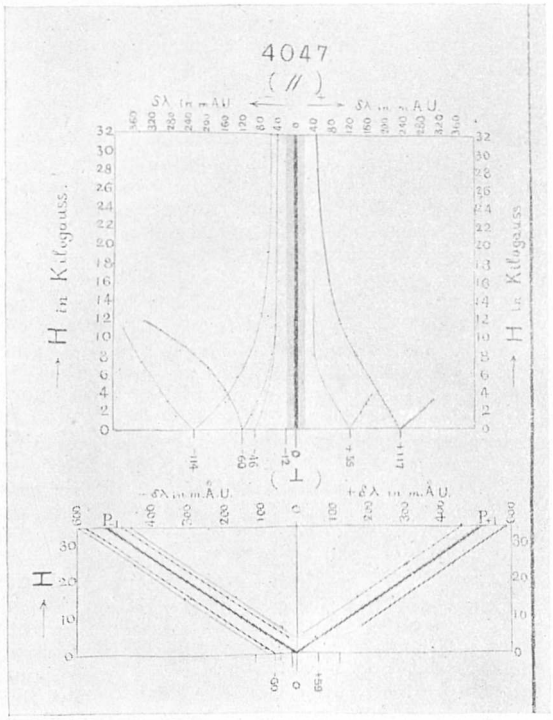
Anomalous Zeeman Effect in the Satellites of Mercury Lines.

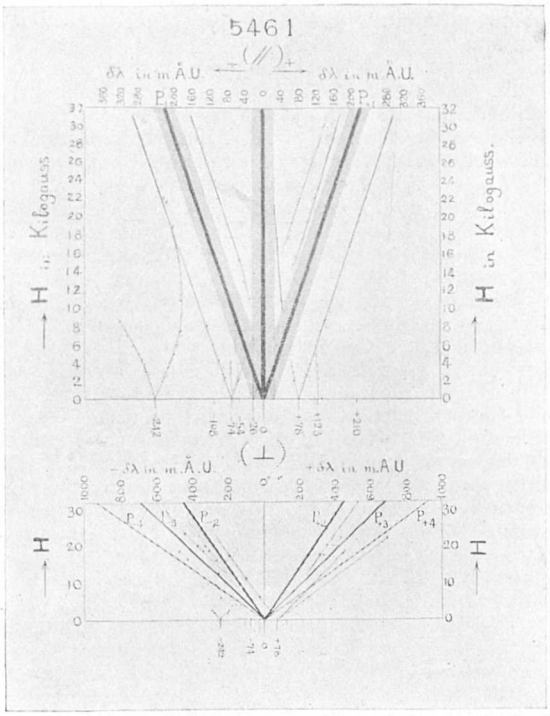
GEHRCKE and Baeyer, Lunelund, and McLennan showed that the satellites of some mercury lines are separated in a regular manner in weak fields; Gmelin found in the yellow line a satellite having anomalous character. Wendt noticed four characteristic lines in strong fields, but the satellites from which these lines proceed could not be identified.

Owing to extreme complexity in the distribution of lines when the field strength is increased, we have as yet no continuous observation indicating the position of satellites of mercury lines in different magnetic fields.

To fill in this gap, we made measurements on the satellites of the violet line 4047 and the green line 5461, up to the field of 30 kilogauss, and arrived at an unexpected result that the satellites show anomalous Zeeman effect, either as regards intensity or the mode of separation, and in nearly all cases both combined.

The instrument used was an echelon grating, but it was sometimes crossed with a Fabry-Perot air plate or a Lummer-Gehrcke plane-parallel plate to eliminate the false lines. From a large number of photographs





of transverse effects obtained in different fields, which were mostly uniform but sometimes heterogeneous, the positions of the satellites were plotted and traced into continuous curves; these are given in the accompanying figures, for components vibrating parallel and perpendicular to the field. The branches of the principal lines are indicated by P, and shaded to show the actual breadth; the positions of satellites in zero field are marked on the axis of abscissa by lines proportional to the intensity.

A glance at the figures for parallel components show that the separation is not generally proportional to the magnetic field. The satellites of 4047 are characterised by approaching the central principal line asymptotically, while in weak fields, the change in wave-length is quite rapid. The most remarkable of them is the satellite at −60 m.Å.U. from the principal; the branch towards the positive side is approximately a parabola with vertical axis, and that towards the negative side a similar curve with horizontal axis; consequently the change wrought by magnetic field is

proportional to $\sqrt{H}$ for the former branch, and to H^2 for the latter, showing that the singular case discovered by Gmelin is not confined to the satellites of the yellow line 5790. The same remark applies to the satellite -242 of the green line; the $(-)$ branch becomes fainter with increase of the field, and is parabolic in the sense above mentioned, the $(+)$ branch increases in brightness with the field, and the wave-length goes on increasing until it reaches a maximum, whence it gradually returns to the initial value in $H=24{,}000$, and decreases farther at a constant rate. The $(+)$ branch becomes ultimately parallel to the principal line P_{-1}. The direction taken by this Branch ultimately coincides with that of the $(-)$ branch of the satellite, -74; on approaching the $(+)$ branch of -242, this $(-)$ branch of -74 becomes fainter, and is finally lost to view; the other branch of -74 runs probably parallel to P_{+1}, and increases in intensity.

The satellites -26 and $+78$ have both a curved branch towards the negative side, and a straight branch on the positive side, both being parallel to P_0. Thus in these lines the different branches to which the satellites are divided ultimately run parallel to the principal lines, whether the vibration takes place parallel or perpendicular to the direction of the magnetic force. This stage is reached earlier in the latter than in the former, as an inspection of the figures will show. The same holds good also for the strong satellites of the mercury line 4359. On reaching this stage, the change in wave-length takes place proportional to the corresponding change in magnetic field, and the separation becomes ultimately normal.

It is in the transition from zero field to this final stage that the separation of the satellite takes place in a singularly anomalous manner, that we seldom meet with in the separation of the principal lines.

This fact will have an important bearing on the elucidation of the nature of the satellite, and probably may have an intimate connection with the recent experiments of Paschen and Back. Before entering into theoretical speculation as to the probable origin of the anomalous mode of separation, we think it advisable to extend the investigation to see if such an effect is common to satellites of lines of other elements.

H. NAGAOKA.
T. TAKAMINE.

Physical Institute, Imperial University, Tokyo, July 31.

The Piltdown Horse "Grinder."

IN the Dawson-Woodward paper on the Piltdown skull of a "hominid" (Q.J.G.S., vol. lxix.) mention is made of a tooth of *Equus*, and an accurate description (so far as it goes) is given. After handling it again at Kensington, and comparing it by measurements with recent finds from this Stort Valley, also with one recently placed in the Sedgwick Museum, and another in the Saffron Walden Museum, I have found that the tooth in question appears to be the *fourth premolar* (p.m. 4) of *Equus robustus*, which Prof. Cossar Ewart has recognised as the true "Solutré Horse" ("Restoration of an Ancient Race of British Horses," Proc. Roy. Soc., Edin., vol. xxx., part 4). The importance of this identification (if it is confirmed by experts) is too obvious to need further comment to those who are familiar with recent advances in our knowledge of the prehistoric horse. It remains to determine the exact horizon in the gravel-deposit at which this tooth was found before we can appraise its precise value as a time-index (see NATURE, July 8, 1909, paper to the Royal Soc. by Prof. J. C. Ewart, F.R.S.). But one may venture to assert that the *stratum* of Piltdown gravel, from which this tooth of Equus came, is of far later date than anything belonging to the Pleiocene.

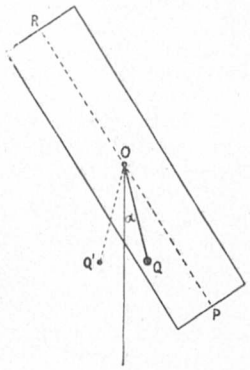
A. IRVING.

Bishop's Stortford, August 16.

Automatic Stability in Aëroplanes.

PROF. BRYAN'S explanation of his model illustrating instability due to friction is somewhat obscure, but in any case it is difficult to see how there is not a violation of the principle of conservation of energy in his conclusion.

If θ and ϕ are the angles made with the vertical at any instant by OQ and OP respectively, the potential energy of the controlling mechanism is $k(\theta-\phi)^2$, where k is some constant. When the system starts to move from the position depicted in the figure, its energy is $C+k(\beta-\alpha)^2$, and when it reaches the position of rest on the other side its energy is $C'+k(\gamma-\alpha)^2$, where C and C′ depend on the position of Q and Q′ relative to O, and therefore are equal, and β and γ denote the angles which OP makes with vertical in the first and last positions. Now Prof. Bryan states that γ is greater than β, in spite of the fact that some energy has been degraded by friction in passing from one position to the other. Where is his concealed source of energy?



J. B. DALE.

THE system contemplated in my letter assumes the existence of an external source of energy, and perhaps it might have saved misunderstanding if this fact had been stated at the expense of brevity. If we imagine an aëroplane performing purely lateral oscillations, and suppose it furnished with a pendulum so arranged as to operate on a pair of ailerons, we have a system the action of which might be represented to a first approximation by the model assumed by me. In this case the necessary energy is being supplied by the wind, which, by its action on the ailerons, causes the aëroplane to rotate like a windmill during the interval that the pendulum rotates with the aëroplane, while the inclinations of the ailerons remain constant. The work done in a small displacement is of the form $k(\theta-\phi)d\theta$, but this does not integrate into an expression representing potential energy.

G. H. BRYAN.

Physiological Factors of Consciousness.

I WISH to ascertain the opinion of physiologists and psycho-physicists on the following point, and I hope some readers of NATURE will be good enough to supply me with the information required.

My query is this: What is the true explanation of the fact that stimuli sufficiently strong to arouse vivid sensations in a subject while he is wide awake apparently fail to arouse any sensation at all in a state of unconsciousness? Four explanations appear to be possible, namely:—

(1) The afferent nervous current does not penetrate at all along the conducting paths into the central nervous system.

(2) It penetrates into it, but only up to a little way, and does not reach the highest nervous centres.

(3) It reaches even the highest centres, but simply touches them and does not enter them.

(4) It enters them, but fails to bring about that physical change in them that is the invariable concomitant of every conscious state.

The first of these explanations appears to me the least tenable of all. The last explanation, on the other hand, seems to be relatively the most probable. Indeed, on purely psychological grounds I am inclined to accept it as the final solution, but I must wait and seek an explanation on strictly physiological lines.

ABDUL MAJID.

Ghasiari-Mandi, Lucknow, India.

IN reply to your inquiry for information upon the question raised by Mr. Majid I beg to say that the view of the matter which is, I think, pretty generally accepted and which I have adopted and attempted to develop in several publications (more especially in a series of papers in *Mind*, vol. xv., "Physiological Factors of the Attention Process"), is that the central nervous system consists of series of sensor-motor arcs superimposed on one another to form strata of successively higher function from below upwards; that the synapses or cell-junctions of the higher level arcs offer higher resistance in the resting state than those of arcs of lower level; that the waking state is essentially one in which the generally diffused excitement of the whole system reduces these resistances of the higher levels to such degree that excitations from lower levels can penetrate them, such penetration being impossible in the quiescent state owing to the high degrees of resistance presented by the synapses of these higher levels.

Anæsthetic drugs (as I first suggested in *Mind* in 1898) seem to abolish consciousness through increasing the resistances of the synapses; and fatigue-products probably act on them in a similar manner, thus co-operating with diminution of external stimuli to the sense-organs in predisposing to or inducing normal sleep. I know of no evidence that points towards Mr. Abdul Majid's fourth type of explanation. His letter raises an interesting question, which is by no means settled, although the type of explanation I suggest is, I think, more or less tentatively accepted by a good many physiologists; and it would be of interest to elicit some expressions of opinion.

W. MCDOUGALL.

Oxford, August 7.

FOSSIL MAN.[1]

IN the summer of 1908 the Abbés A. and J. Bouysonnie and L. Bardon, already distinguished for their researches into the Palæolithic industries in France, made an important discovery. At La Chapelle-aux-Saints, a little south of Brive, in the Department of Corrèze, they found buried in a grave of Mousterian age a human skeleton of Neandertal type, with the head more completely preserved than in any previously known example of its kind. An inquest was held on the spot by some of the best-known "prehistorians" in France, who unanimously confirmed the observations of the discoverers. The skeleton, which Messrs. Bouysonnie and Bardon have generously presented to the National Museum of Palæontology in Paris, was entrusted by a fortunate choice to the director, Prof. Boule, and the result of his investigations is the beautiful monograph before us.

The first chapter is devoted to a history of the discovery. The skeleton was found lying in a hollow of the rocky limestone floor of the cave, and was covered by a magna of broken bones, worked flints, and yellow cave-earth, over which followed first a layer of clay and then of loose soil containing pebbles. Among the animals represented by the bones are the woolly rhinoceros, reindeer, bison, hyæna, marmot, and horse—a characteristic Pleistocene fauna. The implements are for the most part Mousterian points and racloirs; there are a few bouchers of Acheulean type, as well as some grattoirs which seem to presage the Aurignacian; but the assemblage as a whole is typical Mousterian.

The skeleton was orientated east and west, the head to the west. Above the head were the bones of a bison's foot (a metatarsal and some phalanges) still in connection—a proof that the deposits had not been disturbed, and suggestive of much else besides.

The skull (Fig. 1), of which a masterly analysis is given, is unusually perfect, and especially in

FIG. 1.—Skull of the man of La Chapelle-aux-Saints, with the nasal bones and the d ntition restored (×¼).

those parts which are absent from the Gibraltar skull, so that it is possible to determine the position of such important points of reference as the basion, opisthion, and bregma. The base is unfortunately incomplete, and this is the more to be regretted as the base of the Gibraltar skull, which in some respects is better preserved, presents some peculiar features not yet perhaps fully explained. In general there is a strong resemblance between these two skulls, the most marked difference, apart from size, lying in the extreme prognathism of the skull from La Chapelle-aux-Saints. Prof. Boule suggests that the orthognathism of the Gibraltar skull may be due to distortion consequent on pressure, but in the absence of collateral evidence we should be more inclined to regard it as an individual variation.

The most important characters of the skull are as follows: it is very large, especially for a man whose stature did not exceed 1·6 metres, and its capacity, measured directly by Flower's method, is 1620 c.c. The capacity of the Neandertal skull

[1] "L'Homme Fossile de la Chapelle-aux-Sainte." By Prof. M. Boule. Pp. 275+xvi plates. (Paris: Masson et Cie., 1913.) Price 50 francs.

is estimated at 1408 c.c., of La Quina at 1367 c.c., and of Gibraltar at 1296 c.c.

It is long, almost mesocephalic, and very flat: the frontal torus is enormous, the forehead low and retreating; there is a marked occipital torus, and the foramen magnum is situated far backwards; the squamosal is small, the mastoid process reduced, the tympanic slightly compressed, and there is a rudimentary post-glenoid apophysis. The palate is very large. The face has a remarkably brutal appearance, due partly to the retreating forehead and the frontal torus, the great round orbits, and very broad nose, but above all to the massive maxilla, which is without a canine fossa, and projects forwards, continuing the direction of the jugal, to form a sort of snout. The lower jaw is distinguished by the great thick-

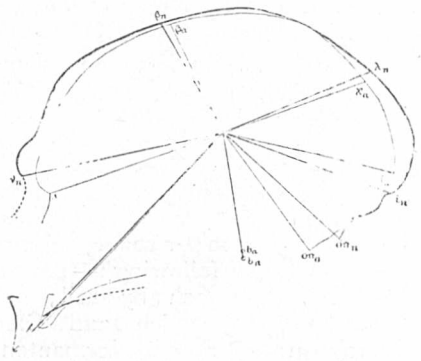


FIG. 2.—Profile of the skull of the man of La Chapelle-aux-Saints (thick line) compared with that of a low Australian aborigine (thin line). (The inions should be interchanged.)

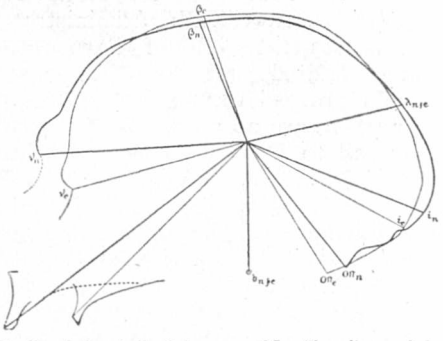


FIG. 3.—Profile of the skull of the man of La Chapelle-aux-Saints (thick line) compared with that of an average European (thin line).

ness of its body, the breadth of the ascending ramus, the obliquity of the symphysis, and the complete absence of a chin. The dentition is megalodont.

As the author justly remarks, it is not so much the occurrence of one or other of these characters which distinguishes the head of Neandertal man (many of them may be found scattered up and down among the members of some existing races); it is rather the association of all of them in one and the same skull, and, so far as we know, in all the skulls of one and the same race.

Very complete measurements are given, but exception might fairly be taken to the use of the glabella-inion line as a base; this is not without value when the Neandertal skulls are compared *inter se*, but it becomes misleading when the comparison is extended to the skulls of existing races. A better method is to superpose sagittal sections on a line drawn from the basion to the centre of form of its cranial area, as in the accompanying illustrations (Figs. 2 and 3).

It was found possible to obtain an internal cast of the skull, and thus to throw some light on the form of the brain, which, notwithstanding its magnitude, presents several simian features. It would be interesting to know what psychological significance may attach to these; Prof. Boule's

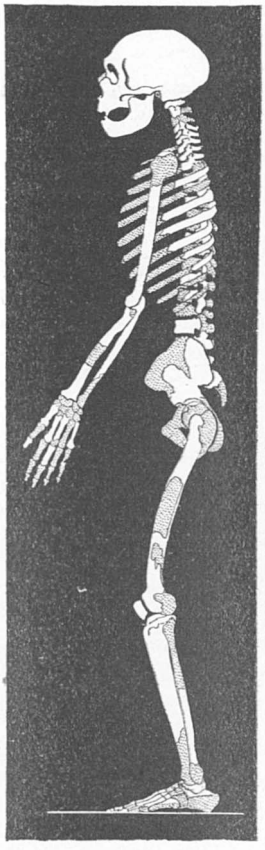


FIG. 4.—The skeleton of the man of La Chapelle-aux-Saints restored (×15).

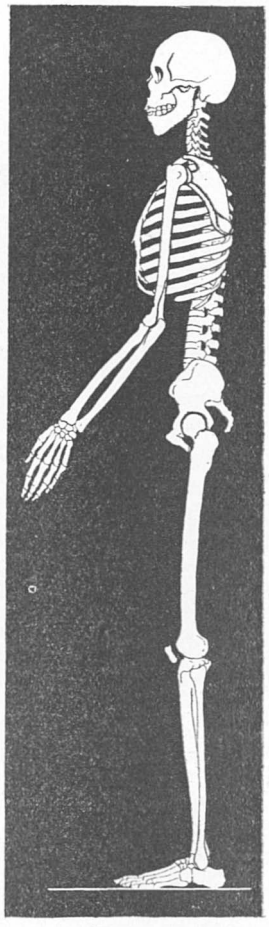


FIG. 5.—The skeleton of an Australian aborigine for comparison with Fig. 3 (×15).

comment is that a small watch may be a better timekeeper than a big clock.

A minute description of the other bones of the skeleton brings to light a number of interesting peculiarities, as in the form of the scapula and the clavicle, the characters of the cervical vertebræ, and others which are summarised in a useful table (pp. 222–6).

In discussing the stature it is pointed out that Manouvrier's rules are founded exclusively on a study of existing white races, and that other factors have to be taken into account when we proceed to extinct races like the Neandertal. Prof. Boule is thus led to assign a stature of from

1·58–1·59 to the man of La Chapelle-aux-Saints, or even perhaps 10 mm. less. The attitude is regarded as having been less habitually erect than in recent races.

The numerous and important differences which we encounter in all parts of the skeleton are sufficient to distinguish Neandertal man from all existing races; he differs more from them than they from one another, and is therefore to be regarded as a distinct species, which, according to the recognised rules of nomenclature, should be named *Homo neandertalensis*.

All anthropologists will welcome the very interesting chapters on fossil Pleistocene man and the evolution of mankind which conclude the work. They are valuable not merely as a compendium of existing knowledge, but above all as an expression of Prof. Boule's personal opinions. We have not space to dwell on these, but we may briefly enumerate one or two points. No very close affinity is admitted between *Homo neandertalensis* and the aborigines of Australia; though they share many primitive characters in common, yet in still more they offer a decided contrast (Figs. 4 and 5). Pithecanthropus is regarded as a gigantic gibbon. The Mauer jaw is assigned to the Chellean stage. Some resemblance is recognised between the Grimaldi skeleton and the Bushmen, and it is admitted that the Aurignacian artists may have been the ancestors of this interesting people. No convincing evidence has yet been adduced of the existence of man before the Pleistocene epoch, and the so-called "rostro-carinates" are rejected.

The whole history of the discovery at La Chapelle-aux-Saints, from the exposure of the skeleton in its tomb down to its lodgment and reconstruction in the museum at Paris and the appearance of this monumental memoir, is a faultless record of skill and foresight. There are no lost opportunities to be regretted, and every significant fact that the material could yield has been elicited and set before us by a master hand.

THE AUSTRALIAN MEETING OF THE BRITISH ASSOCIATION IN 1914.

PROJECTED TOURS BEFORE AND AFTER THE MEETING.

BESIDES numerous excursions, in some cases over long distances, which are being arranged in connection with the meetings in the different capital cities of Australia next year, two more extended tours are projected with the object of giving selected members of the main party an opportunity to see portions of the continent which will otherwise not be touched. The first of these will be in Western Australia, and will be open to a limited advance party composed mainly of geologists, zoologists, anthropologists, and botanists.

The work of the party will lie in various directions from Perth. Geologists will be taken east to the goldfields, and also north to the Irwin River district. The geological relations of the latter (permo-carboniferous glacial beds with good exposures, and with excellent opportunity for collecting specimens) are more readily grasped on a short visit than are those of the goldfields. In addition an excursion will be arranged to Yalling-up (south from Perth), and here there will be opportunity for botanists and zoologists to collect. For the latter, also, a marine excursion with dredging will be arranged at Bunbury on the return journey. A shorter trip by motor from Perth to Mundaring Weir will interest the same members, the zoologists visiting the region where Peripatus occurs. Marine dredging excursions in Swan River (for Ascidians), and by Rottnest Island, will also be arranged.

As regards the time that is required for a satisfactory working of the programme, a week is a minimum, and will mean much crowding and hurry. The Government of Western Australia and the committee in charge of matters connected with the visit would welcome a stay of a fortnight, and are prepared to grant railway facilities and find hospitality for that time. The number in the party must be limited, and membership restricted to people who are keenly interested in the work proposed. Twenty-five to thirty would be a convenient number, which might, perhaps, be extended to thirty-five, but must not exceed this.

The second tour would begin after the last meeting of the association in Brisbane, and the proposed itinerary is the following:—Brisbane viâ Rockhampton to Longreach by rail; coach to Winton; rail to Hughenden and Cloncurry; motor to Croydon and rail to Normanton. The party would then be taken to the mouth of the Norman river, and be met by the steamer belonging to the Administration of the Northern Territory (Dr. J. A. Gilruth, Administrator), and conveyed across the Gulf of Carpentaria, and about one hundred miles up the Roper river. They would proceed through the Territory by motor-car (there are no roads) to Pine Creek, and thence by rail to Darwin, where the steamer to England viâ Java, Singapore, and Colombo would be met.

A very considerable portion of Australia would be covered, and fine opportunities offered for the study of botany, geology, agriculture, &c., and, what is of great importance to Australia at the present time, the conditions of white settlement in the tropics. Obviously the party must be small, and it is suggested that it should include a botanist, a geologist, a zoologist, and a physiologist, or persons connected with mining, agriculture, and the development of Empire. Four would be a suitable number, or at the most five. Representative men only would be acceptable, for the trip will be costly; but if a party of sufficient standing and enthusiasm be prepared to undertake it, the Hon. D. F. Denham, Premier of Queensland, has promised, on behalf of his Government, to bear the expenses of the Queensland section, and the Administration of the Northern Territory will be responsible for the later section. A rough estimate of the time that might be spent on the whole trip is one month, but this would need to be adjusted in accordance with the time-table of the boats from Darwin to England.

It is hoped that both of these parties may be arranged by about the middle of November, while the organising secretary for the Australian meeting (Dr. A. C. D. Rivett) is in England. Inquiries should be addressed to the Secretary, British Association, Burlington House, Piccadilly, W.

TWENTY-FIVE YEARS' WORK AT THE PHYSIKALISCH-TECHNISCHE REICHSANSTALT, CHARLOTTENBURG.

THE Physikalisch-Technische Reichsanstalt, which may be aptly termed the German "National Physical Laboratory," plays such an important part in physical science that it may not be without interest to readers of NATURE to indicate briefly a few of the more prominent questions which have been dealt with at the institution since its foundation in 1885, which, by the way, was due in great measure to Werner von Siemens. Considerable information is afforded in two articles[1] recently published by members of the staff, and these papers should make interesting reading to those desiring further particulars of the work.

In addition to carrying out research work of direct interest to science and industry, the Reichsanstalt carries out the verification against standards of all kinds of instruments in the same manner as does the National Physical Laboratory in this country. It is, however, the research work to which we will confine ourselves here. The remarkable growth in the activities of the institution has kept pace with the advancement in scientific research during the last quarter of a century.

Dealing first with heat, the Reichsanstalt has occupied itself with practically every question in this branch of physics. One of its first tasks after getting into working order was the continuation of Regnault's famous work: he had shown that the scale of the mercurial thermometer could not be used as a standard owing to the influence exerted on the readings of the instrument by the expansion of the glass tube, the indications differing considerably in the range above 100° C. with thermometers made of different sorts of glass. Great difficulty had been experienced in finding a glass suitable for high temperatures when the Reichsanstalt commenced operations. Schott and Genossen, of Jena, experimented with different types of glasses and produced thermometer tubes constructed of new types of glass, and the Reichsanstalt tested these tubes as regards their accuracy over the fundamental interval 0–100° C., and their suitability for higher temperatures. The result is that the well-known Jena 59 quality has up to the present proved the most suitable in respect of small thermal expansion and of robustness. Extensive comparisons were afterwards carried out between the mercury thermometer and the air thermometer, owing to the difficulty experienced in realising the hydrogen thermometer scale at temperatures above 100° C. These measurements were carried to 500° C. At the present day nitrogen-filled thermometers are recognised as the most practical for high temperatures, and their success is to no small degree due to the labours of the Reichsanstalt. The institution has also played a not inappreciable rôle in the development of pyrometry, from the introduction of the thermo-couple by Le Chatelier to the more recent progress which resulted in the introduction of radiation pyrometry, based on the early observations of Becquerel, and on the later investigations of Kirchhoff and Wien on the subject of "black body" radiation. Following on Regnault's experiments, the Reichsanstalt has carried out research on the thermal properties of substances: this included experiments on the expansion of water between 0° and 100° by the communicating tube principle, and the determination of the saturation pressure between −60° and +370° C. The determination of the specific heat of gases—a question of high importance in internal combustion engine work—has been carried out with nitrogen, carbonic acid gas, and water vapour up to 1400° C., thus completing the work of Le Chatelier and Mallard in this connection, and the determination of the specific heat of gases at low temperatures has been made by Callendar's continuous flow method, improved by the counter-flow principle.

The electrical side of the work is no less interesting, and the activities of the institution have kept pace with the unceasing progress of this all-embracing science. It is, of course, of prime importance that the electrical units of measurement should be defined and realised as accurately as possible, and in this connection the Reichsanstalt has taken part in international conferences dealing with the subject, as well as cooperating with the State laboratories of other countries in carrying out measurements. Mercury copies of standard resistances had been found to be inconvenient in practice, and resistance boxes of German silver had proved inconstant and shown the resistance to be an intimate function of the temperature. It was Weston, in America, who first paved the way to improvement in this respect by inventing an alloy which showed but slight change of resistance with temperature; but it was left to the Germans to improve on Weston's discovery, the result being the introduction of the alloy (copper eight parts, nickel four, and manganese twelve) known universally as "manganin." Twenty years' experience at the Reichsanstalt with manganin resistances has shown the material to be unsurpassed by any other.

At the time the Reichsanstalt was founded standard cells were scarcely in use: it was only in the 'nineties that the Reichsanstalt, as the result of investigations, produced a practical standard cell, and one capable, moreover, of undergoing transit. This cell has, however, been superseded by the well-known Weston normal cell, which was accepted as the standard of e.m.f. by the London

[1] "Die Physikalisch-Technische Reichsanstalt; Fünfundzwanzig Jahre ihrer Tätigkeit." By Profs. Scheel, Holborn, Jaeger, and Brodhun. *Die Naturwissenschaften*, 1913, Nos. 8, 10, 12, 14.
"Die Physikalisch-Technische Reichsanstalt in Charlottenburg." By Prof. Karl Scheel. *Akademische Rundschau*, January, 1913.

conference on electrical units and standards (1908).

For direct-current measurements in electricity the three fundamental units—the ohm, the ampere, and the volt—are sufficient; but the Reichsanstalt experiments have contributed to a great extent to the improvement and simplification of methods of measurement. It was this institution that helped largely in the development of the potentiometer, which, in conjunction with the standard cell, forms the real basis of very many electrical measurements.

Mention should also be made of the "artificial loading" method introduced by the Reichsanstalt (separate circuit for current and pressure), which enables tests to be carried out, with but a small expenditure of electrical energy, on apparatus intended for the measurement of outputs up to many thousand kilowatts. It was also the Reichsanstalt which introduced the optical method of measuring current densities by means of the optical pyrometer.

Considerable interest attaches to the testing of sheet-iron employed in dynamo and transformer construction, and endeavours have repeatedly been made to keep down the energy losses in the material while augmenting the permeability (magnetisability) of the iron as much as possible. The Reichsanstalt was the first to suggest the use of iron alloyed with silicon for this purpose; and the researches of Barrett, Brown, and Hadfield appear to show the great advantage of this alloyed iron, which results in the reduction of eddy currents.

The optical work of the Reichsanstalt is not discussed quite so fully as that of the other branches. After a mention of pre-existing units of light, a space is devoted to the amyl acetate lamp of Hefner (briefly, the Hefner lamp) as a photometric standard. Whilst recognising its many advantages the Reichsanstalt has not lost sight of its deficiencies, and for this reason has always endeavoured to establish a measure of light to satisfy the broadest requirements of scientific and technical practice. Successful experiments have been conducted to secure a constant radiation of light from incandescent platinum with the aid of the bolometer, and tests now in hand justify the hope of arriving shortly at a mode of realisation of the "black body" which will fulfil all requirements in regard to accuracy and trustworthiness. Through the labours of the Reichsanstalt Germany was the first country to possess a generally recognised, accurately investigated unit of light.

The Charlottenburg establishment has also kept in close touch with practical requirements connected with saccharimetrical work. For ascertaining the value of sugar use is made of its rotation relative to the plane of polarisation, the Germans (and many other countries) using the Ventzke scale of divisions for the saccharimeters. The hundred point of this scale is defined by the rotation of a standard sugar solution (26 grammes in 100 c.c. of water at 20° C.) in a 20 cm. tube. For checking the readings of this apparatus, a quartz plate ground perpendicular to the axis is employed. Extensive experiments had to be made on the rotation of the pure sugar at the concentration of the standard solution, in order to arrive at a basis for test purposes. Great accuracy is necessary, as it is estimated that an error of 0·1 per cent. would make a difference in the sale value of the annual production of sugar in Germany of about 25,000*l*. The Reichsanstalt has, in addition, introduced the Abbe refractometer for determining the percentage of solids or of dry substance in connection with the impure sugar solutions to be investigated in the course of manufacture. Particulars are given of the method employed. Experiments have also been undertaken on the refractivity of other substances with the Abbe-Fizeau dilatometer, such as the refraction of different gases (air, H, N, and He) at room temperature and at very low temperatures; in addition, accurate measurements have been made on the refractive power of quartz and fluorspar—substances of such great importance in radiation measurements.

A series of optical experiments on metals have been made, yielding important results. The reflecting power was first determined by measuring the quantity of light reflected nearly perpendicular (to within $\frac{1}{4}°$) to the surface, for light of different wave-lengths, not only for the visible part of the spectrum, but also for ultra-violet (to wave-lengths of $0{\cdot}25\mu$) and for ultra-red rays (to wave-lengths of $1{\cdot}5\mu$). In the visible range the work was carried out with the spectrophotometer, and in the invisible range with a Rubens thermopile. In addition to pure metals the technically important mirror-alloys were investigated, and, for the visible range, glass mirrors coated with silver and mercury amalgam. It is interesting to note that silver, which in the visible spectrum reflects better (viz. 90–95 per cent.) than all other metals, reflects much less than all other metals in an ultra-violet region (between 0·25 and $0{\cdot}3\mu$), namely, only about 4 per cent.—or less even than a quartz surface.

An apparatus has been constructed by the Reichsanstalt for producing sharp interference bands, and having a high capacity. Its main constituent is a plane-parallel glass strip into which the light to be tested is transmitted in such manner as to fall on the bounding planes near to the angle of total reflection, thus emerging striated. With this apparatus a number of spectrum lines, particularly the mercury lines, have been tested as regards their structure and the presence of accompanying lines ("satellites").

In conclusion mention should be made of a series of experiments relative to the luminous phenomena in highly evacuated Geissler tubes. A new kind of ray, similar to the kathode rays, was discovered which was emitted from the anode under certain conditions. These anode rays, which are emitted in particular from hot salt anodes, show magnetic and electric deflection like the kathode rays and the Doppler effect (displacement of the lines in the spectrum). They were conceived as being positively charged metallic atoms of the

salts contained in the anode, and are cast off from the anode at great velocity (100 to 1000 kilometres per second). Difficult measurements carried out have had reference to the velocity and to the ratio of the electric charge to the mass of a luminescent particle for different metals. Views, corroborated chiefly by spectroscopic tests, make it probable that the anode rays are identical with the sun's protuberances—that the latter are nothing but anode rays of gigantic dimensions.

The annual report of the Reichsanstalt for the past year, just to hand, gives evidence of continued progress in the various branches of scientific investigation, but space will not permit of touching on the subjects dealt with: readers are referred to the *Zeitschrift für Instrumentenkunde*, March, April, and May, 1913, in this connection.

E. S. HODGSON.

DERIVATION OF POWER FROM TIDAL WATERS.

THOUSANDS of years have been required to evolve the processes by which the energy stored by natural agencies has been made to fulfil our requirements; thousands of years may still be required to evolve processes by which the internal heat of the earth, the phenomena attendant on barometric pressure, and the potential energy of the tidal wave may be similarly utilised.

But with regard to the latter much has in reality been already achieved. Vast fleets of barges and shipping are daily carried to and fro by means of the tidal stream in estuaries and the mouths of rivers. Ships of all sizes are lifted and kept afloat in inland tidal basins. London, Cardiff, Bristol, and numerous seaport towns illustrate the fact that ends impracticable by other means may be attained by the utilisation of the tidal wave; and there is little doubt that as time goes on, the advantages to be derived from the utilisation of the tides in dock work will be manifested by even greater and more important works than have yet been undertaken.

Why, then, should it generally be considered impracticable to utilise some small portion of the potential energy of the tidal wave in the production of energy for other useful purposes? The answer to this question is difficult to find, but it appears that about forty years ago an attempt was made to investigate the matter. An analysis of the initial cost and probable revenue from a tidal installation was made the subject of articles in *The Engineer*. The result of the analysis showed that electricity could be produced at a cheaper rate with gas engines than by a tidal installation. The cumulative result of this weighty opinion was evidently far-reaching, and for many years only half-hearted attempts have been made to prove that the tidal installation is no longer to be considered outside the range of practical engineering problems.

The conditions which obtained forty years ago are no longer in existence. The improvements in plant for carrying out large works are so great that they are difficult to realise. The hydro-electric installations in those days were so few in number and so unimportant in effect, that the vast works which have been executed in the past few years would likewise have been considered impracticable from a commercial point of view, or, at the best, in the light of doubtful experiments. Even so late as 1904, in a paper read before the Institution of Civil Engineers (vol. clvii., session 1903–04, part iii.), Mr. Steiger gives it as his opinion that water power has been chiefly used for driving flour mills, and as the authority of the author is above dispute, it may be safely concluded that an analysis made forty years ago should no longer be allowed to stand without revision.

Perhaps the most important modification of the conditions which obtained until quite recently is the use of ferro-concrete as an auxiliary to the formation of embankments. The strength and durability of structures, such as bridges and landing stages, with struts and braces of ferro-concrete has proved the possibilities of that material in braced structural work, while the small section and great length of ferro-concrete piles has shown the possibility of handling suitably designed beams and girders of this material without risk of injury to them.

Now by constructing braced trestles which can be handled by a crane, and placed so accurately in position that slabs of ferro-concrete, designed for the purpose, may be set between them and fixed, an extremely economical shell may be formed to serve as the matrix of an earthwork embankment.

The present writer has had the privilege of making an exhaustive investigation into modern methods of forming sea walls, wharfs, breakwaters, and other sea works of that kind, and he is in a position to state that where there is no danger from the action of heavy seas, great economy can be effected by forming the face of a sea wall with a skin of concrete slabs, held in position by trestles of the same material.

But even with the saving which can be effected by this method of construction, the tidal installation is only practicable from a commercial viewpoint when the initial cost can be reduced to between 40*l*. and 50*l*. per horse-power; or, stating the matter in another way, unless the sum of the maintenance charges, plus about 10 per cent. on the capital outlay, divided by the capacity of the installation in horse-power, does not exceed 4*l*. per horse-power year.

The financial side of the question is of the first importance, but the difficulties to be overcome on the technical side are also, it is to be presumed, regarded as nearly insuperable as well. To deal with the latter it is necessary briefly to consider the general characteristics of tidal waters in estuaries or similar locations, and to indicate the methods proposed for overcoming them.

When the tidal wave passes from the open sea into the funnel-shaped entrance of a channel or estuary, its volume being constant, the height of

the wave increases as the opening narrows, and the particles of water composing it acquire a horizontal motion. In fact, the tidal wave, after entering an estuary, may be considered to be a stream, which, while the crest of the wave is passing, becomes quiescent for a time, and then flows in the opposite direction until the trough of the wave, in its turn, causes another period of quiescence. These periods of quiescence are called the tidal intervals.

Now it has been found that the potential energy of a river may be converted to useful energy by damming the stream at a convenient place to obtain a working head for turbines; the difference in level of the stream above and below the dam being but a few feet. The economy of this method of generating electricity has been established by experience, and it is clear that if the utilisation of the tidal stream could be effected on somewhat similar lines, similar results might reasonably be expected. This in effect constitutes the problem which has to be solved.

The chief difficulty which has to be surmounted in utilising the tidal stream for power purposes is the tidal interval, and this difficulty must be considered as a problem to be solved for every location. In one case it might happen that it would be found cheaper to form one tidal reservoir and another reservoir inshore above the level of the highest tide.

The inshore reservoir would be filled twice daily by means of pumps actuated by the tidal reservoir, to serve as the supply to an ordinary hydro-electric installation which could be operated when required. In another case it might be found that the difficulty could be best dealt with by forming an auxiliary reservoir at a convenient spot higher up a neighbouring river, thus providing a separate unit to carry the load over the tidal intervals. In another case, again, it is possible that the intermittent operation of the turbines would not be found inconvenient. But speaking generally, the difficulty can be surmounted by the formation of two or more reservoirs connected to the tide and to a central turbine chamber by means of sluice valves; the feed to the turbines springing alternately from the main tidal stream and from the reservoirs in such a manner that a working head of water might be continuously maintained.

But it cannot be too strongly insisted upon that the first requirement for a tidal installation is a suitable site, the peculiarities of which will determine the character of the system adopted. For, since the success of such an undertaking depends on the cost per unit of power for structural work and equipment, it is evident that advantage must be taken of every favourable peculiarity, and that the system adopted will be dependent on the site.

In a case where the tidal interval is to be bridged by means of three tidal reservoirs the sequence of flow between the reservoirs and the tidal way is somewhat difficult to follow, but may readily be understood from the tabular description below. The three reservoirs are severally denoted by the letters "a," "b," and "c."

The tide rising from low water to one-third of its range:—

"a"	"b"	"c"
Turbines fed from reservoir	Standing empty	Emptying into the tidal way

The tide rising from one-third of its range to high water:—

"a"	"b"	"c"
Filling to high-water level	Empty	Turbines fed from the tidal way into the reservoir

The tide falling from high water to one-third of range:—

"a"	"b"	"c"
Standing full	Turbines fed from the tidal way into the reservoir	Filled up to tide level

The tide falling from one-third of its range to low water:—

"a"	"b"	"c"
Full	Emptying to low-tide level	Turbines fed from reservoir

It has been practically established that the basis of calculation for the power of a tidal installation should be one-third of the range of the minimum tide; hence when high tide is reached, water flowing from the tidal way may be passed through the turbines into the empty reservoir "b," the capacity of which must be such that the water level inside will have risen to the height of one-third of the range of the tide when the tide has fallen that distance. Similarly at low tide, water impounded in reservoir "a" to the level of the last high tide may be discharged through the turbines into the tidal way, the capacity of reservoir "a" being such that the tide will have risen one-third of its range before the water level inside has fallen an equal distance.

A third reservoir "c" must be provided to receive the water flowing through the turbines from the tidal way, during the time that the tide is rising from one-third of its range to high tide. It must then be filled to high-tide level direct from the tide, so that when the latter has fallen one-third of its range, the contents may be discharged through the turbines into the tidal way.

By an arrangement of valves and sluices all the reservoirs can be controlled automatically to perform their several functions as and when required.

The technical description of the several sluice valves or gates, of the structural details of the supply, or turbine chamber, and of the embankment walls was given in detail in the author's paper on tidal waters as a source of power, which was read and discussed before the Society of Engineers on May 5. It is, however, necessary to state that the cost of these details has been exhaustively considered, and it has been found that though the expense entailed is very heavy, it cannot be considered prohibitive unless the capacity of the installation is less than it should be to justify the outlay. For it will readily be seen that the length of the embankment walls will not increase directly as the area of the reservoirs, and hence that within defined limits, the greater the capacity of the installation the smaller will be its cost per unit of horse-power.

It is hoped that in the near future an opportunity will be found to obtain, not only a close estimate of the cost of a tidal installation, but also a proof in practice of its convenience and economy as a means of reducing the national consumption of fuel. C. A. BATTISCOMBE.

NOTES.

THE ninety-sixth annual meeting of the Société Helvétique des Sciences Naturelles is to take place this year at Frauenfeld from September 7 to 10. The programme is an interesting one. Among the lectures announced which are likely to attract considerable attention we notice that by Dr. de Quervain, of Zürich, on the Swiss Expedition to Greenland and its results, and that by Prof. Keller, of Zürich, on the geography of the fauna of the Caucasus, both of which are to be illustrated by lantern slides. Prof. Maillefer, of Lausanne, who will speak of his researches on the laws of geotropism, and Prof. Dutoit, of the same city, who will discourse on recent conquests in the realm of analytical chemistry, are equally certain of an attentive audience. Besides these, Prof. Grubemann's, of Zürich, account of the development of the modern theory of rocks, and Prof. Rikli's geographical studies in the flora of the Caucasus, as well as Prof. Fuhrmann's, of Neuchatel, sketch of his scientific researches during his journey through the Cordilleras of Columbia, will be awaited with interest. Among the men of science who have announced their intention of making communications to the separate sections are Prof. Edouard Fischer, of Bern, and Prof. Ernst, of Zürich, in the botanical section; Dr. Paul Arbenz and Dr. H. Schardt, of Zürich, in the geological section; Prof. C. E. Guye, of Geneva, and Prof. Perrier, of Lausanne, in the physical section, as well as Prof. Einstein and his colleague at Zürich, Prof. M. Grossmann, in a discussion of the physical and mathematical basis of the theory of gravitation, to take place at a common sitting of the physical with the mathematical section. In the latter section, though only added of late years, there is a relatively large number of communications inscribed, of which several are concerned with the more recent theories. In the section for geophysics Prof. P. Mercanton, of Lausanne, and in the section for chemistry, Prof. A. Pictet and Dr. G. Baume, of Geneva, are reading papers.

THE third International Congress for Diseases of Occupation will take place under the presidency of Dr. F. von Haberler and Prof. A. Schattenfroh in Vienna in September, 1914. The subjects for discussion will be:—"The Physiology and Pathology of Fatigue, especially with Regard to Professional Work, Overwork, and Nightwork," "work in Hot and Damp Air," "Anthrax," "Pneumoconiosis," "Electrical Industrial Injuries," "Industrial Poisoning, especially by Anilin, Mercury, and Lead," "Industrial Injuries to Hearing," and "Independent Communications." The general secretary is Dr. Ludwig Teleky, Vienna IX., 23, Türkenstrasse.

THE fourth International Congress of School Hygiene was opened at Buffalo on Tuesday last, and will continue in session until Saturday next. The president is Dr. C. W. Eliot. The work of the congress is divided amongst three sections, devoted respectively to "The Hygiene of School Buildings, Grounds, Material Equipment, and Upkeep," "The Hygiene of School Administration, Curriculum, and Schedule," and "Medical, Hygienic, and Sanitary Supervision in Schools."

THE eleventh International Conference on Tuberculosis will be held in Berlin from October 22 to 25. Among the communications promised are the following:—"Clinical Forms of Koch's Bacillosis at Different Periods of Life," by Prof. Landouzy; "The Surgical Treatment of Pulmonary Tuberculosis," by Dr. Brauer; "Life Insurance," by Dr. K. Frankel; "State Insurance and Schools for Children with a Tendency to Tuberculosis," by Prof. Pannwitz.

THE annual meeting of the International Association of Medical Psychology and Psychotherapy will take place at Vienna on September 19 and 20. The general secretary is Dr. L. Frank, 45, Zürichbergstrasse, Zürich.

THE death is announced, from Bonn, of Robert Rieder Pasha, the well-known surgeon, at the age of fifty-one years. In 1898 he became a professor in the University of Bonn. Afterwards he became Inspector-General of Medical Schools in Turkey, and received the title of Pasha. He remodelled the system of medical training in Turkey, and was responsible for the establishment of several hospitals and similar institutions in and near Constantinople, and returned to Germany in 1906.

THE death is announced, in his fifty-sixth year, of Mr. C. Leslie Reynolds, superintendent of the National Botanic Gardens at Washington. He had been connected with the gardens for nearly forty years.

THE death is announced, in his seventy-third year, of Mr. W. Whitehead, president of the British Medical Association in 1902, and from 1894 to 1900 professor of clinical surgery in the Victoria University of Manchester.

THE death is announced of Mr. J. R. Sheldon, a well-known agriculturist, at the age of seventy-three years. Mr. Sheldon was appointed to the chair of agriculture at the Royal Agricultural College, Cirencester, in 1877, being subsequently lecturer on dairy farming at Downton Agricultural College. He was the author of "Dairy Farming" and "Live Stock in Health and Disease."

THE late Sir Jonathan Hutchinson, F.R.S., left by will the following directions regarding his museums at Selby, Haslemere, and Chenies Street, London:—"I leave the three museums at Haslemere, Selby, and 22 Chenies Street, and their contents to my trustees upon trust to dispose of the same as they in their own absolute discretion shall think best, but my desire is that, without imposing any trust upon my said trustees, they shall dispose of my said museums and their contents in accordance with my wishes expressed to them during my life."

By the will of Prof. Emil Chr. Hansen and his wife a fund bearing his name has been established. At intervals of two or three years, beginning in 1914, a gold medal bearing his effigy and accompanied by a sum of at least 2000 kroner is to be awarded on May 8 to the author of a meritorious publication on some microbiological subject, and recently published in Denmark or elsewhere. In 1914 the medal will be awarded to a worker in the field of medical microbiology. The president of the board of trustees is Prof. S. P. L. Sorensen, the Chemical Department of Carlsberg Laboratory, Copenhagen, from whom all information may be obtained.

On the closing day of the International Congress of Medicine, an address on the relationship between medicine and public health was delivered by the President of the Local Government Board, the Right Hon. John Burns, M.P. He surveyed the saving of life which has been effected by the application of sanitary measures, the decline in such diseases as enteric and typhus fevers, which are due to local insanitary conditions, and the stages in the registration of disease, which has proved so powerful an agent in its control. Finally, a tribute was paid to the nursing profession, and the interesting fact noted that Florence Nightingale, who initiated our present nursing system, received her preliminary training in a German institution, the Deaconess's Institute at Kaiserwörth, on the Rhine.

We see by *The Townsville Daily Bulletin* (Queensland) that the Australian Institute of Tropical Medicine at Townsville was officially opened on June 28 by Sir William MacGregor, the Governor of Queensland, in the presence of many men of science and medical men. In the course of an inspiring address, Sir W. MacGregor traced the evolution of the movement for the foundation of the institute, giving especial credit for work done to the Rt. Rev. Dr. Frodsham, formerly Bishop of North Queensland, and to Prof. Anderson Stuart, dean of the faculty of medicine in the University of Sydney. He then spoke of the work to be done by the institute in the following words:—"The field that lies open to this institute for investigation is vast and varied, covering as it does not only different races of men in health and disease in the tropics of Australia, in Papua, and in the Pacific Islands, but also all other creatures in the same great area, for in these times the transmission of many diseases from other beings to man is well known, typical of which is the 'Rossa Cycle' in malaria; but there are many others, such as the Guinea worm, from a small cyclops; yellow fever, flaria, and dengue, from mosquitoes; tapeworm from domestic animals, &c. Research work in this institute will, however, not be limited to animal organisms, but will also embrace the vegetable kingdom, especially in the forms of foods and poisons; and now, in view of the researches of Dr. Erwin Smith on cancer in plants, caused by the *Bacterium tumefaciens*, and of the remarkable conclusions of Johnson, that the bud rot of the cocoanut palm is caused by *B. coli*, the pathology of the vegetable kingdom will demand much greater attention than has hitherto been given to that subject. The institute will also concern itself with such elementary things as earth, air, water, and sunshine; in short, with everything that influences the physical life of man in the tropics. Researches in this institute will also embrace questions that concern industrial life in our tropics. Dr. Breinl's work on nodules has already been of such a character as to demonstrate that the institute will be of much service to our flocks and herds, and be important in our economic pursuits." He then touched upon the investigations that will be carried out with reference to the effect of climate on the white race in tropical Australia; the proper kind of houses to be erected for their use; the most suitable forms of food and clothing for them; the study of insect and bacterial life in disease; the economic work which will be undertaken, and the value of such an institution to the medical man who has to deal with diseases peculiar to the tropics.

A second report (the first was issued in 1910) on infant and child mortality, by the medical officer of the Local Government Board, Dr. Newsholme, has been issued by the Board. The task of the present report has consisted mainly in setting out the facts as to incidence of mortality, and in attempting to render conspicuous the experience of those towns or parts of towns in which an excessive sacrifice of child-life occurs. A great saving of child-life has been effected in the last few years, and a large portion of this decline has occurred in the towns now under report. It is satisfactory to find that this saving of life cannot be attributed merely to favourable climatic conditions, but to some degree at least is the result of improved sanitary and housing conditions. In the first part of this report the detailed facts as to incidence of infant and child mortality are set out. In its second part the close interrelationship between defective sanitation, poverty and intemperance, and excessive mortality is discussed. In its third part, a preliminary statement as to child welfare work is given.

It is announced in *The Times* that Mr. Peter Waite, of Adelaide, South Australia, is sending a collection of animals to the Scottish Zoological Park. The collection includes two kangaroos, four Bennett's wallabies, four rock wallabies, two emus, two opossums, two eagles, two Tasmanian devils, two black swans, two magpie geese, and two ibises. The Adelaide Zoological Garden is sending two dingos, and Mr. S. S. Ralli, of Adelaide, two giant kingfishers. Mr. E. J. Robertson Grant, of Edinburgh, who is at present in the Argentine, has also intimated that he is getting together a collection of animals for the Zoological Park, and will bring them with him when he returns to Scotland in November next..

Hungary possesses a Governmental institution for the scientific study of ornithology, the Magyar Királyi Központ, or Königlich Ungarische Centrale, to which has recently been added an anatomical department, the staff of which publishes its researches in the periodical *Aquila*. Dr. Greschik, one of the assistants, has made a renewed study of the microscopic structure of the rectum of some sixty kinds of native birds.

The histology of this class is usually treated somewhat cursorily in our text-books, mainly because of the minute size of the avine cells in comparison with those of other vertebrates. A number of good text-figures and a plate illustrate the details, most of which naturally can interest the specialist only, but there are also observations and conclusions, for instance, those concerning leucocytes and the protoplasmic rods of the cylindrical epithelial cells, which are of general physiological importance.

To *The Field* of August 23 Mr. R. I. Pocock contributes an article on the skin-glands of shrew-mice, in which it is pointed out that the gland on the flanks of the British species, which is generally supposed to emit the musky odour characteristic of these animals, is present only in the males. On the other hand, it is developed in both sexes of the Indian musk-shrew (Crocidura), as well apparently as in the Continental representative of that genus. It has been generally stated that the musky odour of all shrews is protective, but, in the members of the typical genus, if it be emitted by the gland, it must be a sexual feature, probably designed to attract the females. Before this can be definitely decided, it has to be ascertained whether the females of British shrew-mice are musky. If they are not, the numerous shrew-mice left dead by cats in gardens in autumn must probably all be males. Quite apart from the question whether the glands be its source, it seems, on the other hand, quite evident that in the Indian musk-shrew and its near relatives the musky odour is highly protective, rendering these animals obtrusive and "self-advertising."

THE current number of *The Quarterly Journal of Microscopical Science* (vol. lix., part 2) contains a very interesting article by Mr. E. S. Goodrich on metameric segmentation and homology. He discusses the well-known difficulty that organs which are undoubtedly homologous, inasmuch as they can be traced back to corresponding parts in a common ancestor, may nevertheless occur on different segments in different representatives of a group. The paired limbs of vertebrates are cited as typical illustrations of the problem. These shift backwards or forwards during the course of evolution in the most perplexing manner. Mr. Goodrich holds that, in order that they may be regarded as strictly homologous, it is not necessary that organs should be developed on corresponding segments in different types, and he accounts for their variation in position by a process of "transposition," rejecting the theories of intercalation and excalation of segments, re-division of the body and migration of the organs in question.

THE August number of *The Museums' Journal* is chiefly devoted to reports of the recent conference of the Museums' Association at Hull, including the presidential address delivered by Mr. E. Howarth. It is illustrated with a portrait of the president, and a photograph of the members of the association at Burton Constable, the seat of Major Chichester-Constable.

IN the second volume on insects in *The Cambridge Natural History* it is stated that the family Fulgoridæ "includes the so-called lantern-flies, in which the front of the head forms a huge proboscis that was formerly believed to be luminous." In the August number of *The Zoologist* Mr. H. W. Bell-Marley records the emission of light by the adult of a Natal species (*Rhinorthra guttata*), as well as by parasitic lepidopterous larvæ with which it is infested.

The Scientific American announces an alteration in the system of issue of publications by the United States Department of Agriculture. The old independent series of bulletins and circulars of the thirteen publishing bureaus, divisions, and offices of the department have been discontinued and will be superseded by a new *Journal of Research* for printing scientific and technical matter, and by a departmental series of bulletins, written in popular language for selected and general distribution. By this plan the confusion that has resulted from the multiplicity of series of publications will be avoided, and the saving of a considerable sum will annually be effected. Under the new plan the department will discontinue the general distribution of matter so scientific or technical as to be of little or no use to the lay reader. It will supply technical information only to those directly interested and capable of using scientific analyses, and of understanding the results of research work couched in scientific terms. A larger amount of information in popular form which the average reader can immediately apply to his own direct advantage will hereafter be distributed.

WE have received from Dr. J. H. Maiden a reprint of the presidential address delivered by him last year to the Royal Society of New South Wales. This address ranges over a wide and varied field, and contains much that is of general interest, including obituary notices and memoirs of Sir Joseph Hooker, Lord Lister, and Baron von Mueller. Reference is made to the forthcoming Melbourne meeting of the British Association and to other scientific matters of Australian interest, such as the Northern Territory Expedition of 1911, the exploration of Antarctica, the centenary of the Sydney Botanic Gardens, &c. After dealing with some botanical matters, such as the teaching of botany, a plea for a botanical survey and a new census of New South Wales plants, Dr. Maiden proceeds to set forth in some detail his views regarding the functions of a botanic garden, with suggestions as to work in phyto-chemistry and other practical proposals for increasing the usefulness of botanic gardens in Australia or elsewhere.

DR. W. A. CANNON, of the Carnegie Institution Desert Laboratory, Tucson, Arizona, has forwarded a reprint of an interesting paper on some features of the root systems of desert plants (*Popular Science Monthly*, vol. lxxxi). Among desert shrubs there are three main types of root system: (1) the superficial type, in which the roots extend horizontally from the plant axis, and lie near the soil surface; (2) the tap root, which goes directly down to a depth determined partly by the character of the soil, partly by the penetration of the rains and partly by the character of the root itself; (3) the generalised type of root, which not only reaches widely, but also penetrates fairly deeply.

The third, or generalised type, is characteristic of the great majority of desert plants; the prevalent idea that the roots of such plants are usually very long has no adequate foundation. The author adds interesting notes on the environment of the roots of desert plants—height of water-table in the soil, soil temperature, soil air, &c.—and indicates the problems which are being investigated at the Desert Laboratory with regard to the relation between desert plants and the soil.

THE relative value of strong and weak wheats is a controversial question which has more than once engaged attention in the columns of NATURE. The former type of wheat yields flour which is preferred by the professional baker in large cities for a number of reasons, and therefore commands a higher price. It has come to be considered of higher quality, and it is at present the object of wheat breeders all the world over to convert the indigenous weak wheats into stronger varieties. It is generally stated (for example, Humphries, Royal Society of Arts, 1909, 239) that the wheats which yield flour better suited for British consumption (by which the manufacturing centres and towns are implied), do not suit the native Indian requirements so well; indeed, wheat is more often consumed by the natives in the form of coarse cakes toasted by the side of an open fire than in the form of the light, well-risen loaf known to us. However, Mr. and Mrs. Howard, whose work in improving Indian wheats is receiving wide recognition (see NATURE for August 7, p. 586), write to say that they do not agree with this view of the question, and they claim that the class of wheat preferred by the people of India for their own food is the same as that in greatest demand in the English markets. Mr. and Mrs. Howard realise fully (*Agric. Journal of India*, iii., p. 31) that any improvement in the quality of wheat to be of importance must satisfy both the people of India and the home millers.

THE cultivation of tobacco in the Nyasaland Protectorate would appear to be full of promise, if one may judge from the report of the director of agriculture for the past year. During the period 1902–12 the total export of tobacco has increased from 60 lb. to $2\frac{1}{4}$ million lb., and the locally grown material so strongly resembles Virginian-grown tobacco that it is readily absorbed by the trade. In view of the large grants which have been made from the Treasury towards the cultivation of small quantities of inferior tobacco in Ireland, it is certainly striking that so much progress has been made in Nyasaland, even without the assistance of a tobacco expert. The claim is made that the possibilities of the Protectorate for tobacco-growing are probably greater than those of any other part of the British Empire.

A USEFUL note on "Thunderstorm Statistics of Egypt" is contributed by Mr. E. W. Bliss to *The Cairo Scientific Journal* for June. The data are summarised from a list of all available records of storms prepared by request of the Cairo Department of Ordnance by the Meteorological Service, and refer chiefly to observations at Abbasia between 1868 and 1912. A table including both slight and severe storms, and also many cases where only lightning was observed, shows that during the above period electrical discharges were experienced on 180 days only. Cases occurred in each month except July, the majority being in October and November, and their rarity bears out a statement previously made that in Egypt thunderstorms are comparatively few in number. Storms accompanied by hail or heavy rain, or which did damage to buildings, only amounted to twenty-eight in the forty-five years, an average of rather more than one in two years. The discharges appear to occur most frequently during the evening hours.

THE Canadian Department of the Naval Service, Ottawa, has issued a useful pamphlet on "The currents in the entrance to the St. Lawrence," from investigations of the tidal and current survey in the seasons of 1895, 1911, and 1912. The most modern methods were employed in the investigation; the temperature and density of the water, and complete meteorological observations were also taken. Between the Gaspé coast and Anticosti the currents present a complete contrast in their behaviour; on the one shore there is a current flowing always in the same direction, while on the other the set is weak and continually veering. One of the chief endeavours has been to reduce these currents to law, and in the case of the Gaspé current it has been largely successful. Although the veering currents are weak, and at times irregular, it has been possible to prove that the tide has a dominating influence upon them, and that their directions during flood and ebb are fairly definite as a rule. The features of both currents are discussed in considerable detail.

THE July number of *Himmel und Erde* contains the address delivered by Dr. M. Laue on taking up his professorship at Zürich in December last. Naturally, it deals with the new field of research opened up by his own experiments on the reflection of Röntgen rays by crystals. From the results obtained by himself, and by others who have repeated his experiments, he concludes that the wave theory of the constitution of Röntgen rays is in much closer accord with the facts than the form of emission theory advocated by Prof. Bragg. The difficulties in the way of its general acceptance are not greater than those with which the wave theory of light has to deal, and the rejection of the wave theory in one case would necessitate its equal rejection in the other.

IN a paper read before the American Institute of Electrical Engineers in March last, Mr. C. Fortescue showed how the excessive concentration of electrical stress which is to be found at certain parts of the insulation of electrical apparatus could be replaced by a uniform stress of much smaller amount. A short account of the electrostatic theories which underlie Mr. Fortescue's method is given by Prof. W. S. Franklin, of Lehigh University, in the July number of the Journal of the Franklin Institute. Prof. Franklin shows that the two propositions—an equipotential surface may be to any extent replaced by a thin metal sheet without disturbing the field, and a closed metal shell screens its inside from outside effects—form the basis for most of the devices suggested. Taking the field round a charged wire or

that between two charged wires as his starting point, he builds up by simple processes the most important practical cases. His paper concludes with a warning against the frequent use of the idea of potential in cases in which the simpler one of the electric field will give all the required information.

OUR ASTRONOMICAL COLUMN.

THE ORIGIN OF SOLAR ELECTRICITY.—Among the many interesting papers concerning astrophysical matters which appear in No. 8 of the *Monthly Notices* of the Royal Astronomical Society, attention may be directed to a convincing contribution to our knowledge of the agencies originating the vast solar electrical phenomena demonstrated by the brilliant researches effected at Mount Wilson. In a paper under the above title Dr. J. A. Harker applies the results of laboratory work conducted in collaboration with Dr. G. W. C. Kaye at the National Physical Laboratory to the explanation of cosmical phenomena. This experimental work has shown that at very high temperatures the vapours in the tube resistance furnace become highly conducting, and that under the same condition most refractory substances emit electricity carried by particles many times the mass of an atom of the substance. Calculations show that the measured emissivity of carbon at about 3000° C. would be ample to account for solar currents of magnitude sufficient to give rise to the intense magnetic fields Professor Hale has shown to be probably found in sun-spots.

THE TRUE FORM OF THE EARTH AND ITS INTERNAL CONSTITUTION.—Dr. A. Veronnet contributes a discussion of these subjects to No. 13 of the *Revue Générale des Sciences*. It is now known that this "somewhat irregular round body" on which we live has a rough sort of tetrahedral shape, but mathematicians must have a more generalised form, and thus for them the geoid is an ellipsoid of rotation of which the inverse of the eccentricity is about 297. Dr. Veronnet criticises the various formulæ which have been suggested to represent the hypothetical generating curve, and has himself proposed a new one. By considering the effect of variations of density and velocity of rotation limits are determined for the above-mentioned ratio, and it is shown that if the above value, found by Helmert, is supported, then the earth rotates as one piece. The author is also led to make some interesting conclusions regarding the effect of tides and causes of earthquakes.

COSMOLOGICAL HYPOTHESES.—At the Science Congress held at Lourenço Marques, Mr. R. T. A. Innes, of the Transvaal Observatory, dealt with this subject, and added one hypothesis more which he referred to as "the explosion hypothesis." He assumes that matter will not indefinitely submit to continued reduction of volume under indefinitely increasing gravitational pressure, but that a time will come when this pressure will "break into the atomic structure of its matter and cause explosions." By such explosions the sun threw off the planets and the latter their satellites; in other stars they caused the formation of multiple systems; new stars are due to the eruptive outbursts accompanying the explosions, and when on a smaller scale and rhythmical they are responsible for the phenomena of variable stars. Mr. Innes, we may remark, has shown an inexplicable eclecticism in choosing his foundation facts; for example, he has ignored the harmonious results obtained by modern workers on the temperatures of the individual stars, but has selected a contrary opinion to the effect that solar type stars are hotter than the white stars.

MAGNETIC SURVEYS.[1]

THE introduction tells us that this is the first of a series of volumes to be published dealing with the researches of the department of terrestrial magnetism of the Carnegie Institution of Washington, founded in April, 1904. These volumes, while principally on terrestrial magnetism, will contain memoirs on allied subjects, such as atmospheric electricity. The present volume treats of all the magnetic observations made *on land* by the department from the beginning of its observational work in 1905 up to the end of 1910. These observations are directed towards the accomplishment of one of the principal objects which the department has in view, viz. the acquisition of the data necessary for a general magnetic survey of the earth.

The first fifty pages deal with the general methods of work, the selection and description of stations, and especially with the field instruments and the taking and reducing of observations. The observational instruments—magnetometers, dip circles, and dip inductors—and auxiliary apparatus are handsomely illustrated in plates 2 to 6. Much experience of field-work has accumulated of late years at Washington, and the instructions to observers merit the careful attention of all interested in survey work. Pp. 51–6 introduce us to the results of the observations, which are chronicled in the later part of the volume. On p. 53 is a list of thirty-five observers whose work is included. Amongst them are several eminent foreigners, including Prof. Palazzo, of Rome, and Profs. Beattie and Morrison, of South Africa, who have observed for a time under the auspices of the Carnegie Institution. The stations observed at number almost 1300, of which more than 1200 are outside the bounds of the United States.

Of the continents, Africa shows the largest number of stations, 386, the great majority of which were occupied in 1907 and 1908 by Profs. Beattie and Morrison. Of the 328 stations in North America, 189 were in Canada or Newfoundland, fifty-nine in Central America, and nine in Greenland. In Asia there were 308 stations. Of these 142 were in China—occupied mainly by Messrs. Edmunds and Sowers—thirty-seven in Persia, thirty-two in Russian and eighty-one in Turkish territory. The observations in Asiatic Turkey were due mainly to Mr. Sligh, but partly to Mr. J. C. Pearson. The latter gentleman seems to have taken all the observations in Persia and in Asiatic and European Russia, and most of those in Egypt. He also observed in Canada, in European Turkey, at Pola, Potsdam, and Kew Observatories, and was amongst the crew of the surveying ship *Galilee*, who observed in Japan, Australia, and New Zealand. His experiences as a traveller should be of interest. Of the remaining stations, 111 were in South America, and 119 in numerous islands in the Pacific and Atlantic Oceans.

The tables of results, pp. 58–100, give for each station the geographical coordinates, the date and hours of observation, the observed values of magnetic declination, inclination, and horizontal force, the instruments used, and the observer's initials. Pp. 101–120 contain interesting extracts from the reports made by the several observers. The rest of the volume is occupied by minute descriptions of the stations, to facilitate their identification. An artistically attractive feature is the reproduction in plates 1 and 7–10 of a number of fine photographs, showing a selection of the stations occupied or scenes in their neighbourhood.

1 "Researches of the Department of Terrestrial Magnetism. Land Magnetic Observations 1905–10." By L. A. Bauer, Director of the Department. Pp. 185+10 plates. (Washington, D.C.: Published by the Carnegie Institution of Washington, 1912.)

The work is a striking example of what can be done when scientific zeal and business capacity have behind them resources such as those of the Carnegie Institution. Dr. Bauer and the staff of the department of terrestrial magnetism—both those who took the observations and those who did the necessary office work—are to be congratulated on the progress made towards the achievement of one of their principal objects of ambition, a general magnetic survey of the globe. C. CHREE.

ADVANCE IN ECONOMIC ENTOMOLOGY.

A NOTABLE feature of recent biological research is the attention paid by medical experts to the study of insects. Capt. F. W. Cragg, of the Indian Service, has lately published two Scientific Memoirs (Nos. 54 and 55) of the Medical and Sanitary Departments of the Government of India, which are of importance to students of the anatomy of Diptera. Both memoirs deal with blood-sucking species, No. 54 with *Philaematomyia insignis*, and No. 55 with *Haematopota pluvialis*. The excessively small number of males of the latter fly is believed by Capt. Cragg, after examination of the genitalia of the female insect, to be explained by heavy mortality as the result of pairing. We notice that the bibliography of this paper contains some remarkable misprints, of which "Verh. yool-bat. Gas. Wein" is worthy of record as a piece of unconscious humour! The last published part of the Bulletin of Entomological Research (vol. iii., part 4, December, 1912) contains valuable systematic papers on blood-sucking Diptera, by Mr. E. E. Austen and Prof. R. Newstead, and some very useful diagnoses of the larval stages of African mosquitoes, by Messrs. F. W. Edwards and A. T. Stanton.

The same number of the bulletin is noteworthy for a suggestive paper by Dr. J. Dewitz on the bearing of physiology on economic entomology. The author points out, for example, the importance of a precise knowledge of the effect of stimuli due to light of varying intensity and wave-length if luminous traps for destructive moths are to be used to the best advantage. Temperature is also found to be a factor in the working of this reaction; "the colder the night the fewer the females (and in particular females with eggs) that are caught by acetylene trap-lamps."

In a lately issued bulletin (Entomology, No. 113) of the U.S. Department of Agriculture, Messrs. W. D. Hunter, F. C. Pratt, and J. D. Mitchell describe the principal cactus insects of the United States. The "prickly pears" (Opuntia) are well known as furnishing food and habitation for the cochineal insect; since the decline of the cochineal industry, however, these plants were regarded rather as noxious weeds until the recent recognition of the fact that they furnish valuable fodder for cattle. Insects which injure them are therefore regarded as economically important, and in this short memoir a number of species of various orders are described and figured.

Some very important observations are contained in a small bulletin (No. 203) issued by the Maine Agricultural Experiment Station in 1912. Miss Edith M. Patch has apparently shown that the aphid causing "leaf-curl" on the elm (*Schizoneura americana*) migrates in spring to the apple and other Rosaceæ, and becomes the parent of the aërial colonies of the notorious woolly aphid, *S. lanigera*. The elm is thus the normal host of the sexual forms in autumn, and the apple is to be regarded as an "intermediate" host. The extreme rarity of sexual forms of *S. lanigera* on apple in these countries may perhaps be explained by a similar unsuspected migration here, though our native elm "leaf-curl" aphid (*Schizoneura ulmi*) is generally regarded as distinct from *S. americana*, and identical with the polyphagous root-feeding form, *S. fodiens*.

The gipsy moth (*Porthetria dispar*) and the brown-tail moth (*Euproctis chryssorhoea*) are well-known examples of European insects which, having been introduced into America, have become there very serious pests. From among the voluminous writings of forest entomologists on these species, one or two recent papers are worthy of especial notice. A. F. Burgess gives an account (U.S. Dept. Agric., Entom. Bull. 119, 1913) of the means by which the gipsy moth extends its range. On account of the excessive weight of the female's body, she is unable to fly, though provided with wings, and the spread of the insect from place to place is carried on mostly during the larval stage. The caterpillars are often artificially though unwittingly transported by farm carts, and it appears that one generally unrecognised evil result of automobile traffic is that these destructive insects are carried far more widely and rapidly than formerly by the passage of motors along main roads which are bordered by infested woods. The young larvæ, however, are provided with a natural means of dispersal in form of long hairs, which enable them to be carried by wind for considerable distances. Some ingenious experiments on this subject have been made by erecting tall platforms provided with traps in which the little caterpillars are caught on their aërial journeys.

As these destructive insects were introduced from Europe, the American entomologists have naturally tried the experiment of importing some of their natural enemies, and an exhaustive report on this subject has been published by Dr. L. O. Howard and W. F. Fiske (U.S. Dept. Agric., Entom. Bull. 91, 1912). To summarise the mass of material in this bulletin is impossible, but the magnitude of the work undertaken may be judged from such a fact as that 11,000 egg-clusters of the brown-tail moth were imported from Europe in the autumn of 1906, and 40,000 specimens of a single species of hymenopterous egg-parasite, *Pteromalus egregius*, reared from these were turned out in New England woodlands during the succeeding spring. Many valuable bionomic details with regard to the parasites are recorded, and reference is made to attempts—successful or otherwise—to introduce predaceous enemies of other harmful insects into countries where the latter have themselves obtained a foothold. A short special paper on a cognate subject is R. S. Woglum's report on a trip to India and the Orient in search of the natural enemies of the Citrus white-fly (*Aleyrodes citri*); this forms Bull. 120 of the Entomological Bureau of the U.S. Dept. Agric.

A much-needed systematic monograph of the "white-flies," or "snowy-flies" (Aleyrodidæ) is commenced by A. L. Quaintance and A. C. Baker in the Technical Series, No. 27, of the same bureau. These insects are allied to the Coccidæ and Aphididæ, but have received far less attention from entomologists than those two families. In the work now begun their structure, classification, and bionomics are dealt with as fully as possible in the present state of knowledge; ultimately the authors think that the family may prove as rich in species as the Coccidæ or Aphids.

Another valuable systematic paper of economic interest is Prof. M. Bezzi's memoir on Indian Trypaneids, or fruit-flies (Memoirs Indian Museum, vol. iii., No. 3, 1913). These are small Diptera included in what used to be known as the "acalypterate" series of the Museidæ. The careful, systematic study of such insects is of importance, and Dr. Annandale, the director of the Indian Museum, is to be con-

gratulated on having obtained the help of such an eminent European student as Prof. Bezzi, of Turin.

The Imperial Bureau of Entomology begins this year to supplement the Bulletin of Entomological Research by a *Review of Applied Entomology*, issued in two series—A, Agricultural, and B, Medical and Veterinary. Containing records of recent literature, with full summaries, these publications cannot fail to be valuable to students of insect life.

G. H. C.

METEOROLOGICAL REPORTS.

WE have received the meteorological observations made at the Hamburg Astronomical Observatory for 1910–12. This institution was established in the town of Hamburg in 1825, and was for many years under the able superintendence of Dr. Rümker; it is now situated at Bergedorf, 19 km. E.S.E. of its former position, and is under the superintendence of Dr. Schorr. Very complete and careful observations are made five times daily; the amount of cloud is also given for each hour between 6h. p.m. and 6h. a.m. The sunshine is recorded by Campbell-Stokes (burning) and Jordan (photographic) instruments. The average annual difference in the possible percentage for 1910–12 is 6·7 in favour of the Jordan recorder. Although the observations are not strictly comparable, we should not have expected so much difference. An interesting comparison of temperature and humidity in English and French screens is made with the readings of an Assmann's aspiration psychrometer. The hourly means of temperature in both screens are generally higher than those of the psychrometer; the greatest differences occur in daytime, especially in the French screen (open at bottom), but at the 9h. p.m. observation the reverse obtains. Humidity in the screens is generally higher than the readings of the psychrometer, especially during summer.

The report of the Sonnblick Society for the year 1912 contains the results of the meteorological observations on the summit of the Sonnblick, Salzburg (3105 metres), for twenty-five years, 1887–1911, prepared by Hofrat Dr. J. v. Hann. The mean monthly temperatures were:—January, −13·3° C. (February, −14·0°); July, 0·9°; year, −6·6°; mean of absolute extremes, 9·5°−29·7°. Mean yearly precipitation, 1715 mm., on 216·7 days. Fog was observed on 251·5 days. The mean yearly sunshine was 1496·9 hours, being 35 per cent. of the possible amount. The duration of sunshine varies greatly in different years; September, 1895, had 241 hours, August, 1896, only eighteen hours! November and January have relatively the most sunshine, May and June the least. Winter and late autumn are the brightest seasons, April to June the dullest months. Among other useful summaries contained in the report we may mention the observations at the summit of the Donnersberg, Bohemia (835 metres), for the years 1905–9. The observatory is attached to the German University at Prague, under the direction of Prof. R. Spitaler.

The report and meteorological observations at the Royal Observatory, Hong Kong, for the year 1912 have reached us; the results have been carefully prepared by Mr. T. F. Claxton, formerly director of the Mauritius Observatory. The tables include hourly values of the principal elements, five-day means, and results of magnetic observations. The mean annual air-temperature, 71·9°, was about normal; maximum, 92·5°, in September; minimum, 45·3°, in December. The rainfall, 63·9 in., was about 20·5 in. below the average. The colony was not actually visited by a typhoon, but the tracks of those and of the more important depressions which occurred in the Far East during the year are shown on two plates. A weather map and reports from about forty stations are issued daily; the forecasts drawn from these data for various districts show a very high percentage of success. A large amount of data is extracted from ships' logs; this is utilised in determining typhoon tracks, and to some extent for the eventual publication of pilot charts of the Pacific for the area 9° S. to 45° N. latitude, and 100° to 180° E. longitude, divided into two-degree squares.

HORTICULTURAL INVESTIGATIONS AT THE WOBURN EXPERIMENTAL FRUIT FARM.[1]

IN a flower, such as that of an apple-tree, there is a tubular structure in the centre, forming the female portion of the flower, and that is surrounded and overtopped by a number of rods, bearing at their extremities sacs of pollen, this constituting the male element. When a grain of pollen, either of the same or another flower, enters the central tube, or pistil, fertilisation occurs, and a seed, or pip, begins to form near the base of the pistil. As it develops, the woody substance surrounding it, which is really a portion of the stalk of the tree, gradually swells to a remarkable extent, and eventually forms the fleshy or edible portion of the fruit. We commonly call it the fruit, but it is only a metamorphosed portion of the mother-tree: the real fruit of the tree, the progeny of male and female elements, is the pip. When this is sown in the ground, it germinates, and eventually forms a new tree, which, though probably showing some resemblance to its two parents, will be a new variety, and will not bear apples of the same sort as the mother-tree. One reason which makes it all the more improbable that a pip will give rise to a tree bearing fruit like that of the mother-tree, is that in many cases the female portion of the flower cannot be fertilised except by pollen from a tree of a different variety.

As it is impossible to reproduce a fruit-tree of any given variety from seed, other methods of multiplication must be adopted, namely budding or grafting. A young tree of a similar character is taken (the stock), and in the one case a bud, or in the other case a twig (scion), from the tree to be propagated is united with the stem of the stock. All the growth arising from this bud, or buds, is similar to that of the tree from which it was taken; the stock acts as little else than a channel for conveying nourishment to the ingrafted buds; yet it does exert a certain influence on the character of the growth of scion. For apples we use two classes of stocks; the one, the crab stock, is obtained by sowing the seeds of crab-apples, and is characterised by forming a scanty number of roots, but these are stout, and have a tendency to obtain deep hold of the ground; the other, the paradise stock, is derived from a French variety of apple, and forms a much larger number of roots, but smaller, and tending to spread out near the surface of the ground. The grafted tree partakes of the character of the roots of the stock; on the paradise stock it becomes more spreading in its habit, and grows less vigorously than on the crab stock, and, whilst the former is more suitable for growing trees in the bush form, the crab stock is more suited for standard trees.

In the case of pears, the corresponding stocks are: the pear stock for standard trees, and the quince stock for bush trees.

It must be remembered, however, that the effect of the stock on the growth of a tree is a subsidiary

[1] From a discourse delivered at the Royal Institution on Friday, February 21, by Mr. Spencer U. Pickering, F.R.S.

matter; the characteristics of the growth are mainly dependent on the nature of the scion.

During removal of a tree from the nursery to the plantation many of the roots are destroyed, and nearly all of them are injured. The seat of growth of a root is situated at the extreme tip of the root, the power of multiplication being confined to a few meristematic cells which are centred there, these being protected only by some layers of outer cells, known as the root-cap, which are continually being rubbed off and reproduced from the meristematic cells, as the root forces its way through the earth. The whole root-tip is very minute, and when it is destroyed, growth becomes impossible; but there are certain cells situated at intervals along the roots which are capable of becoming modified and giving rise to new root-tips, just as there are cells in the branches capable of developing into buds if all the visible buds of a tree are destroyed.

When a tree is removed from the soil, most of the root-tips will inevitably be broken off, and the rest will become dried up by exposure to the air, so that the damage to the roots must be serious. But the well-being of a tree depends on the balance between roots and branches, both of which supply certain, but different, elements necessary for growth, and this serious damage to the roots can only be counterbalanced by damaging the branches to a corresponding extent. This is done by severely pruning the branches, cutting them back, as it is termed, to about one-third of their length. The effect of omitting this operation is often disastrous; the tree may become permanently stunted, and even, in the case of plums, which tend to bear heavily after moving, it may be fatal.

Though good horticulturists agree as to the necessity of cutting back after transplanting, they differ as to the time when this should be done. The results of our experiments on a large number of trees show that the time of cutting back makes little difference to the ultimate size of the tree, so long as it is not performed while the tree is in active growth. If it is done in the summer, however, the tree receives a serious check, from which it does not recover for at least the next seven years. Deferring the cutting back until the following winter does not give the tree any such check as regards its growth, but it affects its fruiting. Such deferred cutting back is generally followed in the second year by vigorous growth, the tree making up for the absence of growth during the first year, and it perseveres in this habit of growing in subsequent years, when it ought to be growing and fruiting as well.

Passing on to the question of the annual pruning of a tree; it is a common belief that the more you prune a tree the more it will grow. It seems fairly obvious that, even if true at all, this must be true only within certain limits; and, as applied to young, freely growing trees, it appears to be quite untrue. Various plantations of similar trees at Woburn have been systematically pruned to different extents during the seventeen years since they were first planted, and the photographs of average specimens from these plantations are sufficient to show that, as regards the general size, the trees which have never been pruned are larger than those which have been pruned moderately, and these again are larger than those which have been pruned hard. What may be noticed as to the latter is that it is a sturdier tree than that pruned moderately, the trunk and main branches having gone on swelling, while the extension of the branches was prevented by the severe pruning. On the other hand, the unpruned tree, as might naturally be expected, is somewhat straggly and not well shaped.

Another experiment will illustrate the extent to which pruning is opposed to growth. Four strictly similar twigs, 36 in. long, were selected on the same tree: one was not cut back, the others were shortened to 24, 12, and 6 in., respectively. At the end of the following season the weight of these twigs (taking the average of many series) was in the proportion of 562 : 310 : 178 : 100, and from every point of view the growth of the twigs had been greater in proportion as they had been less pruned (Fig. 1). In addition to this, it was found that there were more fruit-buds, and, therefore, a greater promise of fruit, the less the twigs were pruned; the relative proportions of fruit-buds in these cases were 314 : 238 : 165 : 100. That this promise is actually fulfilled in practice is proved by the records of the crops borne by plantations of similar trees which have for many years been pruned to different extents. In one case these plantations contained three different varieties of apples; it was found that during the first five years, and also during the second five years, the unpruned trees bore twice as much, and the hard-pruned ones little more than half as much, as the trees which had been pruned moderately. These trees were on the paradise stock; but the same was found to be the case with apples on the crab stock, for we have another plantation where 117 different varieties of apples are grown, four trees on the one stock, and four on the other; in each case one-half of them have been pruned lightly, and one-half heavily, and in both cases the crops from the latter have been less than one-half of those from the former.

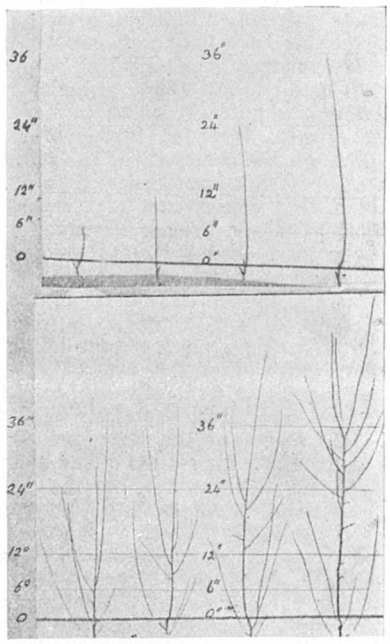


FIG. 1.—Four similar shoots cut back to different extents, showing the different growth made by them.

What has surprised us is that the heavier crops in these cases have not been accompanied by any serious diminution in the size of the individual fruits.

It is thus established as a fundamental principle, that the less pruning there is, the more will a tree grow, and the more fruit will it bear. But this does not mean that we should dispense with pruning altogether. The chief object in training a young tree is to make it sturdy and well-shaped, so that it will be capable of bearing a heavy crop when it comes to full maturity; to effect this, the extension of the branches must be checked so as to give the stem and main branches time to fill out, and occasionally a branch will have to be removed altogether, either to admit light and air into the tree, or to prevent it rubbing against other branches. To what extent this pruning should be carried, and for how long it should be continued, must depend on the habit of the tree. Instances of injury through the absence of pruning may be seen in nearly any farm orchard throughout

the country; but examples of over-pruning are almost as general, and are to be found in most private gardens, where the stunted trees throw out every year thickets of twigs, serving no other purpose than that of feeding the bonfire.

Besides the annual branch-pruning there are other operations included under the term pruning, but the only one to which I can now allude is root-pruning. In this the roots are unearthed and cut back, with the view of increasing the fruitfulness of the tree. The check which such an operation gives to the growth is very severe, and if carried to excess, will kill the tree entirely. It is evidently one which should be undertaken only in very exceptional circumstances, such as where the tree is showing rampant growth, and will neither flower nor fruit. We hear little of root-pruning except in private gardens, and we should scarcely ever hear anything of it there if a more rational system of branch-pruning were adopted. When the branches are cut away to an excessive extent, the balance between branch and root can only be restored by cutting the roots away too. But to injure the tree in one way, and to attempt to correct matters by injuring it in another way, is not a very intelligent procedure.

Passing to the problems connected with the transplanting of a tree; during this operation many of the old root-tips are torn off in lifting the tree, but others are killed by becoming dried up on exposure to the air. Some exposure is always inevitable, and in most cases several days elapse between the lifting and the planting of a tree. It is of great importance, however, that this exposure should be reduced to the narrowest limits. A number of trees were lifted at Woburn, and some of them were replanted at once, whilst others were left in a shed for four days before doing so, and it was found that the latter made only four-fifths as much growth as the former during the following season. It is on this account that planting trees in the spring should be discountenanced, as drying winds are then more prevalent; but if this drying effect is avoided, it is immaterial when the planting is carried out: similar trees planted at different times between November 28 and March 3 were found to do equally well.

Much stress is always laid by horticulturists on the importance of selecting trees with a good supply of fibrous roots, and of taking the utmost care of these roots, spreading them out, and shaking the earth lightly between them. But such precepts are based on ignorance as to the principles of root-growth. Nine-tenths of these roots have lost their tips, they are useless, and as good as dead, for they certainly will die in a very short time. Anyone can satisfy himself on this point; it is only necessary to mark a few of these roots by tying strands of silk round them, and on lifting the tree again at the end of the season it will be found that the rootlets have all, or nearly all, died, and that in their place a new system of rootlets has arisen from the thicker portions of the older roots. In fact, we have found that trees do better if the smallest of the fibrous roots are removed before planting, and also if all the roots are shortened to a certain extent. The reason of this is, not only that it is well to remove parts of the tree which are bound to die, but that the new rootlets which form will be more vigorous if they originate from the thicker portions of the old roots, where the store of material for their nourishment is greater. The practice of leaving the roots as long as possible, and carefully trimming their ends, is quite a mistaken one, for the ends of these roots, having lost the root-tip, cannot start into growth again, and it has been found that of the new rootlets which originate, only some 15 per cent. arise from the neighbourhood of the ends of the old roots, the rest originating from higher up towards the stem, or even from the stem itself.

Two other conclusions may also be drawn from what has been mentioned, namely that it can make little or no difference to the future welfare of the tree whether the ends of the old roots are trimmed, or left jagged and torn as they are when removed from the nursery, nor whether these roots are carefully spread out in the ground, instead of being huddled into the hole prepared for them; for it is the new rootlets which are to be formed, and not the old ones, on which the future life of the tree depends. Both these conclusions have been verified by actual experiment. Even when the roots were twisted and tied together in a bundle, the tree did just as well as when they were spread out in the orthodox fashion.

It is thus seen that all these practices which are supposed to be essential to the proper planting of a tree are really immaterial, and, in fact, that the violation of them within certain limits is beneficial. But the benefit was not sufficient to explain certain results which we obtained, and which puzzled us for many years. We had made a plantation in which, by way of demonstration, the trees had been planted in violation of all the accepted canons, and we expected that these trees would afford an awful lesson to the careless planter. But instead of that, they flourished rather better than their carefully planted neighbours. The results were naturally set aside as accidental, and a repetition, and subsequently many repetitions, were made; but the roughly planted trees refused to behave badly, and flourished so much more than their neighbours that they often showed two or three times more growth than these did. The principal cause of this was eventually traced to the fact that the soil round these trees had been heavily rammed at the planting, instead of being shaken over the roots and merely pressed down. When we consider that the welfare of the transplanted tree depends on its sending out new rootlets from the old roots, it is evident that anything which brings the soil into intimate contact with these roots will be beneficial, and ramming the soil down, especially if it is in a wet condition at the time, will do this more effectually than could ever be done by the gentler method of planting. These somewhat surprising results, therefore, receive a simple explanation, and it is easy to satisfy ourselves, by lifting the trees at the end of a year, that the rammed trees have actually formed more new roots than those carefully planted. Such novel methods of planting naturally excited the wrath of horticulturists, who, as a body, are inclined to carry the veneration for traditional procedure to excess, and we were careful to obtain overwhelming evidence as to the facts before publishing our results. Some seventy sets of experiments were made, in which about 2000 trees were used; the soils in which the trees were planted being of every variety, and situated in eight different counties. Naturally, the results varied, but the average of them showed that ramming might be expected to increase the growth of the tree by nearly 50 per cent., during the first or first two years, at any rate in heavy or fairly heavy soils. In a light sandy soil it naturally had no effect, for the obvious reason that, by the time the tree started into growth, any consolidation of the soil caused by the ramming would have disappeared. In one case only were the results of ramming very bad, and that was in the London clay, where the absence of aëration caused sulphuretted hydrogen to be developed. In other clay soils, no such results ensued (the Woburn farm itself is on the Oxford clay).

That trees will not flourish unless the soil in which they are growing is sufficiently aërated, is well known.

And this is the reason why a tree, when planted, should not be buried deeply in the soil; but a latitude of a good many inches in the depth at which it is planted has been found to make no difference, because the new roots, on which the life of the tree depends, form most readily at whatever depth is most suited to their development, or if they form at other depths, they soon make their way to the most favourable level.

The fact that roots flourish best at some particular level not far below the surface (the depth varying in different soils) is the explanation of some results which appeared to show the exact contrary. A number of paradise stocks were planted with their roots at various depths from 6 to 24 in. below the surface, and it was found that those which had been buried deepest, although they were the most backward at first, rapidly outstripped the others, and in two years had made twice as much growth as these had done. On lifting the trees the reason of this was apparent; in the case of those which had been planted at the ordinary depth, the root-system of the trees was the same as that which they had possessed when planted, though more developed (Fig. 2), whereas, with the buried trees, the original roots, finding themselves at an unsuitable depth, had not developed, but in their place numerous fresh roots had developed from the stem of the tree itself (Fig. 3), and these, finding ample food-material stored in the stem, had developed strongly, and formed a vigorous root-system, with the natural accompaniment of vigorous branch growth. Such results, depending as they do on the ability of the tree to send out new roots from its stem, would not be obtained if a grafted tree were buried in the same way, for roots do not easily arise from the stem of such a tree; indeed, when the experiment was made with crab-stocks instead of

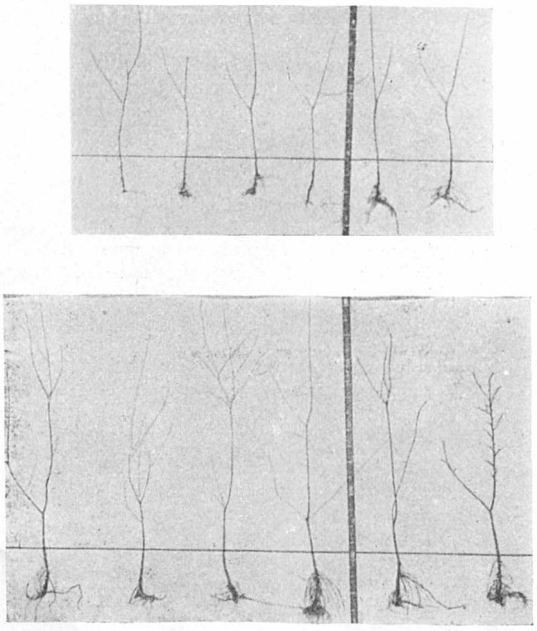


FIG. 2.—Apple stocks planted 6 inches below the surface, and lifted two years afterwards.

paradise-stocks, the results were unfavourable, for the crab-stock does not root so easily from the stem as does the paradise-stock. Thus, these experiments are the reverse of showing that an ordinary fruit-tree should be planted at a great depth.

It will be seen that all the anomalous results which have been obtained on the subject of planting are easily explained by, and are the natural consequences of, the fact that a tree when transplanted has to form a new root-system before it can begin to grow again,

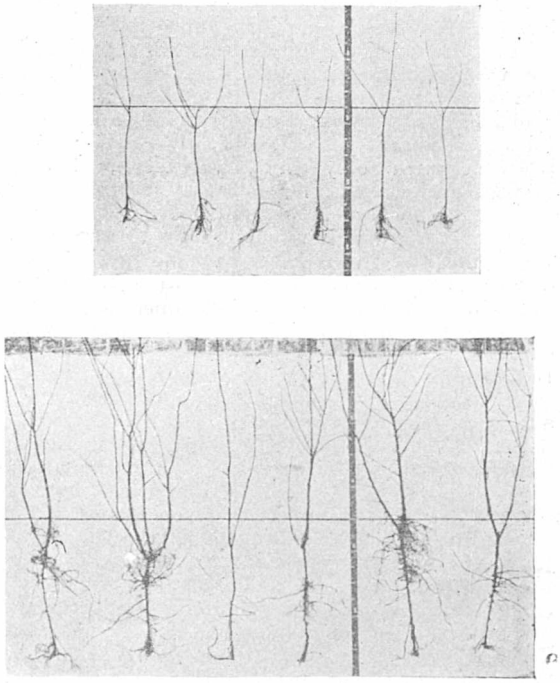


FIG. 3.—Apple stocks planted 24 inches below the surface, and lifted two years afterwards.

and if this is but kept in view, the whole subject becomes simplified, and the reason becomes evident why many of the practices supposed to be essential to the proper planting of a tree do not bear the test of actual experiment.

EXPLORATIONS AND FIELD-WORK OF THE SMITHSONIAN INSTITUTION IN 1912.

FOLLOWING the custom established in 1911, the Smithsonian Institution has issued an illustrated pamphlet dealing with the scientific expeditions conducted under its direction, or in which its representatives participated. The pamphlet describes the work of about twenty different parties.

The institution was represented by two small parties in Borneo—those of Mr. H. C. Raven, who has been collecting mammals and ethnological material in Dutch East Borneo for the past two years, and Mr. Daniel D. Streeter, of Brooklyn, N.Y., who has served as a collaborator for the National Museum in the collecting of mammals, in a trip through Sarawak and Dutch Borneo.

Dr. W. L. Abbott, who financed the Dutch East Borneo Expedition under Mr. Raven, and has presented many large collections to the National Museum, has been carrying on a personal investigation in Cashmere, where he has been trapping and studying the smaller mammals of that country, specimens of which have been sent to the museum.

Through the invitation of Dr. Theodore Lyman, of Harvard University, the institution was enabled to cooperate with the Museum of Comparative Zoology in an expedition to the Altai Mountains of Siberia and Mongolia. Mr. N. Hollister represented the National

Museum. The party spent nearly five months in the field, returning with fine series of mammals and birds from this little-known part of Central Asia. Of especial interest in the series of big-game are four rams of the largest known of the wild sheep, as well as specimens of two forms of ibex, and a gazelle. Out of a total of about 650 mammals in the collection, eleven forms are new to science, and some twenty were not previously represented in the National Museum. Mr. George Mixter also visited Siberia, where he secured certain mammals from the region about Lake Baikal, among them bear and seal.

Of particular interest was a trip made by Dr. Ales Hrdlička to Siberia and Mongolia, to study the physical anthropology of the natives. His main object was a search for data concerning the race which is supposed to have peopled America. He gathered extensive information and collections, from which he draws the conclusion that there exist in several places in Siberia, Mongolia, and Tibet numerous remains of an ancient population which was physically identical with, and in all probability gave rise to, the American Indian.

The hunting trip carried on by Mr. Paul J. Rainey in British East Africa, in which the institution was represented by Mr. Edmund Heller, was very successful; nearly 4000 mammals, 1000 reptiles, and 400 birds were obtained, as well as many land shells and botanical specimens. From the collection, which supplements that of the Smithsonian African Expedition, there have been as many as forty new species and twelve new genera described.

The Astrophysical Observatory of the Smithsonian Institution again sent an expedition to Bassour, Algeria, for the continuation of the observations relative to the heat of the sun, an investigation on which the observatory has been working for the past seven years, with observing stations on Mt. Wilson, California, and during two seasons in Algeria. Mr. Abbot, the director of the observatory, states that the results of the work of 1911 and 1912 thoroughly establish the supposed variability of the sun.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—The scheme for the administration of the East London College, a school of the University of London in the faculties of arts, science, and engineering, was sealed by the Board of Education on August 15. It establishes a governing body of nineteen members, nine of whom are representatives of the Drapers' Company, the body from which the college derives rather more than half its annual income; three representatives of the University, one of whom must be a woman, with the principal of the college *ex officio*, two of the Academic Board, which consists of the principal members of the teaching staff, one of the London County Council, and three coopted members. The representatives of the University are Lady Busk, Principal Sir Henry Miers, F.R.S., and Mr. F. D. Acland, M.P., Under-Secretary for Foreign Affairs, who is a member of the Senate of the University.

MR. HAROLD PEALING, Liverpool, has been appointed lecturer in physics in the South African College, Cape Town.

PROF. W. H. YOUNG, F.R.S., has been appointed Hardinge professor of mathematics in the University of Calcutta, for the purpose of organising a new school of higher mathematical thought and research. Prof. Young is retaining his chair in Liverpool University.

WE learn from the Allahabad *Pioneer Mail* that at a meeting of the Bombay University Senate on July 26 Sir Alfred Hopkinson, K.C., until recently Vice-Chancellor of the Victoria University of Manchester, was appointed expert adviser on university teaching to the University for a period of six months.

THE calendar for the session 1913–14 of the Merchant Venturers' Technical College, Bristol, is now available. It will be remembered that the faculty of engineering of the University of Bristol is provided and maintained by this college, which, in addition, includes a secondary school for boys and a comprehensive series of evening classes in science, technology, and commercial and other subjects. The evening courses of work in technology have been arranged to meet the special needs of engineers, men engaged in the building trades in general, carpenters and joiners, plumbers, and painters and decorators. Saturday afternoon classes for miners have been arranged by the Gloucestershire and Bristol Education Committees and are given in the college. In addition special courses of instruction for women in domestic subjects are provided.

THE Education Committee of the Staffordshire County Council has published its "Directory for Higher Education, 1913–14." The booklet contains the regulations of the committee and details of schemes of work in operation throughout the county. Instruction in mining is provided by means of lecturers, whose whole time is devoted to the work, and their assistants. For this purpose the county is divided into two portions, comprising the North Staffordshire coalfields and the South Staffordshire coalfields respectively. Classes in metallurgy and iron and steel manufacture are conducted in accordance with the regulations of the Board of Education and the City and Guilds of London Institute. Classes in pottery and porcelain manufacture have been arranged at Burslem, Hanley, Longton, Stoke, and Tunstall. Boot and shoe manufacture, silk manufacture, horticultural and smaller agricultural industries are each to be taught in suitable centres. The directory also gives particulars of the numerous scholarships awarded by the committee, the holiday courses arranged, and the steps taken to provide suitable technological instruction in the rural districts.

PARTICULARS have been issued by the Royal Horticultural Society with reference to the examinations for the national diploma in horticulture, which, so far as possible, will be held in the latter part of June of each year. The scheme, which has been approved by the Board of Agriculture and Fisheries, sets forth that candidates for the diploma must (*a*) register themselves with the society, and (*b*) pass two examinations, a preliminary and a final. The examinations are open to both men and women. The preliminary examination will be based upon the general principles of plant-growing, an elementary knowledge of botany, chemistry, and physics, so far as acquaintance with these subjects is essential to an understanding of garden practice. Care will be taken to ascertain that the candidate is able to perform the operation of gardening with proper skill, and also that he understands the reasons for the methods employed. The syllabus for the final examination will be divided into sections each dealing with one particular branch of horticulture. Candidates may enter for the branch in which they feel themselves most proficient. All particulars, forms, &c., may be obtained from the secretary of the Royal Horticultural Society, Vincent Square, S.W.

THE calendar of the Royal Technical College, Glasgow, for the coming session contains details of the scheme affiliating the college to the University of

Glasgow. The college retains its autonomy in all matters relating to its internal affairs—finance, appointment of staff, and so on—but it has no representation in the Court of the University. An advisory committee has been set up, consisting of members of the University Court and representatives of the college, which will consider all matters affecting their joint interests. A joint board of studies in the faculty of applied science is provided, and will consider all matters relating to the subjects and standard of the several courses. The degree examinations will be conducted by a board of examiners representative of both institutions, with external examiners appointed by the University Court. Students will be free to attend the classes constituting the courses of study in either the University or the college, or in both, the fees being the same. The combination and coordination of the resources of the University with those of the college should be to the advantage of both. The University of Edinburgh, too, has recognised the day classes of the college as qualifying for its degree of bachelor of science under certain regulations.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 18.—M. A. Chauveau in the chair.—M. **Borrelly**: Notes on Hind's nebula. This nebula is now at a maximum period of brightness.—M. **Aries**: The formula for the velocity of sound. Reply to M. Duhem.—MM. **Massol** and **Faucon**: The presence of absorption bands in the ultra-violet spectrum of some abnormal alcohols of the fatty series. The study of pentane and some derivatives of methylpropane and methylbutane shows that the two absorption bands previously found in the three primary alcohols do not appear in the corresponding hydrocarbons; the halogen derivatives are also free from bands. The aldehydes give one large absorption band intermediate in position between the two alcohol bands.—Paul **Godin**: Free thoracic and abdominal respiration in the course of growth.—De Montessus de **Ballore**: Remarks on the earthquake at Gallipoli, August 9, 1912.

BOOKS RECEIVED.

A History of British Mammals. By G. E. H. Barrett-Hamilton. Part xiv. Pp. 361–408+plates. (London: Gurney and Jackson.) 2*s.* 6*d.* net.

Handbuch der Vergleichenden Physiologie. By Hans Winterstein. Lief. 36. Zweite Hälfte. (Jena: Gustav Fischer.) 5 marks.

Świat I Cztowick. By Dr. J. Mianowskiego. Pp. 355. (Warsaw.) 2 rub.

A Treatise on Quantitative Inorganic Analysis. By Dr. J. W. Mellor. Being vol. i. of a Treatise on the Ceramic Industries. Pp. xxxi+778. (London: C. Griffin and Co., Ltd.) 30*s.* net.

The Application of Physico-Chemical Theory to Technical Processes and Manufacturing Methods. By Prof. R. Kremann. Translated from the German by H. E. Potts, and edited by Dr. A. Mond. Pp. xv+212. (London: Constable and Co., Ltd.) 8*s.* 6*d.* net.

Botany. By Prof. E. Brucker. Pp. xv+185. (Thresholds of Science Series.) (London: Constable and Co., Ltd.) 2*s.* net.

Ministere de l'Agriculture. Direction Générale des Eaux et Forêts. Service des Grandes Forces Hydrauliques. (Région du Sud-Ouest.) I., Comptes rendus des Opérations Effectuees. II., Résultats Obtenus pour le bassin de l'Adour au 31 Décembre, 1910. Tome i. Pp. 262+plates. Résultats Obtenus pour le bassin de la Garonne au 31 Décembre, 1910. Tome ii. Pp. 515+plates. 2° Partie Eaux et Améliorations Agricoles. Service des Grandes Forces Hydrauliques. (Région des Alpes.) Comptes rendu et Résultats des Etudes and Travaux au 31 Décembre, 1911. Tome vi. Pp. 494. Annexe du tome vi. Nivellements.

Ist es Wahr dass 2×2=4 Ist? By Fred Bon. Erster Band. Pp. xxviii+523. (Leipzig: E. Reinicke.)

British Rainfall, 1912. By H. R. Mill. Pp. 372. (London: E. Stanford, Ltd.) 10*s.*

A New School Geometry. By R. Deakin. Part ii. Pp. viii+161–202. (London: Mills and Boon, Ltd.) 1*s.* 6*d.*

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