THURSDAY, APRIL 15, 1909.

POPULAR SCIENCE.

(1) *Astronomy of To-Day. A Popular Introduction in Non-Technical Language.* By the late Dr. Cecil G. Dolmage. Pp. 362; illustrated. (London: Seeley and Co., Ltd., 1909.) Price 5*s.* net.

(2) *Scientific Ideas of To-Day. Popularly Explained.* By Charles R. Gibson. Pp. 344; illustrated. (London: Seeley and Co., Ltd., 1909.) Price 5*s.* net.

(1) WHILST possessing a thorough knowledge of any science, it is often found to be a difficult matter to coordinate one's facts so that the novice shall be at once sufficiently interested and efficiently instructed; but the former of these two works demonstrates to us that the ideal is not unattainable; the late Dr. Dolmage succeeded in a task in which so many writers have failed.

By the arrangement of the various branches of the subject, the reader is ever led from coordinated generalities to the more specific details, and is always prepared for what he is reading by the knowledge acquired from the previous chapters. Thus, while the general features of the solar system are expounded in the third chapter, the various members of it are not discussed in fuller detail until chapters xii.–xviii., the reader meanwhile being prepared for this fuller treatment by carefully reasoned chapters on gravitation, celestial distances and magnitudes and their measurement, eclipses, the evolution of methods of observation, and spectrum analysis.

Occasionally it appears that the endeavour to employ only popular language has resulted in some ambiguity. Thus the term "thicker" is applied to the sun's successive layers when, as shown in the succeeding paragraph, "denser" was presumably intended; but such slips are few in number and, to the general reader, comparatively unimportant.

In describing the planets the author accepted the conventional terminology, but protested against the use of "inferior" and "superior" instead of the more generally descriptive terms "interior" and "exterior"; certainly for the general reader the latter terminology appears to be preferable.

The discussion of Martian features, and their imports, is a difficult one for any writer of the present day to tackle, but in this volume the reader is given a very clear and concise statement of the various theories and their corroborative observations.

The chapters which follow deal in the same popular—yet scientific—manner with comets, meteors, the stars and the universe, and an interesting volume is brought to a close by two chapters dealing respectively with the beginning and the ending of things, the latter containing a graphic, if terrifying, picture of the collision of a dark sun with the solar system.

The twenty-four illustrations and twenty diagrams have been carefully chosen and well reproduced, and, with the clear statements of the text, they should certainly open the eyes of the "general reader" to most of the wonders of the universe surrounding him.

(2) Mr. Gibson's work, a companion volume of the "To-Day" series, is also intended for readers whose acquaintance with the latest concepts relating to the matter and motion around them is of the "general" order, and a great deal that has been said above concerning the good arrangement and clear statements of Dr. Dolmage's work may also be said of this volume.

The author's ideal is to explain in popular language how the matter around us is built up and how the energy affecting that matter is transformed, transmitted, and received. No previous knowledge of science or mathematics is assumed; all that the reader has to do is to take the subjects in the order in which they are discussed; he will then find that no serious difficulties occur because his previous reading has prepared him for what follows.

A marked feature of this book is the number of analogies by which the various actions and interactions are illustrated. These are selected from everyday life, and are always apt and illuminating, so that totally new ideas concerning, say, the construction of the atom, the nature of electricity, the causes of radio-activity, and like subjects are always clothed in a familiar garb.

The subjects dealt with are too diverse to treat *seriatim* in a brief notice, but they may be classified under the headings matter and its construction, the nature, measurement, and perception of various forms of radiation, energy and its transmission, gravity, the *aether*, and the origin of life. We are thus introduced to the latest ideas concerning electrons, the dissociation and association of atoms, radio-activity, spectrum analysis, action at a distance, and the origin of life and matter. In every branch the author remembers that he is endeavouring to reach minds previously ignorant of such matters, and is, therefore, very careful in his selection and definition of terms. Thus, for example, in order to avoid any possible ambiguity, he prefers "electrons" to "corpuscles," and employs "*aether*" instead of the "ether" now so often used, and in these and similar cases he discusses the reasons for doing so.

Four appendices give further information on various subjects, and should prove very useful in supplementing the necessarily brief explanations in the book itself. The first of these gives the ingredients of the world, *i.e.* the elements, their atomic weights, and the order, with dates, of their discovery. That these lists have been carefully prepared is illustrated by the fact that, in the last, helium is mentioned twice; discovered in the sun, by Lockyer, in 1868, and on the earth, by Ramsay, in 1895. Appendix ii. outlines the history of the modern theory of light, iii. gives particulars of *aether* waves, and iv. describes, more fully, the methods by which invisible electrons are counted and measured.

The forty illustrations are admirable; instead of the old-fashioned diagrams, with which he has been regaled so often, the general reader will find here reproductions of actual photographs, either of working apparatus showing just how the experiments are performed, or illustrating clearly the results obtained.

These, with the concise and illuminating descriptions in the text, should give any reader of ordinary intelligence a very fair idea of the marvellous discoveries of modern science regarding the things and movements around him.

WILLIAM E. ROLSTON.

RARE ELEMENTS.

Introduction to the Rarer Elements. By Dr. Phillip E. Browning. Second edition, thoroughly revised. Pp. x+207. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1908.) Price 6*s.* 6*d.* net.

DURING the last few years our knowledge of the chemistry and properties of the rarer elements has been largely developed, and the scientific and commercial interests connected with them having assumed considerable importance, the publication of a second edition of the above useful handbook is to be welcomed.

The scheme of the work remains the same as in the edition of 1903; with each element an account is given of its discovery, occurrence, extraction, properties, &c., concluding with more or less voluminous details of experimental research work. The revision has been very thorough; some matter dealing with supposed elementary substances, the existence of which has since proved more than doubtful, has been removed—for example, the so-called elements etherion, lucium, glaukodymium, &c. A chapter on radio-elements by Dr. B. B. Boltwood is included, and the section on rare earths has been largely increased, and much valuable matter added to it.

The description of niobium and tantalum has been brought up to date, and all that is known of the latter interesting and very valuable metal, with its chemistry and unique properties, is given. The gases of the atmosphere, argon, helium, krypton, neon, and xenon, with their history and properties, are described in detail, and several pages are devoted to an account of some of the technical applications of the rarer elements which greatly emphasises the importance of research among these practically unknown substances; the book concludes with a series of tables for the qualitative separation of the rarer elements.

Speaking generally, as might be expected from the repute and position of the author, the work is thoroughly practical and trustworthy, and is confined to a brief description of known facts, the author having wisely refrained almost completely from touching upon the huge mass of speculative matter that has unhappily been woven into this branch of chemistry; no mention is made of the alleged transmutation of copper into lithium by radium emanation, and no surmises are given of the results that may be expected to follow the production of so many pounds of radium, &c.; in fact, the brevity is carried to an extent that is almost to be regretted, but what is given is to the point. The chapter on the radio-active elements commences with a brief account of the discovery of radio-activity by M. Henri Becquerel, and of radium by P. and S. Curie and G. Bemont, with the properties of uranium, ionium, actinium, thorium, &c., and the section concludes with a table of radio-activities giving the "radiation emitted," "disintegration constant," and "half-value time period" for all the known radio-elements.

Much valuable matter has been added to the section on rare earths; a list is given of more than 170 rare-earth minerals, with the composition, percentage of yttria, ceria, thoria, and zirconia, so far as is known in each case; and in the portion dealing with the chemistry, a diagrammatic scheme for their separation is shown; this diagram is a novelty, and will be found a distinct help in elementary work on rare earths, but considering the obscurity that undoubtedly still surrounds the reactions of many of these bodies it can only be taken as suggestive.

It is much to be regretted that little or nothing is said about the spectra of these obscure bodies, particularly as it is by the study of their spectra that most of them have been recognised and isolated; the extremely characteristic spark spectra of yttrium, samarium, europium, ytterbium, scandium, and other elements are passed over without notice; when we take as only one instance the fact that the very rare element scandium can be directly detected in minerals containing it by a single observation, this is the more remarkable.

We may give as an instance of the present activity of research among the rare earths the fact that since this edition went to press the announcement has been made by G. Urbain and by Auer von Welsbach of the decomposition of ytterbium into two distinct substances.

It is a very great pity that the work has not been properly indexed; brevity in this direction is a decided disadvantage, and takes much from the usefulness of the work.

J. H. G.

A GENERAL HISTORY OF SCIENCE.

Aus der Werkstatt grosser Forscher. Allgemeinverständliche erläuterte Abschnitte aus den Werken hervorragender Naturforscher aller Volker und Zeiten. By Dr. Friedrich Dannemann. Dritte Auflage. Pp. xii+430. (Leipzig: W. Engelmann, 1908.) Price 6 marks.

DR. DANNEMANN'S book represents an attempt to trace the gradual growth of scientific knowledge by a superficial examination of critical epochs in which some new discovery has been made available or some truth apparent. It seems a very desirable, as it is a very pleasant, task to survey the whole history of natural science, to recall the men whose genius and achievements have widened the outlook, and given force and direction to new researches. Such a study may be pleasantly impressive and momentarily stimulating, but while it lacks in thoroughness and precision its educational value must be small. A student of a particular department of science should know, it is true, the successive stages by which that subject has advanced, and the author is quite justified in intimating that the study of the original memoirs in which the great masters have developed their results, in the language in which they have expressed themselves, is eminently calculated to present the clearest insight into the processes that have been employed and the reason for the direction which progress has taken. It is a long cry from the ancient Greek to the modern physicist, from Aristotle to Pasteur, and by a few scanty references to the work of eminent men in past centuries we do not get any continuous picture of the growth of any one science, be it physics or chemistry, zoology or botany, geology or astronomy, for all these and some others figure within the modest compass the author allows himself.

A comparison with Ostwald's "Klassiker der Exacten Wissenschaften" would be inevitable, even if the author had not frequently directed attention to that work, and occasionally availed himself of its contents. Such comparison is, however, to the disadvantage of the present work. In that case, the classics of science hitherto accessible only to the few were made available to the many. Specialists, each eminent in his own branch of science, were responsible for the presentation of the work, each in his own department, to which ample space was allotted. But here the only arrangement that can be recognised is roughly chronological, and the student is led from subject to subject without leisure to concentrate his attention upon any. Perhaps there is no great reason to quarrel with the choice of researches the author has made in order to illustrate particular phases in the history of discovery. No selection could be entirely satisfactory when there is overlapping of research or contemporaneous advance. Why, for example, should Torricelli be omitted and Guericke appear, or Celsius be chosen in preference to Reaumur? Sir William Herschel finds a place, Bradley does not; Chladni discusses the origin of meteors, Schiaparelli is passed over in silence. One might ask whether Humboldt and Goethe fairly come within this scheme, or whether Darwin is adequately represented by an extract from the "Journal of the *Beagle*," or Helmholtz by a quotation from a popular lecture? But it would be unfair not to remember and admit that this work is only a portion of a larger treatise. It is the first volume of a "Grundrisz einer Geschichte der Naturwissenschaften," and possibly if the whole treatise were before us the scheme could be better appreciated.

SANITARY SCIENCE.

The Essentials of Sanitary Science. By Gilbert E. Brooke. Pp. xii+413. (London: Henry Kimpton, 1909.) Price 6*s*. net.

THE author of this work states in his preface that he hopes it will meet its aim of covering all the necessary ground for the student preparing for the diploma of public health, and that he has endeavoured to make it as useful in the laboratory as in the study; furthermore, he hopes it may also be useful to sanitary officers and medical officers of the public services. A glance suffices to make it plain that he has not achieved his aim. He has failed because he attempted the impossible when he set himself the task of covering the whole range of the science and practice of hygiene and public health within the narrow compass of a small, handy volume. The work is, in fact, little more than a digest or summary, which is not suited to the student's needs, and the lack of detail is also an essential respect in which it will fail to meet the needs of the public-health official. It is not sufficient, for instance, to tell the student for the diploma of public health that in reference to the working of a barometer, corrections have to be made for capillarity, temperature, and altitude (p. 29), when his examiners expect him to know how these corrections are made; nor is it sufficient to offer a sanitary official, presumably for reference purposes, a digest of sanitary law in which the whole of the important and complicated subject of legislation dealing with the food supply is dismissed in a page and a half of printed matter.

Although the general scrappiness of the information so materially limits the value of the book to the student and practitioner alike, it possesses some good points which add to one's regret at having to criticise unfavourably the work as a whole. Little fault can be found with the selection made of the material dealt with. Indeed, for the most part it is wise and in good proportion; but a glaring exception to this rule is to be noted in the case of tuberculosis, which is not mentioned in the index, and is only referred to in connection with dust and milk in the text of the book. Again, there are few instances of inaccuracies—the faults of commission, in fact, sink into insignificance before the all-prevailing faults of omission; but an insufficient statement of the subject is often responsible for leading the student by implication to erroneous conceptions. In this connection the author's attention is directed to the fact that for the purpose of aërobic bacteriolysis it is not usual to put a layer of sand on the top of the filter and another layer at the bottom immediately over the effluent pipes; nor is the average composition of crude sewage in this country represented by albuminoid ammonia in the amount of 0·28 of a part per 100,000.

It is conceded that a vast amount of information is comprised within the small compass of the work, but it is information of a scrappy and incomplete order, and information in respect of which essentials, both from the standpoint of the student and practitioner, are omitted. As evidence of the justice of this statement it is not necessary to do more than direct the reader's attention to the fact that the bacteriological examination of water is dismissed in three and a half pages, or not much more than 100 lines of print; that to the chemical examination of disinfectants three-quarters of a page of printed matter is devoted, and carbolic acid is the only disinfectant dealt with; and that the important subject of school hygiene, the importance of which to the public-health student cannot well be exaggerated now that the Education (Administrative Provisions) Act is a force in the land, is dismissed in four pages.

Dr. G. E. Brooke has had experience both as a health officer and a teacher, and is the author of one or two useful handbooks, and he must realise that this work stands in need of a considerable extension if it is to meet the objects for which it was designed.

CRUSTACEA OF NORWAY.

An Account of the Crustacea of Norway. By Prof. G. O. Sars. Vols. i.–v. Vol i., Amphipoda. Pp. 708; 248 plates. Vol. ii., Isopoda. Pp. 270; 104 plates. Vol. iii., Cumacea. Pp. 115; 72 plates. Vol. iv., Copepoda Calanoida. Pp. 171; 108 plates. Vol. v., Copepoda Harpacticoida. (Bergen: Published by the Bergen Museum, 1890–1908.)

THE monumental work under the above title by Prof. G. O. Sars, of Christiania, is still being added to, although the first parts appeared so long ago as 1890. It is indeed no small task that the distinguished author has set himself. From the first he proposed to give a description of all the species of Crustacea hitherto known from Norway, and furthermore, to accompany the diagnoses by accurate figures of all the forms. There was no doubt that a work so extensive and so profusely illustrated would prove of great value to all systematic workers, but there was also little doubt that the publication would spread over years, and the work extend to hundreds of pages and a great number of plates. This has proved to be the case, for the most recent parts published (parts xxiii. and xxiv. of vol. v., 1908) bring the total up to 1540 pages of letterpress and 724 plates.

It is seldom that a work of this kind has been so lavishly illustrated, but Prof. Sars rightly urged that trustworthy figures enable a species to be indentified much more easily than the most elaborate descriptions. The plates have been produced by the "autographic" process, and while this falls short of first-class lithography, the figures are all of a good size, and quite sufficiently illustrate the points at issue. Those who have had occasion to use the plates for purposes of identification will agree as to the accuracy and care with which the drawings have been executed.

The first volume of this work—that on the Amphipoda—was published by a Christiania firm during the years 1890–95. The publisher not wishing to continue, there was some danger that the account would come to a premature end, until the Bergen Museum, with commendable public spirit, stepped in and undertook the responsibility of publishing the remaining volumes.

The scientific study of fishery problems is of comparatively recent growth, but nowadays a knowledge of the smaller Crustacea, which are so important a part of the food of fishes, is essential, and it is precisely these forms which Prof. Sars is making recognisable by his valuable work. British fishery experts cannot fail to find these volumes indispensable, for they refer to species a large proportion of which occur also in British waters.

It has been far too generally assumed that the Copepoda is a group containing principally pelagic forms. That this is by no means the case is emphatically shown in the present work. Vol iv., dealing with the Calanoida, which are in the main plankton forms, contains descriptions of sixty-eight species. The yet incomplete fifth volume, devoted to the Harpacticoida, which are mostly true bottom forms, has already treated of 182 species, without by any means exhausting the subject. When completed this will furnish the first adequate account ever published of this very extensive and important group.

Besides giving descriptions of a considerable number of new genera and species, the author has rendered perhaps even greater service by furnishing us for the first time with the means of identifying numerous species established by other writers, but only briefly described, and either unfigured or figured very imperfectly. It cannot be doubted that this work is one of the most important contributions ever made to our knowledge of the Crustacea, and that Prof. Sars deserves the thanks of the scientific world for publishing it in a manner which renders it so readily accessible.

W. A. CUNNINGTON.

BRITISH FUNGI.

Synopsis of the British Basidiomycetes: a Descriptive Catalogue of the Drawings and Specimens in the Department of Botany, British Museum. By Worthington G. Smith. Pp. 531; 5 plates and 145 figures in text. (London: Printed by order of the Trustees of the British Museum, 1908.) Price 10*s*.

A MODERN handbook dealing in a concise form with all the larger British fungi has long been desired by mycologists in this country. The appearance of Mr. Worthington G. Smith's "Synopsis" meets this desire in so far as it contains in one volume descriptions of all the British Basidiomycetes (*sensu* de Bary).

The new work is of a more popular character than either Lister's monograph of the Mycetozoa or Crombie's Monograph of the British Lichens, references to literature and synonymy being omitted. The genera are provided with keys to the species, and the latter bear numbers which correspond to those of Mr. Smith's fine series of coloured drawings in the British Museum. The descriptions are almost without exception confined to field characters, and are for the most part brief. Each genus is illustrated by line drawings. The derivation of both generic and specific names is given, and a full glossary is appended.

As stated on the title-page, the synopsis is a descriptive catalogue of the drawings and specimens in the department of botany in the British Museum, and for this reason the sequence of genera is practically that of Fries's *Hymenomycetes Europoei* (1874). In Fries's arrangement of the Agaricaceæ the large genus Agaricus (comprising groups of subgenera arranged according to their spore-colour) is placed first, followed by a number of other genera, also grouped together according to the colour of their spores. Modern writers have given Fries's subgenera generic rank, and have modified his arrangement so as to bring all the genera together according to their spore-colour. The author of the present work treats Fries's subgenera as genera, but leaves them in the same sequence as the *Hymenomycetes Europoei*. To a number of amateur mycologists who are accustomed only to the more modern method, this arrangement will probably be somewhat inconvenient.

Spore-measurements are omitted throughout the entire work, the author regarding the existing records as untrustworthy. This has to be admitted to a certain extent, but could some of the spore-measurements from recent critical work have been included, the value of the descriptions would have been much increased. Everyone who has paid serious attention to the spores of the larger fungi knows that these structures are often of the greatest help for systematic purposes, and it is to be hoped that before long spore-characters will always form an essential part of the diagnosis.

Novelties in the form of new genera and species are few. Attention may be directed to the new genus Togaria, into which the author has placed all the terrestrial species of Pholiota. The recent additions to the British flora have been incorporated, but it is to be regretted that names now known to be synonyms still figure as independent species. A very large number of changes will be observed in the authorities quoted for the Agaricaceæ. This is due to the fact that the author has followed the Vienna rules with regard to the raising of subgenera to the rank of genera.

The book will be of most help to the beginner, and should prove a useful introduction to the study of Basidiomycetes. In the case of the Agaricaceæ several seasons' experience will be necessary before the student acquires much confidence in determinations derived from book descriptions. The diagrams at the end of Smith's synopsis should aid in grasping the generic features, and the numerous keys should save much time in identifying the species.

A. D. C.

OUR BOOK SHELF.

The Planning of Fever Hospitals and Disinfecting and Cleansing Stations. By Albert C. Freeman. Pp. viii+165. (London: The Sanitary Publishing Company, Ltd., n.d.) Price 7*s*. 6*d*. net.

THIS is a work compiled by an architect more particularly for reference purposes by other architects. It provides a practical guide to the planning of fever hospitals, disinfecting and cleansing stations. It contains a large number of plans showing in detail the construction of many fever hospitals which have been provided during recent years; and although the object of the author has been to place before his readers only those examples which demonstrate the most approved principles of design or other points of special interest, several of the plans reproduce the features of other designs and present no essential differences in the details of construction. Mr. Freeman devotes about thirty-five pages to a consideration of the general principles of design and construction in reference to fever hospitals, disinfecting and cleansing stations, and then devotes the rest of the book to the plans and more important features of construction above referred to. The scheme is a good one; but it is a question whether the purpose of the book might not have been even better served if the author had extended his statement upon the most approved features of design and construction, by giving the reader the benefit of more of the opinions and criticisms of one who has evidently made a special study of this matter, and then presenting the plans and details of construction of about a dozen existing hospitals which are specially commended.

The manual embodies much useful information, and it cannot fail to be of value to those who are called upon to design and construct hospital buildings. On the subject of disinfecting stations the work is not likely to be so generally useful. This section of the book stands in need of extension, and here and there of slight amendment. If, for instance, the various types of steam disinfectors are to be dealt with in such a book, the present statement is insufficient. One of the less well-known steam disinfectors (the Velox) is the only apparatus illustrated, and, indeed, the only one which is fully described. The description, moreover, is not so clear as it might be. On p. 148 it is stated that among the practical advantages claimed for this type of machine is the fact that there is no boiler to require scaling, whereas it is stated in the next paragraph that there is a boiler employed to raise steam.

Photographic Optics and Colour Photography, including the Camera, Kinematograph, Optical Lantern, and the Theory and Practice of Image Formation. By Dr. George Lindsay Johnson. Pp. xii+304. (London: Ward and Co., 1909.) Price 7*s*. 6*d*. net.

THE author is "examiner in photography and theoretical and applied optics to the Spectacle Makers' Company," and states that the primary object of this volume is to cover the ground of this company's examination. The first chapter deals with cameras in a popular rather than a scientific manner. The next two chapters constitute about half the volume, and deal with photographic lenses and the optics relating to their manufacture and use, including the consideration of shutters and artificial illumination. The remaining sections of the book deal with sensitometers, and the other subjects mentioned in the title.

With the exception, perhaps, of the strictly optical part, the various items receive very unequal treatment. Although a whole chapter is devoted to sensitometry, Hurter and Driffield's method, which is the only method stated to be "largely used," is disposed of in the following sentence:—"A sensitometer consisting of a rotating sector, furnished with a ring divided into steps, is now largely used in England, and was invented by Messrs. H. Hurter and Driffield." Dr. Hurter's Christian name was Ferdinand, and his is not the only name given incorrectly. We should like to know what the author means, when referring to the action of light upon a sensitive plate, by the statement that "the light acts on the gelatine substratum and starts freeing the hydrogen." There are many other parts that will certainly mislead the student as they now stand, as, for example, two pages devoted to what appears to even a careful reader to be an attempt to prove by calculation that the focal length of a lens has a direct influence on the relative proportions of the images of objects at different distances. We notice, too, errors in some of the illustrations. The volume needs a thorough revision.

Untersuchungen fossiler Hölzer aus dem westen Vereinigten Staaten von Nordamerika. By Dr. Paul Platen. Pp. xvi+155; with three plates. (Leipzig: Quelle and Meyer, 1908.) Price 3 marks.

THE Tertiary rocks of some of the south-western portions of the United States have been long known to be remarkable for the abundance and diversity of the silicified trunks of Coniferous and Angiospermous woods, often beautifully preserved, which they have yielded. In this dissertation Dr. Paul Platen, a pupil of Prof. Felix, of Leipzig, whose work on the anatomy of petrified woods is widely known, has described the structure of a considerable number of trunks, for the most part of Tertiary age, from California, Nevada, Texas, Arizona and elsewhere, including also two specimens from Alaska. The great majority of the woods have proved to be Angiospermous, and two new genera, with many new species, are attributed to the families Quercineæ, Simarubaceæ, Araliaceæ and Platanaceæ among others.

Several Coniferous trunks of the Pityoxylon, Cupressinoxylon and other types are also described, and the author contributes some interesting diagnostic conclusions respecting a comparison of the structure of the wood of the recent Sequoia and Taxodium with the fossil stems known as Cupressinoxylon. Certain pathological features observed in some of the Coniferous woods, and in one case the presence of a parasitic fungal mycelium, are also noted.

LETTERS TO THE EDITOR.

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

The Rate of Fall of Fungus Spores in Air.

IN the year 1905 I made what I believe was the first direct test of Stokes's formula for the fall of small spheres in air by using spores liberated spontaneously from the pilei of the mushroom and of allied fungi. The conclusion to which I then came was that the spores of these fungi fall at a rate which is roughly in accordance with Stokes's formula, and this fact was announced by Prof. A. J. Ewart in his translation of Pfeffer's "Physiology of Plants" (vol. iii., 1905, p. 416). The results of further observation were communicated to the Royal Society in 1907 in a paper which I subsequently withdrew.[1]

Recently, Messrs. Zeleny and McKeehan,[2] of the University of Minnesota, have announced that they have made a direct test of Stokes's formula by using lycopodium powder. Their method of measuring terminal velocity consisted in allowing the powder to fall in wide tubes and noting the rate of movement of the centre of the cloud. They came to the conclusion that, for lycopodium spores, the formula gives velocities 50 per cent. in excess of those observed.

In view of the fact that a correct determination of the rate of fall of small spheres in air has now become of considerable importance in connection with the cloud method used by Sir J. J. Thomson and Dr. C. T. R. Wilson for investigations upon the electronic charge, and also because the full details of my experiments will not be published for some months, I have thought it advisable to make a preliminary statement with regard to my methods and results.

The following equation represents what is known as Stokes's law for the fall of small spheres in a viscous medium:—

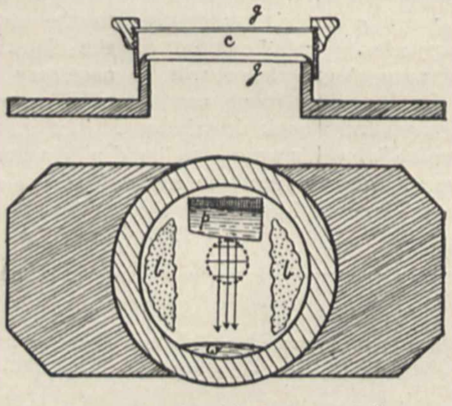
$$V = \frac{2}{9} \frac{\rho - \sigma}{\mu} g a^2,$$

where V = the terminal velocity, ρ the density of the falling sphere, σ the density of the medium, g the acceleration due to gravity, a the radius of the falling sphere, and μ the viscosity of the medium. The new data which were required for testing the law for the fall of small spheres in air by my method were the terminal velocity, the density, and the radius of the fungus spores.

After a considerable amount of preliminary experimentation, the spores of *Amanitopsis vaginata* were chosen for a critical test of Stokes's law, for the following reasons:—

(1) they are spherical, except for a tiny "tail," and smooth-coated; (2) they are sufficiently large, so that one can measure their diameters, which are about 10 μ, very accurately; (3) their density is almost that of water, and can be measured within 1 per cent. of accuracy; (4) they can easily be procured.

The average diameter of the spores was obtained by measurements made with the Poynting plate micrometer as applied to the microscope. The density of the spores was determined by the heavy fluid method. Drops containing the spores were placed in the tiny chamber of an apparatus used for counting blood corpuscles, and observations were made as to whether the spores rose or sank in the fluid. The terminal velocity of fall was found in the following manner. A small piece of a pileus of *Amanitopsis vaginata*, including portions of three gills, was placed in a compressor cell in the position shown at p in the accompanying figure. To prevent the falling spores from drying, two pieces of soaked blotting-paper or cotton wool, b, and a drop of water, w, were then added. Upon the cap being adjusted, the piece of fungus became fixed by slight compression and hermetically sealed in the disc-shaped chamber, of which the base and top were of glass (g). The compressor cell was then placed in a vertical position, so that the gills came to look downwards in the natural manner. Thus enclosed in the chamber, the gills continued to rain down spores for some hours. With a horizontal microscope having a magnification of about 25 diameters, a field was focussed just beneath the gills, and the spores were observed crossing the eye-piece



Plan and Section of the Compressor Cell.

lines. In the figure the field is shown by the dotted ring, and the course of three falling spores by arrows.

On viewing the field just below the gills, spores can be seen as distinct, but only just visible, minute, dark objects steadily crossing the field in a vertical direction. Every spore so falling is not in focus, but when the fungus material is in good condition spores in focus come into view at least every five seconds. Convection currents in the tiny chamber are reduced to a minimum, and produce no disturbing effect on one's observations. Even with the minute spores of *Collybia dryophila*, which take about eleven seconds to cross a field 4·55 mm. wide, the direction of fall is vertical, and there is practically no swerving from the course. The records of the velocity of fall of the spores were made with the aid of a large drum, which was driven by electricity, and was provided with a delicate regulator. To the recording fountain pen was attached an electric tapping key, by the depression of which with the finger the passage of each spore across the field of view became recorded on the drum paper. The drum records of the fall of 100 spores served to give the average time taken by the spores in falling a distance of 4·55 mm.

The following table gives a summary of the data obtained in testing Stokes's law. The velocities were the average velocities of 200 spores in Specimen I., of 100 in Specimen II., and of 50 in Specimen III. The densities are doubtless correct to within 1 per cent. The diameters are the average diameters for at least fifty spores. The

[1] The paper, which was partly botanical and partly physical in character, was accepted for publication in the Philosophical Transactions of the Royal Society on conditions which I was unable to accept. This paper, together with other researches, is in course of publication in a book called "Researches on Fungi. The Production, Liberation, and Dispersion of the Spores of Hymenomycetes treated Botanically and Physically, &c." (Longmans, Green and Co.).

[2] "An Experimental Determination of the Terminal Velocity of Fall of Small Spheres in Air." A paper read before the American Association for the Advancement of Science. Abstract in *Science*, March 19.

chamber was closed in each case for half an hour before observations of velocity were made.

Fruit-bodies of fungus	Density of spores	Diameter of spores in μ	Observed terminal velocity in mm. per sec.	Calculated terminal velocity in mm. per sec. for a sphere with density and diameter equal to those observed for the spores	Actual terminal velocity exceeded calculated by a percentage of
Specimen I.	1·02	11·65	6·07	4·14	47
Specimen II.	1·02	10·19	4·85	3·21	51
Specimen III.	1·02	10·87	5·11	3·64	40

From the results just given it is clear that the figures obtained by observation for the rate of fall of the spores are of the same order of magnitude as those demanded by Stokes's law. However, the law is not confirmed in detail, for, as an average of the three experiments, it was found that the actual velocity of fall of the spores was 46 per cent. greater than the calculated. I have not been able to find any satisfactory explanation for the discrepancy between observation and theory.

My method for testing Stokes's law appears to have various advantages over that used by Zeleny and McKeehan, for the following reasons:—Amanitopsis spores have smooth walls, and are practically truly spherical, whereas lycopodium spores have sculptured walls, and are four-sided. Amanitopsis spores have a diameter only one-third as great as lycopodium spores. In the tube method convection currents cannot be eliminated, and it must surely be somewhat difficult to decide the exact centre of the spore clouds. By my method of using a very small chamber the difficulty of convection currents was reduced so as to be negligible, and the velocities of the individual spores could be measured with considerable accuracy. Amanitopsis spores are liberated spontaneously by the fungus, whereas lycopodium powder requires to be set in motion by artificial means.

In conclusion, I wish to thank Prof. J. H. Poynting for permitting me to carry out the experiments here recorded in the physics department of the University of Birmingham, and also Dr. Guy Barlow for valuable criticism.

A. H. Reginald Buller.
The Botanical Department, University of Manitoba, Winnipeg, March 25.

Ionisation by Röntgen Rays.

The relative ionisations produced in different gases by beams of X-rays have been found by many investigators to depend so markedly on the penetrating power of the X-rays used that no regularity in behaviour has been discovered (see Mr. Crowther's paper "On the Passage of Röntgen Rays through Gases and Vapours," Roy. Soc. Proc., January 14).

Recent experiments which I have made upon homogeneous beams have, however, shown the connection between ionisation, secondary radiation, and absorption in a most striking way. As in the case of absorption phenomena (see letter to Nature, March 5, Barkla and Sadler), a knowledge of the secondary radiation characteristic of an element is essential and sufficient to explain many of the phenomena of ionisation.

In order to test if such a connection existed, the first substance experimented upon was ethyl bromide—a substance which has been investigated in some detail by Mr. Crowther.

By using homogeneous beams of X-rays, I found that all radiations experimented upon which are not more penetrating than the secondary radiation characteristic of bromine (coefficient of absorption in Al = about 50) produce ionisations which are proportional, or at least approximately proportional, to the ionisation produced by the same beams in air.

When the radiation passed through the vapour was made more penetrating than the radiation characteristic of bromine, the ionisation rapidly increased—that is to say, the ratio of the ionisation in ethyl bromide to that in air rapidly rose to several times its original normal value. It was found to be essential to the production of what may be called the abnormal ionisation simply that the primary radiation be more penetrating than the secondary radiation which bromine emits. This result must be connected with the results of experiments on absorption and secondary radiation.

Thus, when an X-radiation incident on a substance R is softer than the secondary radiation characteristic of R, it is absorbed according to a simple law, the absorption being approximately proportional to the absorption in any other substance in which a characteristic radiation is not excited; it produces no appreciable quantity of this secondary radiation, and it produces what may be called a normal ionisation in R. When the incident radiation becomes more penetrating than the secondary radiation characteristic of R, it is absorbed by an amount greater than given by the law stated; it begins to excite the secondary radiation in R, and it produces an increased ionisation in R. The absorption and ionisation increase to several times their previous value, while the intensity of secondary radiation becomes very great.

As the penetrating power of the incident radiation is increased still further, the absorption by R diminishes, and the secondary radiation excited in R diminishes at the same rate as the ionisation produced by the incident radiation in a thin film of air.

(It should be pointed out that the great increase in ionisation is not due to the secondary radiation.)

In a similar manner, from a knowledge of the secondary X-rays emitted by iodine, the variable behaviour of methyl iodide may be explained. The effects of the lighter elements are comparatively small in all the three phenomena of absorption, secondary radiation, and ionisation.

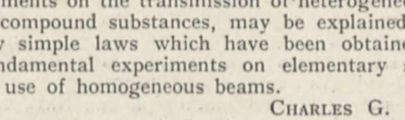
Very many of the apparently complex results, obtained by experiments on the transmission of heterogeneous beams through compound substances, may be explained in terms of a few simple laws which have been obtained by the more fundamental experiments on elementary substances with the use of homogeneous beams.

Charles G. Barkla.
University of Liverpool, April 7.

A Simple Fabry and Perot Interferometer.

During a course of experiments with interferometers it was found that a very simple and inexpensive Fabry and Perot instrument could be constructed of plate glass which gives results almost as good as the costly interferometer. The construction of this apparatus for demonstration purposes will well repay the teacher and student. The sharp-coloured interference rings obtained by using luminous gases in vacuum tubes as sources are extremely beautiful. The D lines from a sodium burner are easily separable. If the interference pattern, using a copper or iron arc, is focussed on a wide slit of a single-prism spectrometer, a section of the interference rings is seen in the various spectrum lines, illustrating the method of Fabry and Buisson, and Eversheim, for the determination of the new standard table of wave-lengths. The Zeeman effect can also be easily shown with this apparatus.

Take two pieces of plate glass about an inch square (I have used the so-called German plate) and silver[1] them



until one surface of each plate cuts down the intensity of the transmitted light to about a quarter of the incident light. Separate these silvered surfaces by two strips of cardboard. A useful thickness to begin with is about 0·45 mm., as this will clearly separate the D lines. Mount these plates over a half-inch hole in a metal plate by means of three pressure screws, two of which are shown in the above diagram, being a section through

[1] For silvering solutions see the appendix to Baly's "Spectroscopy."

the centre. The third screw is midway between the other two, and at the end of the plates.

Looking normally through the plates at the glowing filament of an incandescent lamp, a number of images of it will probably at first be seen. Adjust the pressure screws until these images are in juxtaposition in the line of sight; the silvered surfaces are then approximately parallel. Place the instrument in a clamp stand, and focus the light from a sodium flame or a vacuum tube upon the plates, and look at the interference bands with a small laboratory telescope focussed for infinity. Usually the eye-piece has too large a magnification for the above retardation, and it is better to use in place of it a single lens of focal length about 2 inches. At first only a small section of the interference pattern is seen, but with a little careful adjustment of the pressure screws the whole ring system is obtained in sharp focus. Removing the telescope, and with the above lens used as eye-piece, focus the interference system from the above sources, or an arc upon the slit of a spectroscope. The bands in the different spectrum lines are thus observed with the telescope on the spectrometer.

For further suggestions regarding the adjustments and other experiments for which this apparatus can be used reference may be made to an article by the writer in the *Philosophical Magazine* for May, 1904.

JAMES BARNES.

Bryn Mawr College, Bryn Mawr, Pennsylvania.

An Ornithological Coincidence.

ON September 18, 1908, a fine, typical male of *Anthus bertheloti*, Bolle, the common Canary Islands pipit, was caught near Cremona, the first of its kind obtained in Italy. I received the interesting specimen "in the flesh." On March 16 of this year Mr. W. P. Pycraft presented at the meeting of the Zoological Society of London an account of the fossilised remains of a small Passerine bird from the "Gabbro" (Lower Pliocene) near Leghorn, which he identified as those of Berthelot's pipit (see NATURE, p. 119). The coincidence is certainly worth noting.

I may add that last autumn, during the later migrations, we had in Italy an unusual inflow of western species of birds, and amongst others and the above-mentioned pipit I received, also "in the flesh," a fine specimen of the large variety of the wheatear (*Saxicola leucorrhoa*, Gm.), known to breed in Greenland and to migrate southwards along the extreme west of Europe into Senegal. The specimen, a female, is the first registered in Italy; it was captured, also near Cremona, on November 7 last.

HENRY H. GIGLIOLI.

Royal Zoological Museum, Florence, March 29.

April Meteors.

MOONLIGHT will not hinder observations of the Lyrids and other shooting stars in the latter part of April in the present year. The following are the principal meteor showers that become due during the period April 19–30. The times of the various meteoric events as calculated by the writer are expressed in Greenwich mean time.

Epoch April 19, 12h. Shower of eighth order of magnitude, the maxima of which occur on April 20, 10h. 45m., 22h. 30m., and April 22, 6h. There is also another smaller shower connected with this having its maxima on April 20, 12h., April 21, 18h., and April 22, 7h.

Epoch April 25, 1h. This shower, which is of the thirteenth order of magnitude, has its principal maximum on April 27, 14h. Secondary maxima take place on April 25, 14h. 30m. and 20h. 30m.

Epoch April 29, 18h. Shower of seventh order of magnitude. Its principal maximum occurs on April 27, 9h. 45m., and there are other maxima on April 27, 23h. 45m., and April 29, 3h.

From the foregoing it seems that meteors should be found especially numerous on the nights of April 20 and 27. On the latter night there are two principal maxima occurring at times very suitable for observation.

April 12. JOHN R. HENRY.

THE GRAMOPHONE AS A PHONAUTOGRAPH.

IT is well known that during the last few years the gramophone (invented by Berliner in 1887), in its more complete and expensive forms, has been so much improved as to have completely eclipsed the phonograph. It is now an instrument that not only records pitch and intensity, but also quality to a surprising degree, so that one can listen to orchestral music in which the quality of each musical instrument is rendered with much fidelity, and also to the fine voices of many of the most celebrated vocalists of the day. Chorus effects are also remarkable, and one can, for example, enjoy the Soldiers' Chorus from *Faust* or the Wedding Chorus from *Lohengrin*. The nasal effects, the thin reediness of the voices, the alterations in quality, so characteristic of the phonograph, and of the gramophone in its earlier stages, have now almost entirely disappeared; indeed, it is no exaggeration to say that no scientific instruments have made greater progress since the inception of the phonograph a little more than thirty years ago.

Certain interesting data regarding the gramophone disk are worth recording. These I have determined on one of the smaller disks having a diameter of $10\frac{1}{2}$ inches, with the record beginning $\frac{1}{4}$ inch from the margin. The record then traces its spiral groove until it is $2\frac{1}{4}$ inches from the centre, so the record has a breadth of a little more than $2\frac{3}{4}$ inches, or, say, 3 inches. The diameter at the beginning of the record is 10 inches, in the middle 7 inches, and at the close of the spiral, towards the centre of the disk, 4 inches. Multiplying each by 3·14 gives the circumference of the circle as 31·4 inches, in the middle 21·98 inches, and in the centre 12·56 inches, or, together, 65·94 inches, giving a mean of 21·98 inches, or, say, 22 inches. There are 100 grooves per inch from the centre towards the circumference; $100 \times 22 = 2200$ inches; the breadth of the record $= 3$ inches; therefore $2200 \times 3 = 6600$ inches; or 550 feet, or 183 yards, is the average length of the record groove. That is to say, in reproducing Waldtenteufel's waltz, *Estudiantina*, the needle, in 205 seconds, ran over a distance of 550 feet. This gives a rate of 32·2 inches per second. With disks of a larger diameter, the length the groove in a long record may be more than 200 yards.

But when this record was reproduced (it is a remarkably good orchestral record) the disk travelled at the rate of 76 revolutions per minute, or 0·8 second per revolution. At the beginning of the record, therefore, 1 inch was covered in 3/100 second, at the middle in 4/100 second, and at the close of the record in 6/100 second. In other words, the needle traverses a shorter and shorter distance, but in the same time, in passing from the circumference to the centre. Consequently there is no alteration in pitch. It follows also that, given vibrations of the same frequency for a note sounding at the beginning of the record and at the close, the marks of each vibration must be closer together at the centre than at the circumference. Thus, supposing a frequency of 200 per second, there would be about six vibrations in an inch at the beginning (outer circumference) and twelve in an inch at the end of the record (centre). A note of 1000 vibrations per second would have thirty in an inch at the beginning, and sixty in an inch at the close of the record. I was able substantially to verify this by placing the disk under a microscope, with a low power, and counting the number of marks in a lineal inch. This also gives a convenient method of determining the pitch of any note, provided one can count a sufficient number of marks in an inch, or in the fraction of an inch. Thus, suppose ten marks in one inch, then the frequency would be more than 300 vibrations per second. A difficulty arises when we find a complete vibratory period not represented by one wave, but possibly by three, one, the first, large, and the other two smaller. Then, to ascertain the real pitch, only the large marks must be counted.

Many attempts have been made to obtain an enlarged record of the wave-forms on the phonograph and gramophone, and much success was attained long ago by Fleeming Jenkin and Ewing, and, in later times, by Hermann, Scripture, and myself. Still, none of these were *facsimile* tracings. It seems to me that the gramophone, in its present condition, holds out the hope of an experimentalist being able to obtain from records tracings on a smoked glass circular plate travelling at the same rate as the record. Then, by placing the plate in a lantern, we should see a representation of the waves amplified, but amplified in all proportions. This I have succeeded in accomplishing, with a considerable measure of success, after a trial of a good many methods.

(1) Place a smoked glass plate, 10 inches in diameter, with a hole in the centre, on the platform of the gramophone (the recording of waves on a smoked glass plate was a method employed by Berliner in his early experiments). As the swinging arm (or taper arm, as it is technically called) of the gramophone tends to swing outwards, and as the outer lip of the groove on the record tends to draw it inwards, and thus to follow the spiral, the needle, if placed on the smoked plate, will not move inwards. To overcome this I attached by a thread the swinging arm to a very slow-moving train of wheels, driven by an old phonograph, and thus I gradually drew the swinging arm inwards, so that a spiral was made on the smoked glass having a thread of about fifty to the inch. I was unable with my apparatus to obtain a slower motion. Then I removed from the gramophone the large horn, and sang, spoke, or shouted into the tube at the end of the swinging arm. The disk of the gramophone vibrated, and the needle described minute waves of various forms on the glass plate. I found, however, that when a cord connected the taper arms of the two gramophones there was not a continuous pull, but a rhthymic oscillation, producing a tracing showing light and dark bands, as the oscillations of the arms of the gramophones had not the same period. A beautiful tracing was thus obtained, showing, at regular distances, light bands owing to the lines becoming very close together, giving a figure such as one has seen for the illustration of waves of sound, or such as occurs in Crova's disks. By this method and the use of an eccentric arrangement, Crova's disks might be prepared. These light and dark bands were got rid of by connecting the arms of the two gramophones by a rigid rod. The finest gramophone needles were used for recording.

I also, by this method, caused a loud phonograph to act, by a connecting tube, on the mica disk of the gramophone, through the tube of the swinging arm, and I obtained tracings.

(2) Another method was unsuccessful, and had to be abandoned, both owing to difficulties of adjustment and because it gave incorrect results. It consists of elongating the vertical rod in the centre of the gramophone platform. A glass plate, smoked, is then fixed to the rod by passing the rod through a hole in the centre and through a collar, that can be clamped. The plate is of the same diameter as the gramophone disk record; it is smoked on its under surface, so that, when matters are adjusted, the disk of the gramophone is directed upwards and the smoked surface downwards, and about 2¾ inches above the record. A firm upright bar of steel is soldered to the outer surface of the end of the spring attached to the needle of the sound-box, and this bar carries vertically a very fine needle. The point of this needle is brought with a minimum of friction against the under surface of the smoked disk. The gramophone is then started, and the platform with the central rod carries both the record disk and the smoked glass disk. The tracing so obtained was not satisfactory.

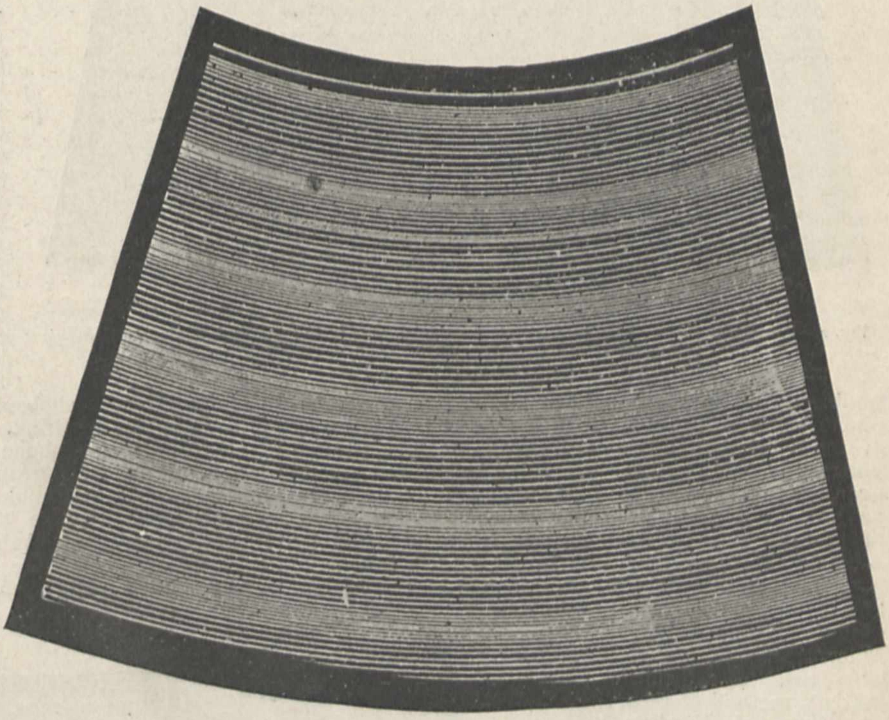


FIG. 1.—Portion of gramophone disk showing the oscillatory periods of the taper arms of two gramophones. No sound vibrations. Examine with magnifying glass.

(3) I obtained the best tracings by causing one gramophone to sing or play at the usual rate, and, at the same time, by a rigid rod connecting the two arms, to draw towards itself the arm of a second gramophone on which was placed a circular smoked glass plate. The needle of the second gramophone described a spiral with intervals between successive spirals of 1/100 inch, exactly similar to the spirals on the record of the first gramophone; but, before

starting, the resonator of both gramophones was removed, and the circular openings at the base of each taper arm were connected by a wide tin tube. When the first gramophone acted the sound waves passed, not out by the resonator, as usual, but along the transverse tin tube to the other gramophone, the sound disk of which then vibrated and wrote the tracings on the blackened glass plate. This method, apparently so simple, gave rise to great trouble owing to the sound-box of the second gramophone being so heavy as to damp or obliterate many of the vibrations transmitted from the first gramophone. I substituted for the sound-box of the second gramophone (1) one of Pathé's simple reproducers, having, by a cork, a needle attached to the centre of the disk; (2) a very delicate tambour made by Albrecht, of Tübingen, used in Heurthle's ingenious arrangement for recording the sounds of the human heart; (3) one of Brodie's tambours, made by C. F. Palmer; and (4) a capsule, made by Joos, of Frankfort, for Marbe's method of recording the vibrations of König's flames. The first gave the best results, but was not quite satisfactory. Nos. 2, 3 and 4 were of no service, as they were too mobile, and too susceptible of vibrations due to inertia. The same objection applied to the needle in No. 1. After a great deal of trouble, however, I found the ordinary sound-box of the gramophone most effective after suspending it so as to remove weight, and so as to allow the needle to touch the smoked glass plate with a minimum of friction. In these experiments one had a striking illustration of the delicacy of the movements of the drum-head of the ear. The more delicate tones, or, rather, the weaker tones of a fine voice, on which expression so much depends, were not recorded by any of my mechanical appliances, and only loud, strong, rich tones (like those of a powerful orchestra) left their traces. When the record was made by the gramophone operators, say, of the sounds of an orchestra, air currents carried the vibrations against the diaphram of the recording instrument with sufficient intensity to enable the recording needle to cut its way into the soft matrix employed; but the energy of tones coming from the sound-box of the *reproducing* gramophone (that is, the gramophone working on the disk)[1] was, of course, very much diminished; still, sounds were heard (the drum-head was moved), although no movements of the disk of the second gramophone could, by the above method, be recorded. The amplitude of the movements of the drum-head must be inconceivably small, and yet they are sufficient to transmit pressures to the nerve terminations in the cochlea.

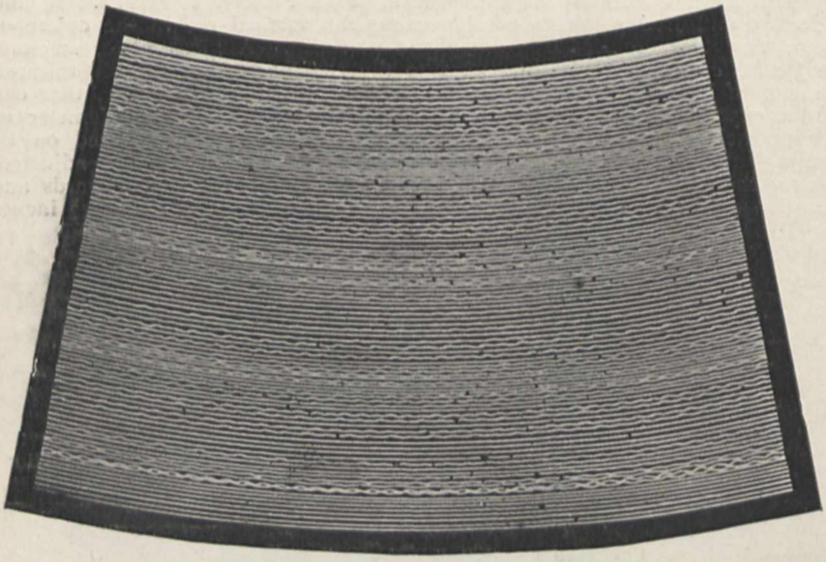


FIG. 2.—Portions of the record of a powerful bass voice (Oreste Luppi, of Milan) singing *La Calunnia* from *Il Barbiere di Siviglia*. Examine with magnifying glass.

These experiments were made at home and without the appliances of a laboratory, and as, owing to circumstances, I cannot continue them, I will be glad if the method or methods above described are taken up by a younger worker. The sound waves may also be *seen* by the ingenious method of reflecting a beam of light from a small mirror attached to the diaphragm on to a revolving Wheatstone mirror. This method was invented by Mr. Bowron. Several years ago Dr. James Erskine Murray showed me an arrangement of his own of a similar kind.

(4) The gramophone is an excellent phonautograph. Take two gramophones; one to draw the needle over the smoked glass plate on a second gramophone; remove the resonator of the second gramophone; suspend the sounding box of the second gramophone until the needle barely touches the smoked glass plate; and then, through a wide tin tube, having a diameter the same as that of the opening at the end of the taper arm of the second gramophone, speak or sing into the second gramophone. Thus the vibrations are recorded, while the speed of the smoked glass plate is known. Long ago I traced vowel curves and other sounds (using a phonograph recorder) on a vertical smoked glass plate moving

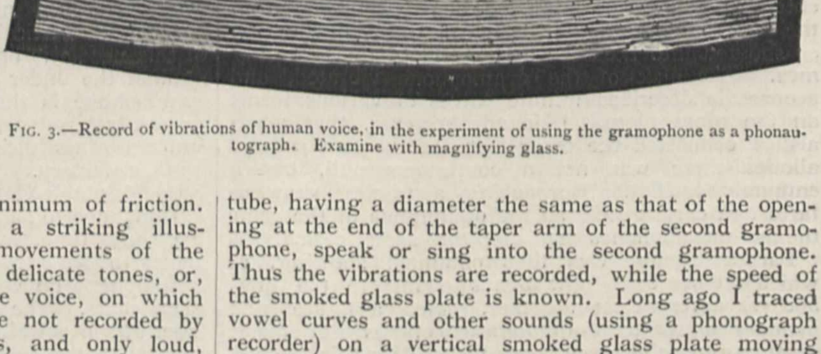


FIG. 3.—Record of vibrations of human voice, in the experiment of using the gramophone as a phonautograph. Examine with magnifying glass.

[1] For an account of the gramophone, see an interesting paper by Mr. Lovell N. Reddie, read before the Royal Society of Arts, May 6, 1908.

rapidly horizontally, but by this method I could only record in each experiment during the time of the movement of the glass plate—about one second. By the gramophone, records of vocal sounds might be taken during a period of three minutes.

An inspection of the curves so obtained of a voice or of an orchestra only makes the performance of a gramophone more wonderful and more difficult to understand. We see a long series of waves of various forms which the eye cannot follow; but when these waves appeal to the ear, then music starts into life. Each sense has its own beat.

John G. McKendrick.

THE POISONS OF THE PHARMACY ACT.

One of the minor legislative achievements of last session was an amendment of the Poisons and Pharmacy Acts. So far as poisons are concerned, it may be noted that these Acts restrict the facilities for obtaining certain substances which experience has shown to be often responsible for fatalities, whether by accident or by intentional administration. Besides the commoner violent poisons—the arsenic and strychnine of the wilful poisoner, the prussic acid and carbolic acid of the suicide—there are milder varieties of toxic substances which may lead to fatal results through ignorant or careless usage, and which should therefore not lightly be dealt out to ignorant or careless users. Such, for instance, are the narcotics, as morphine and sulphonal; the emetics, *e.g.* tartar emetic; and the abortifacients, such as ergot and savin.

What is a poison? Precise definition is difficult. Very largely it is a matter of quantity; most medicines are poisonous if taken in excess. Personal idiosyncracy and immunisation are also factors. The proverb "One man's meat is another man's poison" contains at least the half-truth characteristic of proverbs; and the Styrian arsenic-eaters, as Sir Henry Roscoe showed nearly fifty years ago, can easily withstand doses of arsenic which would be fatal to ordinary people.

In the Act before us the legislature defines its poisons by enumerating them. To toxicologists and pharmacists the list is no doubt familiar enough. To other readers, however, it may be of interest to glance at the list of articles now included in the schedule of poisons. These, as explained below, are only to be sold under certain specified conditions.

Part i. of the schedule is concerned generally with the more active poisons, upon the sale of which the more stringent restrictions are naturally placed. The buyer must be known to the seller, or must be introduced to him by a third person known to both; the sale must be recorded in a special book and the entry signed by the purchaser, and the purpose for which the drug is required must be stated.

Arsenic, alkaloids, and the poisonous cyanides form most of this first division. Several of the alkaloids—aconite, aconitine, atropine, belladonna, strychnine, and morphine—are specifically named; but there is also a general category of "all poisonous vegetable alkaloids," which brings in any not otherwise enumerated. Coca, cantharides, corrosive sublimate, tartar emetic, ergot, picrotoxin, and savin complete the list as regards part i.

Part ii. of the schedule contains a list of articles which (1) are to be sold only by registered chemists, and (2) must be labelled as poisons when sold. It includes oil of almonds (unless deprived of prussic acid), antimonial wine, carbolic acid and its homologues, chloral, chloroform, digitalis, the iodide, sulphocyanide, chloride, and oxides of mercury; poppies, strophanthus and sulphonal, together with all preparations which contain a poison within the meaning of the Pharmacy Acts and are not otherwise dealt with.

Most of the foregoing articles are well-known poisons, and the reasons for including them are, perhaps, sufficiently obvious. But a few notes upon the less familiar of them may not be without interest.

One of the most noteworthy is the drug coca. This, the source of the alkaloid cocaine, consists of the dried leaves of *Erythroxylon coca*, a shrub which flourishes on the slopes of the Andes. It has been used as a nerve stimulant by the Peruvian and Bolivian natives from time immemorial. Furnished with a small stock of the leaves to chew, they will work or travel without food from morning until night. As there is no appreciable amount of nourishment in the leaves, the sustaining effect is regarded as probably due to the nerves of the stomach being locally benumbed by the drug, thus preventing the feeling of hunger. Although habitual excessive use of coca brings on insomnia, dropsy, and death, yet a single large dose is said, in the case of the natives, to give a sensation of peculiar physical beatitude. Joyous visions and brilliant phantasmagoria are recorded as the result of a very large dose in one case. On Europeans, however, the action appears to be curiously different from this, fear and terror rather than joy having been noted in numerous cases of coca poisoning.

Cantharides, the Spanish blistering fly, is the dried beetle *Cantharis vesicatoria*. It comes chiefly from Spain, Italy, and Russia. Internally, the drug acts as a powerful irritant, with a peculiar direction to the urinary and genital organs; externally it is used as a blister and rubefacient.

Ergot is the sclerotium of a fungus, *Claviceps purpurea*, arising in the ovary of the rye plant. It is scarcely a poison in the ordinary sense of the word, as most persons—the exceptions being women in pregnancy—can take large doses without fatal effect. Nevertheless, epidemics of poisoning on the Continent have been ascribed to the use of rye-bread contaminated with the fungus. Medicinally it produces contraction of those muscles which act involuntarily, and slows down the action of the heart.

A poison which is said to have been used as a hop-substitute in malt liquors has a place in the schedule. It is picrotoxin, a bitter, crystalline substance obtained from the berries of *Cocculus indicus* (*Anamirta paniculata*). The drug is a potent poison, producing convulsions and violent peristalsis. Savin has been much used in uterine affections. It consists of the dried tops of the shrub *Juniperus sabina*, Lin., a native of southern Europe and the United States. The volatile "oil of savin," obtained from it is a powerful local irritant which has been employed, often with fatal results, in producing criminal abortion. Strophanthus, the seeds of *S. Kombé*, is notable as the source of the Kombé arrow-poison, used in Senegambia, Guinea, and other parts of Africa. For the rest, space allows only a brief mention of sulphonal, which is a soporific drug (dimethyl-methane-diethyl sulphone) synthesised from acetone and mercaptan. Its narcotic action is usually quiet, without disagreeable after-effects; but chronic poisoning and fatal results have frequently accrued from long-continued and injudicious use of the drug.

A large number of deaths by accident and suicide are yearly attributable to poisoning by mineral acids. Restrictions are therefore now placed by the Act upon the sale of hydrochloric, sulphuric and nitric acids, as also of soluble oxalates. These articles must be labelled as poisonous, and bear the name and address of the seller; but the latter need not be a registered chemist, as in the case of the scheduled poisons.

On the other hand, greater facilities are given for obtaining certain toxic substances used in agriculture and horticulture. In country places there has often been difficulty in obtaining poisonous insecticides, fungicides, and bactericides, as also sheep-dips and weed-killers containing arsenic or nicotine; it has consequently been enacted that these articles may henceforth be sold by any persons duly licensed for the purpose by the local authority. No doubt this provision will be a convenience in rural districts, and will to this extent assist the farmer in dealing with the pests which encumber agriculture.

C. Simmonds.

RAINFALL IN ITALY.[1]

THE Italian Meteorological Department has issued an important work on the rainfall of Italy. The tabular matter contains the total precipitation and the number of rain-days for each month of the twenty-six years 1880 to 1905 for 215 of the 700 rainfall stations in connection with the Italian office. The records are not complete in all cases, but fifteen years is the shortest period dealt with. The largest annual total is 90 inches, at Gemona, near the Austrian frontier, the smallest 18·6 inches, at Foggia. On looking through the tables we are struck by the fact that no attempt seems to be made to secure uniformity of exposure for the gauges. The heights above the ground vary between 60 metres and half a metre. A set of excellent coloured plates shows the average rainfall conditions for each month, each season, and for the whole year.

The seasonal variation of rainfall differs widely in different regions. In the extreme north we have a single very pronounced maximum at midsummer, while in Sicily there is an equally pronounced mid-winter maximum. The one curve is almost exactly the reverse of the other. Over the northern plains and in the northern half of the peninsula there are two maxima, one in May, the other in October or November, the latter being the more pronounced. Over the southern half of the peninsula the winter rains make themselves felt, and we find a principal maximum in October and secondary maxima in January and April. The preparation of the work has been in charge of Dr. Filippo Eredia.

SIMPLE STUDIES IN NATURAL HISTORY.[2]

THE subject of forest trees is such an attractive one and is just now so much to the fore that the little book at the head of our list ought to have a warm reception. It is well illustrated by thirty-two coloured drawings of trees, their leaves, flowers, and fruits, and the text is simply and well written. For children such a work is invaluable, and will enable them to identify trees with great ease. At the present time, when so much ruthless destruction is being effected in country districts by the wholesale felling of young and old timber, it is urgently necessary to emphasise the value of trees. This little book should be especially useful, not only in teaching the different kinds and their uses, but also in nurturing that affection for the noblest of plants which must be more widely entertained if the policy of devastation is to be checked.

Mr. Westell's stories form a complete contrast to this unassuming work on trees. They consist of reprints from publications of the Society for the Prevention of Cruelty to Animals, and contain a series of sketches of animal life that is disjointed, unorganised, and sententious. There are so many good books on this subject suitable for children that it is difficult to see on what grounds this series has been resuscitated. The affection of the author for flies is

Drinker moth (*Oaonestis potatoria*) just emerged from Cocoon. From Prof. Ainsworth Davis's "Nature Study."

not a very discriminating one. The pupal stage of the house-fly does not last "some weeks," nor is the blue-bottle fly a desirable acquaintance. The style of the author may be judged from the following reference to the feet of the house-fly:—"The adhesive power of our little feet is not impaired when atmospheric pressure is removed," a sentence that is followed by the naïve remark, "I have tried to make (this explanation) as simple as possible, and trust I have succeeded"; or, again, *àpropos* of the lapwing, "Notice the lapping movement carried out, after which we have been accorded one of our English names," a sentence that is as cryptic as it is ungainly.

[1] "Le precipitazioni atmosferiche in Italia dal 1880 al 1905." Annals dell Ufficio Centrale Meteorologico e Geodinamico Italiano, vol. xxv., parte i.

[2] "Trees shown to the Children." By Janet Harvey Kelman, and described by C. E. Smith. Pp. xiv+131; with 32 coloured plates. (Edinburgh and London: T. C. and E. C. Jack.) Price 2s. 6d. net.

"Animals at Home." By W. P. Westell. Pp. 240; 24 plates. (London: Dent and Co., 1908.) Price 3s. 6d.

"Nature Study." By J. R. Ainsworth Davis, M.A. Pp. xii+274. (London: Dent and Co., 1908.) Price 2s. 6d.

Principal Davis's little book consists of two parts. The first, devoted to plants, gives an admirable *résumé* of their being and well-being, their varieties and adaptations. The second treats in systematic fashion the chief groups of animals, and, though less "biological," is well arranged and packed with information. The illustrations throughout are most attractive, and the plan of the text well designed. For schools the book is certain to be found useful, and the only faults we have to find with it are the attempt to explain everything and the absence of any attempt to give practical directions for the simplest experiment. The first is certainly a serious mistake. The too ready application of the magic word "protection" in regard to colouring, for example, is frequently unjustified, and the bald statement, *e.g.*, that birds are derived from reptiles that rose on aëroplanes, is at least a daring one when its speculative nature is not hinted at. Phylogenetic speculation should be rigorously excluded from elementary teaching.

The absence of experimental advice is a too common drawback to books of this kind, and yet perhaps no method is equal to this one in value. With animals there is always a difficulty in suggesting an experiment that has not an unnatural or even a cruel look, but plants are made for experiment, and a training in that branch of work is one that can be effected cheaply and conveniently. These defects do not, however, prevent this little book from being a fund of attractive information on both animals and plants. The subject-matter is highly compressed, and teachers will find that a single paragraph has to be expanded and illustrated before it can be properly grasped by their pupils. Such compactness is, however, inevitable in a work of such small size and wide compass.

INTERNATIONAL CHART OF THE HEAVENS.

THE permanent committee of the Astrographic Congress of 1887 will meet at the Paris Observatory, April 19 to 24. Our readers will remember that the great international undertaking—the Carte du Ciel—was inaugurated at a congress held at Paris in 1887. No astronomer who attended the meeting can forget the man whose name will ever be associated with that work—Admiral Mouchez, then director of the Paris Observatory. But for his earnest and sympathetic character and genial influence it is doubtful if this great work could have been launched at all; it certainly could not have been so with the same prospect of success without his tactful and energetic cooperation.

At that congress a scheme was prepared and a permanent committee appointed to carry the work into execution. The committee in question consisted of eleven members, selected by vote, together with the directors of observatories cooperating in the work whose names did not appear in the original list. This committee met at intervals of from two to four years at Paris until the year 1900 inclusive, but since that time no further meeting of the permanent committee has taken place, and we shall see presently how urgent is the need for the coming meeting.

Broadly speaking, the programme entrusted to the committee was as follows:—

(1) To construct charts of the entire sky, each map measuring 2°×2°, and containing all stars to the thirteenth magnitude.

(2) To catalogue the exact positions and magnitudes of all stars to the eleventh magnitude.

At first the chart appeared, even to some astronomers, to be the more important object to be realised, but there has been a growing conviction that, for the broad fundamenta of astronomy, the catalogue, though by far the more laborious, is infinitely the more important of the two objects.

The chart, it is true, preserves a permanent record of the state of the sky for a mean epoch about 1900, to which reference can be made, as occasion may arise, in connection with variable stars and the appearance of new stars, and, *after special measures,* it will yield the places of stars fainter than the eleventh magnitude which may be suspected of large proper motion, &c.

But, with the completion of the catalogue, astronomers will be provided with absolute places of all the stars down to the eleventh magnitude, and this will enable them, when the work has been repeated after a sufficient interval, to derive the proper motions of all stars to the eleventh magnitude in the most simple and direct manner, and so to investigate such problems as the precession, the solar motion in space, star-drift, &c., and to discuss the general problems of sidereal astronomy with a completeness unattainable in any other way.

By the complete execution of our present programme we lay upon astronomers of the future the moral compulsion to execute a similar work, say, one hundred years hence, and, in addition, to derive from the three or four millions of proper motions so obtained the broad cosmical conclusions which must follow from the proper discussion of these motions.

This, surely, is a large enough task to bequeath to futurity—a noble bequest indeed if it be left in the complete, permanent and accessible form of a printed catalogue of positions and magnitudes. To leave it in any other form would be to endanger the permanent value of our work by throwing such an undue share of labour upon our successors as almost to justify them in refusing to utilise what we have done.

The work of the chart and of the catalogue was originally divided amongst sixteen observatories, and naturally has proceeded at different rates in different observatories according to their opportunities, the varied energy of their directors, and the means at their disposal. Practically the work has now continued for nearly twenty years, but, of course, a good deal of time was lost at first in the construction of instruments and in experimental research before definite routine work was commenced.

But whilst some of the observatories have nearly completed their share of the work, others are far behind, and it will be an important duty of the present meeting to inquire into the progress of each zone, to divide up the unexecuted work amongst the more active observatories, and to take such other steps as are necessary to bring the whole to an early and satisfactory completion.

In a circular letter addressed to the directors of the cooperating observatories and to others invited to attend the present meeting, M. Baillaud, director of the Paris Observatory, and president of the permanent committee, makes the following requests, viz.:—

(α) That each observatory which, up to the present time, has cooperated in the work, shall prepare a report showing the amount of work done, not only in taking the plates, but in the measurement, reduction, and publication of the results.

(β) That those astronomers who find themselves in a position to aid in the completion of zones which have fallen into arrear either in the matter of taking the plates or in their measurement and reduction, should intimate their readiness to assist in the work.

In entering into the whole question of the present state of the work, and taking such farther steps as shall ensure its completion, the present meeting of the permanent committee has a most practical and important duty before it. But it has still further matters of interest and importance to deal with.

First, as regards the chart and catalogue, it must be remembered that to a great extent the sixteen observatories have been working independently, and it is impossible that, in existing circumstances, these results can be entirely homogeneous.

For example, at some observatories the diameters of the star-discs have been measured; at others, the magnitudes have been estimated by comparison with sets of photographed images assumed to represent stars of known magnitude. It will be the business of the "Magnitudes Committee" to devise effective means for reducing these measures of diameter and miscellaneous estimates to a uniform and absolute system of magnitudes. Another committee will deal with the systematic errors which have been found to exist in the coordinates of star-images measured in certain series of plates. In some cases these errors depend on the magnitude of the star, in others on its distance and position angle from the centre of the plate. The optical committee will have to trace, so far as possible, the origin of these errors, and devise means for eliminating their effects from the final results.

The coordinates of the star-images measured on the plates are of no value for the purposes of fundamental astronomy unless the system of the coordinates of each plate is referred to a number of stars the absolute positions of which on the sphere are known. In the case of some of the zones the places of the reference stars depend on meridian observations, few in number and made a considerable number of years ago; in other cases they depend on recent but only locally observed zones. It is essential that not only should adequate provision be made for proper meridian observation of the zones, but also for their coordination to a common system on the plan so far carried out by Dr. Kastner at Bonn. The arrangement of this part of the work will rest with the fundamental stars committee.

At the last meeting of the permanent committee in 1900, a good deal of time was given to consideration of the steps to be taken for the observation of the then recently discovered planet Eros, at its opposition at the end of 1900. The bureau of the committee has published a large number of the observations of Eros that were secured at the opposition of 1900, as well as the results of meridian and photographic observations of the comparison stars, and an accurate ephemeris of the planet for that opposition. The unique characteristics of the orbit of Eros present conditions which are exceptionally favourable for researches of extraordinary astronomical interest and importance, viz. for the trigonometrical determination of the solar parallax and mass of the moon, and for the dynamical determination of the mass of the earth by the perturbations which it produces in the motion of Eros. In 1900 Eros approached the earth within one-third of the earth's mean distance from the sun, but at the opposition of 1931 it will approach the earth within half that distance, viz. within one-sixth part of the earth's mean distance from the sun. It is not, even now, too soon to begin preparation for this unique opportunity, and accordingly an Eros committee will be appointed for the following purposes:—

(*a*) To receive reports on the actual state of the reducductions of the past observations of Eros, and to prepare a report upon them.

(*b*) To take steps for the preparation of an approximate ephemeris of Eros at the opposition of 1931 of sufficient accuracy to permit the selection of the most suitable comparison stars.

(*c*) To discuss the best methods of observing the opposition in question, especially with a view to avoid systematic error in the final results.

(*d*) To discuss the basis of the choice of comparison stars, and how to ensure their proper observation.

(*e*) To devise means for the regular observation of Eros from this time forward in order to perfect the ephemeris that will be finally employed in the definitive reduction of the observations of 1931, that is to say, for the direct determination of the solar parallax and mass of the moon, and also for the ultimate determination of the mass of the earth by means of the perturbations which it produces in the motion of Eros.

There can be no doubt that all these objects can only be attained by international cooperation, and that they furnish ample material for an interesting and important meeting. The following astronomers have accepted M. Baillaud's invitation on the part of the French Government to be present on the occasion:—

Prof. Andoyer, Paris; Ch. André, Lyon; M. Angot, Paris; T. de Azcarate, San Fernando; O. Backlund, Pulkova; B. Baillaud, Paris; J. Baillaud, Paris; H. G. van de Sande Bakhuyzen, Leyden; Le Général Bassot, Nice; de la Baume Pluvinel, Paris; M. Bayet, Paris; G. Bigourdan, Paris; G. Boccardi, Turin; Prince Roland Bonaparte; F. Boquet, Paris; H. Bourget, Marseilles; Sir W. H. M. Christie, Greenwich; W. E. Cooke, Perth, W. Australia; M. Cosserat, Toulouse; M. Deslandres, Meudon; A. Donner, Helsingfors; F. W. Dyson, Edinburgh; John Franklin-Adams, London; A. Gaillot, Paris; P. Gautier; Sir David Gill, London; M. Gonnessiat, Algiers; G. E. Hale, Mount Wilson; M. Hamy, Paris; A. R. Hinks, Cambridge; S. S. Hough, Cape Town; Fernand Jacobs, Brussels; J. C. Kapteyn, Groningen; E. B. Knobel, London; M. Kromm, Bordeaux; F. Küstner, Bonn; Le R. P. Laïs, Rome; I. Lagarde, Paris; A. Lebeuf, Besançon; G. Lecointe, Brussels; G. Leveau, Paris; M. Lumière, Lyon; Major P. A. MacMahon, London; J. Palisa, Vienna; C. D. Perrine, Mount Hamilton; L. Picart, Bordeaux; A. A. Rambaut, Oxford; H. Renan, Paris; A. Ricco, Catania; J. Scheiner, Potsdam; M. Stéphan, Marseilles; E. Strömgren, Copenhagen; H. H. Turner, Oxford; F. Valle, Tacubaya; M. Verschaffel, Abbadia; W. Zurhellen, Bonn.

DR. ARTHUR GAMGEE, F.R.S.

HIS numerous friends and fellow-workers in science, both in this country and abroad, will hear with deep regret of the unexpected death of Dr. Arthur Gamgee, in Paris, on March 29. He was in his sixty-eighth year, and though not a young man was in full possession of an exceptionally endowed intellect which was ever urging him on in the path of research. Throughout a somewhat unsettled life his enthusiasm for research never waned from the time of his early student days, when he followed his natural leanings towards original physiological work, to which his exact knowledge of physics and chemistry was to be applied with a success that gained for him a wide and well-deserved reputation.

To many of the younger physiologists Dr. Gamgee was personally unknown. He was born in 1841, in Edinburgh, a younger son of Joseph Gamgee, a distinguished veterinary surgeon and pathologist, whose work, particularly that on rinderpest, was well known in England and on the Continent. An elder brother, Joseph Sampson Gamgee, long connected with the general hospital in Birmingham, was a man of great mental gifts and remarkable personality, who made a name for himself in his profession, and will be remembered for the introduction of improved methods in the treatment of wounds in the pre-antiseptic days of surgery. Educated at University College School, Arthur Gamgee subsequently entered Edinburgh University, and came under the influence of John Goodsir and Christison, for both of whom he retained a warm affection throughout his life. After taking his medical degree in 1862, the subject of his thesis, for which he was awarded a gold medal, being "An Inquiry into the Physiology and Pathology of Fœtal Nutrition," he became assistant to Maclagan, who was at that time professor of medical jurisprudence. Ten years later, after the publication of several physiological papers, among which the most important are those on the action of nitrites on hæmoglobin, on the development of heat in the process of arterialisation of the blood, which Mario Camis has only recently shown to be an exothermic reaction (*Mem. Real. Acc. del Torino*, 1908, 58, pp. 141–69), and, with J. Dewar, on the constitution of cystine—urinary calculi being at that time the only known source of this amino-acid, Gamgee was elected a Fellow of the Royal Society. He was at that time thirty-one years of age. In 1873 he became the first Brackenbury professor of physiology in Owens College, Manchester, where he founded the school in this subject, and as Dean of the medical school actively assisted in the transformation of the college into the Victoria University. His work in this direction seems to have been most unaccountably ignored, for his name is not even mentioned in a recently published history of the development of the university. From 1882 to 1885 he was Fullerian professor of physiology in the Royal Institution. A few years after leaving Manchester in 1885 Gamgee was elected assistant physician at St. George's Hospital, where he lectured on pharmacology and materia medica, and then, having decided to reside abroad, he practised as a consulting physician in Switzerland at Lausanne, and for several years at Montreux. During this time he was also actively engaged in research, and on his return to England in 1904 he continued his original work in Cambridge and in the physiological laboratory of the University of London, where, indeed, he was at work on the morning of the day of his departure for Paris. On two occasions, in 1902 and 1903, he was invited to America, and his first visit was undertaken with the view of reporting upon the present state of our knowledge of nutrition, a subject which was being elaborately investigated by Chittenden, Atwater, and Benedict. From the Universities of Edinburgh and Victoria he received the honorary degrees of LL.D. and D.Sc., and during the last few months of his life was engaged in furthering the success of the International Congress of Applied Chemistry, which meets on May 26; of this he was vice-president of the physiological chemistry section. The council of the Royal Society chose him to represent the society at the celebration of Albrecht v. Haller's bicentenary at Berne last year.

The twelve years during which Dr. Gamgee worked in Manchester were in some respects the period of his greatest activity. Owens College was the foremost scientific institution in this country at that time, which was one of stress and strain for all who had the real interests of scientific work at heart. The paramount influence of Owens College in the 'sixties as a centre of scientific thought is hardly realised to-day, when the struggle from which an entirely new type of education was to be evolved is over, indeed is almost forgotten. The names of Sir Henry Roscoe, Balfour Stewart, Stanley Jevons, Boyd Dawkins, and Julius Dreschfield occur to us, among others, whom Gamgee found as his colleagues and friends, and he will always be associated with them as aiding in making the college the most conspicuous school of scientific research in the country.

The science of physiology, which has actually arisen and developed in this country within the last three decades, and become a school which easily ranks with any on the Continent or in America, owes much to its real founders, Michael Foster, Burdon Sanderson, and Arthur Gamgee, who were all well acquainted with the work of Claude Bernard, Carl Ludwig, Du Bois Reymond, Helmholtz, and Kühne, and had recognised that only by an application of the experimental method to physiology, which was a subject that must be studied in adequately equipped laboratories, was there any probability of bringing this subject into line with other experimental sciences. In the development of this movement Arthur Gamgee took his share, and brought an acute intellect and a highly trained knowledge of chemical and physical methods to bear on the study of physiology. Apart from the original work which was done under his direction, the publication of the first volume of the "Text-book of the Physiological Chemistry of the Animal Body, including an Account of the Chemistry of Pathological Processes," marks an epoch in English physiology. This volume was dedicated to Christison. It at once established Gamgee's reputation, and even to-day remains one of the most accurate and valuable works in medical literature. The subject is treated from the biological rather than from the purely chemical point of view; it involved a vast amount of experimental work, and the book was what the author claimed it to be, an original work, and not a compilation of facts obtained by the evisceration of pre-existing treatises on physiological chemistry. The book will long remain a lasting credit to British physiology. Thirteen years later a second volume, which dealt with the chemistry of digestion, appeared, and, like its predecessor, this gave a complete survey of what was known at that time on the subject; that portion of the work which treated of the bile, jaundice, and the formation of gall-stones was of particular excellence. His address in 1882, when as president of the Biological Section of the British Association it fell to his lot to express the loss which science had suffered by the deaths of Darwin and F. M. Balfour, was an historical account of the growth of our knowledge on the process of secretion. This address may well be studied by those who wish to grasp clearly the literary and scientific qualities of Gamgee's mind.

The application of physical and chemical methods to physiology was well seen in Gamgee's work. In the Croonian lecture before the Royal Society in 1904 he gave a full account of his life-long researches on hæmoglobin—the dextro-rotatory properties of this pigment, its absorption bands in the violet and ultra-violet portions of the spectrum, the para-magnetic property of hæmin and hæmatin, together with the demonstration that hæmoglobin falls as a coloured cloud in the colloidal state through a clear supernatant liquid in the anodic compartment of an electrolytic cell. These additions to knowledge we owe entirely to Gamgee. In later years his attention was devoted to the solution of a problem which had occupied his mind from the early days when he worked in Tait's laboratory, and in a paper published in the Philosophical Transactions for 1908 he showed for the first time how, by the employment of special thermoelectric junctions, improved thermostats, and the photographic recorder or the string recorder devised by Horace Darwin, a continuous or quasi-continuous registration of the diurnal curve of the fluctuations in the body temperature of animals could be obtained. He completely solved this problem, and believed that this method was destined to prove an indispensable aid to clinical diagnosis. In this we do not think he was mistaken, though the technical difficulties in carrying out the method are considerable.

Dr. Gamgee, as is well known, was a man of the most affectionate disposition, enthusiastic in his work, a good linguist, a fluent speaker, and an excellent classical scholar. The simplicity of his mind and his single-heartedness of purpose endeared him to a wide circle of friends by whom he will be sincerely mourned; for those even nearer and dearer to him, his wife and children, his loss is great and irreparable.

G. A. B.

NOTES.

Prof. H. G. van de Sande Bakhuyzen has retired from the directorship of the Leyden Observatory. His place as professor of theoretical astronomy in the University is to be taken by Dr. W. de Sitter, of the Groningen Astronomical Laboratory, whilst Mr. E. F. van de Sande Bakhuyzen is to succeed him as professor of general astronomy and director of the observatory.

Prof J. Bauschinger has been appointed to succeed Prof. E. Becker as professor of astronomy and director of the university observatory at Strassburg, and Prof. Becker asks that all communications for him should now be addressed to Freiburg i. B., Reichsgrafenstrasse, 17.

With regard to the expedition for the exploration of the Charles Louis Mountains in New Guinea, announced in our issue of March 11, we are asked to state, on behalf of the subscribers, that this expedition is being sent out under the auspices of the British Ornithologists' Union in commemoration of its jubilee, held last December, and described in Nature of December 24 (vol. lxxix., p. 238). It was then decided that this expedition should be known as "The British Ornithologists' Union Jubilee Exploration of the Charles Louis Mountains."

Arrangements have been made for a visit by Count Zeppelin in his airship to the International Aëronautical Exhibition to be opened at Frankfort in July next. The airship will be accommodated during the exhibition in one of the large halls now being built in the grounds, and ascents with it will be made.

We learn from the *Times* that a wonderfully vivid mirage was witnessed from Grimsby on April 8 in the evening. The Humber is six miles wide there, and beyond is three miles of land. This appeared to be lifted high into the air and reversed, the trees inland having the appearance of growing upside down. The Spurn Lighthouse, reversed, was seen four miles from its position, and below the reflection of the land was the North Sea, on which were large steamers, with masts and funnels downwards, passing to and fro.

The Health Congress, Leeds, 1909, organised by the City and the University of Leeds, with the cooperation of the Royal Sanitary Institute and the Royal Institute of Public Health, will be held on July 17–24. The president is Colonel T. W. Harding, J.P., D.L., and the general secretaries are Dr. Spottiswoode Cameron and Mr. Robert E. Fox, the medical officer of health and town clerk respectively of Leeds. A programme of the preliminary arrangements is published in the Journal of the Royal Sanitary Institute for April (xxx., No. 3).

One of the special features of the great Missionary Exhibition, entitled "Africa and the East," which will be held at the Royal Agricultural Hall from June 8 to July 3, under the auspices of the Church Missionary Society, will be a special exhibit of outfit suitable for missionaries and travellers, which will be shown in a special outfit section. One of the special features of this section will be an exhibition of the various methods of protection from mosquitoes and other insects, which play an important part in the spread of many tropical diseases. The organiser of the section is Dr. C. F. Harford, principal of Livingstone College, Leyton, E.

To encourage enterprise and experiment in British aviation, the *Daily Mail* offers a prize of 1000*l*. to the aëroplanist who, within twelve months of April 7, flies a distance of one mile either in a circuit or from a given point to another and returns to the starting point without touching the ground. The other conditions of the award are:—(1) that the motor, planes, propellers, and all other parts be entirely of British manufacture; (2) that the inventor and the aëroplanist be British subjects, and by British subjects we naturally include those in British colonies; (3) the flight shall take place within the British Isles, and be approved by officials of the recognised aviation organisation. Other prizes offered by the *Daily Mail* are:—10,000*l*. for a flight by a heavier-than-air machine from London to Manchester with not more than two stops to take in petrol. Offered in November, 1906; and open to aëronauts of all nations. 1000*l*. for a flight across the Channel by a heavier-than-air machine before the end of 1909. Open to all nations.

Dr. William Jones, assistant curator of the Field Columbian Museum of Chicago, has been murdered by tribesmen in the Philippines about fifty miles south of Echague. He had gone to the islands in 1906 on a four years' expedition to study the life of the Ilingots. Dr. Jones had Indian blood in his veins, and was born among the Sauk and Fox Indians of Oklahoma about thirty-four years ago. He was educated at the Indian school at Hampton, at Andover Academy, and at Harvard, where he had a distinguished career. He took a post-graduate course at Columbia University, and was then engaged by the Carnegie Institution at Washington on ethnological investigations. His success in unravelling many mysteries of Indian religions led to his appointment at Chicago. According to his chief, Prof. G. A. Dorsey, he was the most promising student of ethnology in America, and a similar opinion has been expressed by the head of the Federal Bureau of Ethnology. The day before the receipt of the cablegram announcing his death, Prof. Dorsey had heard by letter from Dr. Jones of his intention to leave the friendly tribe with whom he had been living in order to pursue his researches in a remote section of the country, which would necessitate his passing through a hostile territory.

The geological department of the British Museum (Natural History) has received from the National Museum of Natural History, Paris, a plaster cast of the finest skull and mandible of the long-chinned mastodont, *Tetrabelodon angustidens*, from the Middle Miocene of Sansan (Gers), France. The specimen has just been mounted for exhibition with Dr. Andrews's well-known models of the skull and mandible of Mœritherium and Palæomastodon from the Upper Eocene of the Fayum, Egypt. These three specimens are arranged in series with the American Pleistocene *Mastodon americanus*, so that the principal stages in the evolution of the proboscidean head can now be studied in one view. They show very clearly the lengthening of the symphysis of the lower jaw, which must have been accompanied by an elongation of the soft face, as the mastodonts increased in size in successive geological periods. In the latest genus, Mastodon proper, this elongated soft face, no longer supported by an extension of the lower jaw, must have formed a hanging proboscis, as in the true elephants.

We regret to announce the death, at the age of sixty-eight years, of Prof. F. E. Hulme, author of several works on botany of a popular character.

The annual meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers on May 13 and 14, when the following papers may be expected to be submitted:—On the production of iron sheet and tubes in one operation, by S. Cowper-Coles; on the preservation of iron and steel, by A. S. Cushman; on the manufacture of peat fuel, by Dr. M. Ekenberg; on the chemical physics involved in the decarburisation of iron-carbon alloys, by W. H. Hatfield; on the relation of the solubility of iron and steel in sulphuric acid to its heat treatment, by Prof. E. Heyn and O. Bauer; on high-tension steels, by P. Longmuir; on the Bristol recording pyrometer, by P. Longmuir and T. Swinden; on a heat-treatment study of Bessemer steels, by Prof. A. McWilliam and E. J. Barnes; on the Roechling-Rodenhauser electric furnace, by W. Rodenhauser; on the value of physical tests in the selection and testing of protective coatings for iron and steel, by J. Cruickshank Smith; on further experiments on the ageing of mild steel, by C. E. Stromeyer; on a comparison of the methods of determining the hardness of iron and steel, by Prof. T. Turner; on the rusting of iron, and modern methods for its prevention, by Prof. W. H. Walker. A supplement to the report on the determination of carbon and phosphorus in steel, presented by the special committee appointed in 1901, will be submitted by Mr. A. A. Blair. The autumn meeting of the institute will be held in London on September 28, 29, and 30.

On Tuesday next, April 20, Prof. F. W. Mott, F.R.S., will begin a course of two lectures at the Royal Institution on "The Brain in Relation to Righthandedness and Speech," and on Thursday, April 22, Mr. J. Paterson will deliver a lecture on "How a True Art Instinct may be best Developed," being the first of three lectures on "Aspects of Applied Æsthetics." On Saturday, April 24, Mr. R. T. Günther will begin a course of two lectures on "The Earth Movements of the Italian Coast, and their Effects." The Friday evening discourse on April 23 will be delivered by Mr. Alexander Siemens on "Tantalum and its Industrial Applications," and on April 30 by Dr. Edmund Gosse on "Pitfalls of Biography."

On April 7 the Guernsey States or legislative assembly rejected a proposal to introduce daylight-saving legislation by a practically unanimous vote. A proposal that Guernsey standard time should be Greenwich mean time was adopted.

A conference of members of the Museums' Association and others interested will be held at Towneley Hall, Burnley, on Saturday afternoon, May 15, for the purpose of discussing subjects of interest to those concerned in the work of museums, art galleries, and kindred institutions. Offers of papers or suggestions of suitable subjects for discussion should be sent to the hon. secretary, The Sycamores, Burnley.

A committee, consisting of the members of the scientific staff of the Royal Observatory of Belgium at Uccle, is undertaking the preparation and publication of a list of magnetic and seismological observatories, and this list is to be followed by another dealing with the societies and periodicals particularly concerned with magnetism, seismology, and atmospheric electricity. Such lists will prove of great assistance to physicists occupied with these subjects, since by their aid reference to the researches of other workers will be facilitated greatly. To assist in the work which has been undertaken, the Belgian committee would be glad to receive information from the officials of scientific societies concerned with the physics of the globe. The committee desires to be informed as to the rules of such societies, the date of their foundation, the place of meeting, the subscription, the number of members, the frequency of the meetings, the names of the executive committee, and the publications of the society, and would be greatly assisted by receiving specimen numbers of these. Communications should be addressed to the committee at the observatory.

For some time past very alarming reports have been in circulation as to the work on the Panama Canal, and especially as to the stability of the proposed great dam at Gatun. Three years ago it was settled, after an exhaustive inquiry by a commission of engineers, that, taking everything into consideration, and under the special conditions that prevail on the Isthmus of Panama, it was desirable that the canal should have locks in preference to being made throughout at sea-level. There has, however, since that decision was arrived at, been a continuous agitation kept up in the American Press impugning the recommendation of the commission, and alarmist reports have been circulated, especially with reference to the safety of the Gatun dam. About three months ago another commission was appointed by President Roosevelt to inquire into this matter and generally to report as to the works. The main findings of this commission are a full endorsement of the scheme and works as now being carried out, and an expression of confidence in the engineers entrusted with the work. The dimensions of the locks as finally settled are to be 1000 feet in length and 110 feet in width. It is now estimated that the cost of the canal will be seventy-two millions sterling, whereas a sea-level waterway would cost upwards of one hundred millions. It is anticipated that the lock canal will be completed in five years' time, whereas a sea-level canal would take several years longer. From 40,000 to 50,000 men are now employed on the canal. Owing to the very efficient sanitary arrangements that have been carried out, the district has now become fairly healthy, and yellow fever and other diseases common to a tropical swamp, which formerly prevailed, have almost entirely been stamped out.

Among the contents of No. 5 of the Bulletin of the Imperial Academy of Sciences of St. Petersburg for 1909 is an article, by Dr. W. Salensky, on the development of the nemertine worm *Prosorochmus viviparus* (=*Monopora vivipara*). As the result of the author's investigations, it appears that the proboscis is in no wise concerned with the formation of the œsophagus; the proboscis and the œsophagus are, in fact, developed independently of one another, and only later come into mutual connection; and, finally, the atrium of the proboscis in Prosorochmus (and very probably also in all metanemertines, in which the mouth-opening lies in a so-called rhynchodæum) forms, not only a portion of the proboscis, but also a part of the œsophagus.

The parasites of the cotton-worm are under investigation in the West Indies, and a report of some of Mr. Jemmett's work thereon appears in a recent issue of the

Agricultural News. The two parasites dealt with are *Chalcis ovata* and a Spirochalcis. The latter was found to be parasitic on the Sarcophagidæ, which in turn are parasitic on the cotton-worm, but whether they attack healthy or only damaged pupæ is not yet clear.

THE February number of the *Journal of Agriculture of South Australia* contains the results of manurial experiments on wheat made at certain centres in South Australia. Small dressings of superphosphate were found to give remarkable increases in crop, but neither nitrate of soda nor sulphate of potash had much effect. These results are so unusual that it would be interesting to know the composition of the soil and the meteorological data at the various centres.

A PAMPHLET was recently issued by the Midland Publishing Company, Cradock, Cape Colony, on lucerne, in which the characteristics of this valuable crop are set out in detail. The methods of cultivation and of dealing with the pests to which it is liable are described; sections are also devoted to discussing the value of lucerne as food and as green manure. For the South African farmer lucerne has the double advantage of being a leguminous crop, and therefore increasing the amount of nitrogenous organic matter in the soil, and of withstanding drought, because of its deep-rooting habit.

THE rainfall conditions of many districts of the Transvaal are not altogether favourable for vegetation; the fault does not lie so much in the amount of the rainfall as in its irregular distribution. Similar conditions exist in parts of the United States, but have been overcome by special methods of cultivation, and "dry farming" is now extensively practised. The essential part of the scheme is to plough the soil deeply and cultivate the surface frequently, but to keep the subsoil compact; in these circumstances the water is found to remain near the surface, and is not readily dissipated by evaporation. Mr. Macdonald, the official of the Transvaal Agricultural Department who devotes himself to dry farming, has given in the current number of the *Transvaal Agricultural Journal* an interesting account of the various methods adopted and the principles on which they are based.

BULLETIN No. 5 of the Sleeping Sickness Bureau contains a summary of various papers on the development of trypanosomes in, and mode of transmission of trypanosomes by, tsetse-flies, on treatment, on human trypanosomiasis, &c. Now that so much is being written on this subject, it is very useful to have a summary of this kind.

TUBERCULOSIS is the subject of two papers in the March number of the Bulletin of the Johns Hopkins Hospital (xx., No. 216). One, by Dr. Kober, deals with the influence of sewerage and general sanitation on the prevalence of the disease; the other, by Dr. Moss, outlines a plan of study of tuberculosis in all its bearings, and is well worthy of consideration. The place of protozoology in the medical curriculum is also discussed by Dr. Schultz, and the ground such a course should cover is indicated.

THE influence of radium rays on germination and other life processes in plants is discussed by Prof. C. S. Gager in the *Popular Science Monthly* (March). Experiments were made with sealed glass tubes containing radium bromide of different degrees of activity, and with a rod coated with radium bromide. It was found that radium of strong activity or a long exposure produced retardation of growth, or even killed the plants, but emanations of less activity, in certain cases, produced acceleration of growth.

AN article on sand-binding plants is published in the *Indian Forester* (February), in which the author, Mr. V. Subramania Iyer, furnishes an ecological account of the plants growing on the Coromandel coast. The ten species noted as typical sand-binders are *Spinifex squarrosus, Cyperus arenarius, Ipomoea biloba, Canavalia obtusifolia, Hydrophylax maritima, Spermacoce hispida, Launaea pinnatifida, Pupalia orbiculata, Pandanus odoratissimus,* and *Casuarina equisetifolia*. It is mentioned that *Cyperus arenarius* throws out shoots to a distance of 50 feet, and an underground stem of *Ipomoea biloba* measured 40 feet, with internodes averaging 6 inches in length.

THE hardness of oil-palm kernels might well be proverbial, so that the reported discovery on the West Coast of Africa of a variety with soft shells has aroused much interest. Information on the subject, received from various British and foreign colonies along the coast, has been collated in the *Kew Bulletin* (No. 2). The reports confirm the existence of such a variety in the various countries from the Gold Coast to the Cameroons, and point to its being a botanical variety, *microsperma*, of *Elaeis guineensis*. It is doubtful whether this variety comes true to seed, and in this connection experiments are necessary to ascertain whether the plants are generally self-pollinated or if cross-pollination occurs.

THE account of a South African bamboo, contributed by Dr. O. Stapf to the same number of the *Kew Bulletin*, illustrates the difficulty of naming some of these grasses. It has been known for seventy years that a bamboo grows in Cape Colony, but the reference to a genus was uncertain until flowering specimens were collected recently on the Drakensberg above an altitude of 5000 feet, when it proved to be an Arundinaria. Mr. J. M. Hillier supplies an article on the lalang grass, *Imperata arundinacea*, distributed through Ceylon and parts of Asia, where it is regarded as a veritable pest. In the search for plants which might provide the material for paper pulp, samples of lalang were submitted to analysis and manufacture. The paper produced was very suitable for a wrapping paper, and was somewhat improved by the addition of cotton.

IN the April number of the *Reliquary* Mr. W. Turner describes a collection of Roman metal-work found at Deep Dale Cave, about three miles from Buxton. The objects seem to have belonged to a party of Roman-Britons who were massacred here by some invading host, possibly Picts or Scots. It is almost certain that the victims met a violent death, because in the talus of the cave hundreds of human teeth were found, but very few interments, indicating that the bodies were devoured by beasts and birds. The objects discovered consist of various fibulæ, one of Celtic origin, with the head of a dragon, or, as some say, of a sea-horse; a lady's toilet appliances hung on a ring; a Celtic penannular brooch; a ring and tweezers—all these articles being of bronze. An iron spear-head was found in a part of the cave near a human interment. The collection, which belongs to Mr. Micah Salt, of Buxton, resembles in many respects the articles found by Prof. Boyd Dawkins at the Victoria Cave, near Settle, and it is believed to be the largest assortment of Romano-British remains found in any single cave in England.

THE Francis Galton Eugenics Laboratory (University College, London) has commenced the issue of a new periodical under the title of the *Treasury of Human Inheritance*, in which will be given collections of pedigrees illustrating the inheritance of various characters in man. In the first double part, which is before us, the pedigrees, collected from various sources, relate to the transmission of diabetes insipidus, pulmonary tuberculosis, chronic hereditary trophœdema, split foot, polydactylism, brachydactylism, deafmutism, and ability. Each group of pedigrees is accompanied by an introductory memoir by the contributor, giving a brief description of the character itself, illustrated in several cases by very finely executed plates, a verbal description of the individuals referred to in the pedigrees, and a bibliography. The pedigrees themselves, of which there are seventy-four, are given on large plates, special symbols being used to denote individuals possessing or not possessing the character, or showing it only to a modified degree. The *Treasury*, which is published by Messrs. Dulau and Co., promises to be of the highest value, and Prof. Karl Pearson, who acts as general editor, is to be heartily congratulated on his adoption of the scheme. Anyone who has attempted to trace the published pedigrees relating to the transmission of any one character knows how much labour is involved in the search, and the collection of such pedigrees, both new and old, into one publication will render inestimable service to all those who are interested in the study of heredity.

The summary of the weather for the week ending April 10, just issued by the Meteorological Office, shows the period to have been quite phenomenal for the duration of bright sunshine. The sky was almost cloudless, especially over England and Wales, where the maximum shade temperatures generally exceeded 70°, whilst at night there were sharp radiation frosts. Over the kingdom generally the week was reported as among the brightest ever recorded, the possible duration amounting to 89 per cent. in the east of England, 87 per cent. in the south-east of England, and 82 per cent. in the English Channel. The highest percentage of the possible amount reported from individual stations was 93, at Lowestoft, Yarmouth, Felixstowe, Tunbridge Wells, and Worthing. At Greenwich Observatory the sunshine for the week was 90 per cent. of the possible duration. The thermometer in the sun's rays at Greenwich was 110° or above each day, and on April 9 registered 130°. The week was rainless in most parts of the kingdom.

We have received a copy of the international balloon observations made by the Bavarian Meteorological Service at Munich in 1908, compiled by Dr. A. Schmauss. They are given in the form of the publications of the Aëronautical Committee, and the separate ascents are generally accompanied by useful remarks and deductions. The results for the year have also been carefully discussed; the following are some of the conclusions arrived at, which agree with those obtained in previous years:—(1) The zone of least variation of temperature is in the region of the upper inversion, while the greatest amplitudes of temperature are recorded at the surface of the earth and at a height of about 8 kilometres; between these places, at about 3 km. above sea-level, a relative minimum is found. (2) The temperature gradient has a maximum variation where, generally speaking, it has the smallest values, viz. at the earth's surface and in the region of the upper inversion, and a minimum in the strata of greatest decrease of temperature, viz. from 3 km. to 9 km. (3) The boundary of the upper inversion is higher in summer than in winter; the lowest temperature occurs, on an average, in summer at 14 km. and in winter at 13 km. (4) The summer temperatures in the inversion are generally 3° C. to 4° C. higher than in winter.

In the *Atti dei Lincei*, xviii., 4, Prof. P. Pizzetti discusses the theorem according to which the mean value of a continuous function V of the coordinates over the surface of a sphere of radius R is $(\sinh R\nabla/R\nabla)V_0$, the suffix referring to the centre of the sphere and ∇^2 being Laplace's operator.

The *rôle* of thermal analysis in many metallurgical and chemical problems is so important that considerable interest attaches to the report on methods of obtaining cooling curves, by Mr. George K. Burgess (Reprint No. 99, Washington Bureau of Standards). Using a thermocouple and a galvanometer, the method of obtaining photographic records is fairly obvious; for autographic records the friction of the pen is obviated by limiting the tracing to a series of dots. The paper is illustrated by curves representing the relations between temperature and time, differential, rate of change of temperature and reciprocal of the latter, for typical transformations, one being isothermal, another exothermous, and the last endothermous.

A number of papers have recently appeared dealing with electromagnetic theories, and in particular with the impossibility of explaining electrical and mechanical actions on the hypothesis of a continuous medium. This question forms the subject of a paper, by Dr. Hans Witte, in the *Annalen der Physik*, xxvi., and contributions on pure electromagnetic fields, by Prof. Tullio Levi Civita (*Atti del R. Istituto veneto*, lxvii. [2]) and Leonella Caffaretti, of Rovigo (*Nuovo Cimento*, xv., xvi.). In two contributions to the *Atti dei Lincei*, xviii., 2, 3, Prof. Levi Civita obtains asymptotic expressions for the action of currents and for electric radiations, while the dispersion of energy due to moving charges is described by Dr. Hannibal Comessatti in the *Nuovo Cimento*, xvi.

We have received the first two numbers of the *Internationale Revue der Gesamten Hydrobiologie und Hydrographie*, a journal specially devoted to the study of oceanography and limnology in all their branches. Prof. Weismann contributes an introductory article, and amongst the authors of original papers are Sir John Murray, Drs. R. Hertwig, Raffaele Issel, A. Nathansohn, Alfred Fischel, C. Klausener, and Gustav Götzinger. An important part of the magazine is a series of reports on recent work and summaries of new publications, by experts. The editor is Dr. R. Woltereck, of Leipzig, and the appearance of the journal, as Sir John Murray justly says, "is a very important event for the future progress of these sciences, and may possibly mark an era in the development of knowledge concerning the Hydrosphere as a whole." We wish our new contemporary every success.

By the courtesy of Mr. Alfred E. Dean, of 82 Hatton Garden, who is the London agent of Messrs. Jougla, we have been able to try a sample of the "omnicolore" plate to which we referred on February 4 (vol. lxxix., p. 409). These, like other colour-screen plates, contain in themselves all that is necessary for the photography of objects in "natural colours." The general character of the plate we have already given, and as Lumière's autochrome plates have been in common use for a year or two, it is natural to compare new-comers with them. The procedure recommended by the makers of the omnicolore plate is much simpler than the method of working the autochrome; indeed, it is the simplest possible, considering the general principles involved. The plate, after exposure, is developed, rinsed, placed in an acidified solution of potassium bichromate to dissolve away the silver image, rinsed, returned to the original developer to reduce the silver salt to the metallic state, rinsed, fixed, and washed. Intensification is not necessary, for the sensitive film gives ample density without it; no clearing baths are necessary, and the original developer works excellently for the second treatment—in all these details the manipulation of the new plate is simpler than what is desirable, if not necessary, in the case of the autochrome. The colours of the omnicolore plate are much more transparent than those of the autochrome, being applied as paints or varnishes instead of being absorbed by translucent starch granules; but this method has its drawbacks as well as its advantages, for the density of the colour is not even all over each little patch of red and green. The colour is lighter towards the margins of the patches, and their shapes, too, are rather irregular, but doubtless improvements will be made in these directions. The plates, as they are, are simple and easy to manipulate, and give results that must be distinctly useful to those who wish to reproduce, or, more correctly, to imitate, by the simplest known method, the colours of the objects they photograph.

OUR ASTRONOMICAL COLUMN.

Observations of Comet Morehouse.—Comet 1908*c* was observed, with the 284 mm. Amici equatorial, at Arcetri on forty-one days between September 4 and December 7, 1908, and 127 determinations of its position were made with the micrometer. These are now recorded by Prof. Abetti in No. 4316 of the *Astronomische Nachrichten*, together with a valuable set of notes describing the comet's visual appearance on a number of days.

Mr. Metcalf's note and excellent photographs are also reproduced, from the Harvard Circular No. 148, in the same journal.

A series of six photographs taken at the Dominion Observatory, Ottawa, between October 6 and November 26, is reproduced and described by Mr. Motherwell in No. 1, vol. iii., of the Journal of the Royal Astronomical Society (Canada). The comet was visible at Ottawa for more than three months, but dense smoke and unusual cloudiness prevented an extensive series of photographs from being obtained. Those reproduced show similar knots in, and displacements of, the tail-matter, as previously recorded. On October 20 the head of the comet passed over an eighth-magnitude star without perceptibly dimming it.

Observations of the comet, made with a sextant on board the German steamship *Paranaguà*, are recorded in No. 4317 of the *Astronomische Nachrichten*.

Measures of Double Stars.—The micrometer measures of double stars made by Dr. Lau and Herr Luplau-Janssen at the Copenhagen Observatory during 1908 are recorded in No. 4315 of the *Astronomische Nachrichten*. The stars observed chiefly lie between declinations 0° and 20°, special attention having also been paid to neglected pairs. In addition to the date, position-angle, and distance, the authors give brief notes concerning the colours of the components, and, where possible, compare the values obtained with those computed from previously published elements.

Diameter and Position of Mercury.—In these columns on December 24, 1908 (No. 2043, vol. lxxix., p. 232), we noted the corrections to the diameter and position of Mercury, derived by Prof. Stroobant from the observations of the transit of the planet, on November 14, 1907, made at thirty-three observatories. Since the publication of the memoir in which he gave those corrections, Prof. Stroobant has received observed values from eleven additional observers, and has incorporated them in the final results which appear in No. 4317 of the *Astronomische Nachrichten*.

These show, from the time between first and second contact, that the planet's apparent diameter was $9''.166$, whilst the observations of the third and fourth contacts give, similarly, $9''.092$. These values correspond to diameters, at unit distance, of $6''.20$ and $6''.15$ respectively, the latter being probably the more correct.

The corrections to the equatorial and ecliptical coordinates are found to be $\Delta\alpha = +0.070$s., $\Delta\delta = -0''.25$, and $\Delta\lambda = +1''.03$, $\Delta\beta = +0''.02$, respectively, in the sense observed-calculated.

The agreement of the Italian observations of this passage of Mercury with the data given in various ephemerides is discussed by Signor Pio Emmanuelli in No. 110 of the *Revista di Fisica, Matematica e Scienze Naturali* (Pavia) for February.

The Vatican Observatory.—We learn from the *Times* Milan correspondent that the inauguration of the new section of the Vatican Observatory, which was to have taken place on March 18, was postponed because one of the components of the 40-cm. object-glass for the new equatorial refractor was found to be defective, and has to be re-cast.

When this new section is complete the Gregorian Specola will be abandoned, and the whole of the observatory will be located on the summit of the Vatican hill, 100 metres above the square of St. Peter's, where Father Lais has been engaged, since 1891, in taking the photographs for the International Astrographic Chart (the *Times*, Engineering Supplement, April 7).

PRODUCER GAS FOR ENGINES.

I.—Processes and Plants.

It is well known that what is technically called "producer gas" has been in use for many years in connection with furnace work. Herr Bischof, of Mägdesprung, was the first to use an internally fired gas producer for this purpose in 1839; but little progress was made in our country until 1857, when the late Sir William Siemens introduced the combined gas producer and regenerative furnace with which his name is associated. Some twenty years later it occurred to me that a gas engine might be worked with producer gas if a suitable plant were devised. For furnace work the hot gas is taken direct from the producer to the furnace without cooling or cleaning, and the condensable hydrocarbon vapours, which usually accompany the gas, and add appreciably to its value, are burnt. But for engine work it is essential to wash and clean the gas, especially as it must be free from tar. It is also desirable that the gas should be cool when it enters the cylinder of the engine. Incidentally, this involves the removal by condensation, &c., of the condensable hydrocarbons which leave the producer, and after their removal the gas must still be strong enough to fire well and give good working results in the engine. I succeeded in making a suitable plant, and it was first tried with a small Otto engine in 1879; the results were good, and they encouraged the makers of the engines to build them of larger size so as to compete favourably with steam-power. Many thousands of horse-power are now working with gas plants of this type, and during the last few years a still further impetus has been given to the subject by the use of a modified plant, which is known among engineers as a *suction plant*, and which will be more fully described later.

For the moment we will consider briefly the process of making producer gas, and some of the chemical reactions involved. Producer gas is made by forcing or drawing air, with or without the addition of steam or water vapour, through a deep bed of incandescent fuel in a closed producer. Usually the fuel is fed in at the top, and the currents of air, or of steam and air, enter at the bottom, the gas outlet being near the top. An important characteristic of the process is that no external heat is applied to the producer, as in the case of an ordinary gas retort. When once the burning of the fuel *inside* the producer has been started, the air which is used to make the gas keeps up a continuous process of combustion, and a sufficiently high temperature is maintained to decompose the steam and to effect other necessary reactions.

We know that if there were a shallow fire of carbonaceous fuel and a sufficient supply of air, the carbon would be completely oxidised. The product of this complete combustion would be carbon dioxide, with the development of a large amount of sensible heat; but if there were a considerable depth of carbon in the producer (as there should always be in practice) the resulting gas would be carbon monoxide instead of carbon dioxide, for when there is an excess of highly heated carbon the dioxide formed in the lower part of the fire is reduced to the monoxide. Carbon monoxide may also be formed by the direct combustion of the carbon with oxygen, and actually both these reactions may, and probably do, occur. Theoretically, if we were dealing only with carbon and air, about 30 per cent. of the heat of combustion would be liberated in the producer, and about 70 per cent. would be liberated when the carbon monoxide is afterwards burnt to carbon dioxide in a furnace or engine, &c.; the practical result, however, is still less favourable, and *primâ facie* the conversion of solid fuel into gas does not seem a promising performance.

It is true that not all the heat set free in the producer need be lost if the gas can be used while it is hot (as in furnace work); but for gas engines it must be cold. Apart from this, the liberation of so much sensible heat in the producer overheats it, and indirectly it promotes the formation of clinker, which is a practical drawback. To avoid these and other difficulties, the almost invariable practice is to add a certain proportion of steam or aqueous vapour to the air sent into the producer.

It should, however, be clearly understood that from the point of view of the heat quantities involved, the use of steam in a gas producer is simply a means for absorbing the sensible heat developed by the partial combustion of the fuel, and storing it for future use. Obviously there can be no actual increase of the total amount of heat which can be obtained from a given quantity of fuel. Besides avoiding excessive heat in the producer, the use of steam has the further practical advantage that a gas of considerably greater calorific power per unit volume can be obtained than is possible when air alone is used. The use of air necessarily involves the presence of the diluent nitrogen, and when steam is decomposed the resulting hydrogen and carbon monoxide displace some of the nitrogen.

With the exception of coke and charcoal, all ordinary fuels give off volatile substances when subjected to heat; and in a gas producer, working in the ordinary way with an upward draught, each fresh charge of fuel is heated, and is then subjected in some degree to a process of distillation before it descends into the zone where partial combustion takes place. The gas actually obtained may

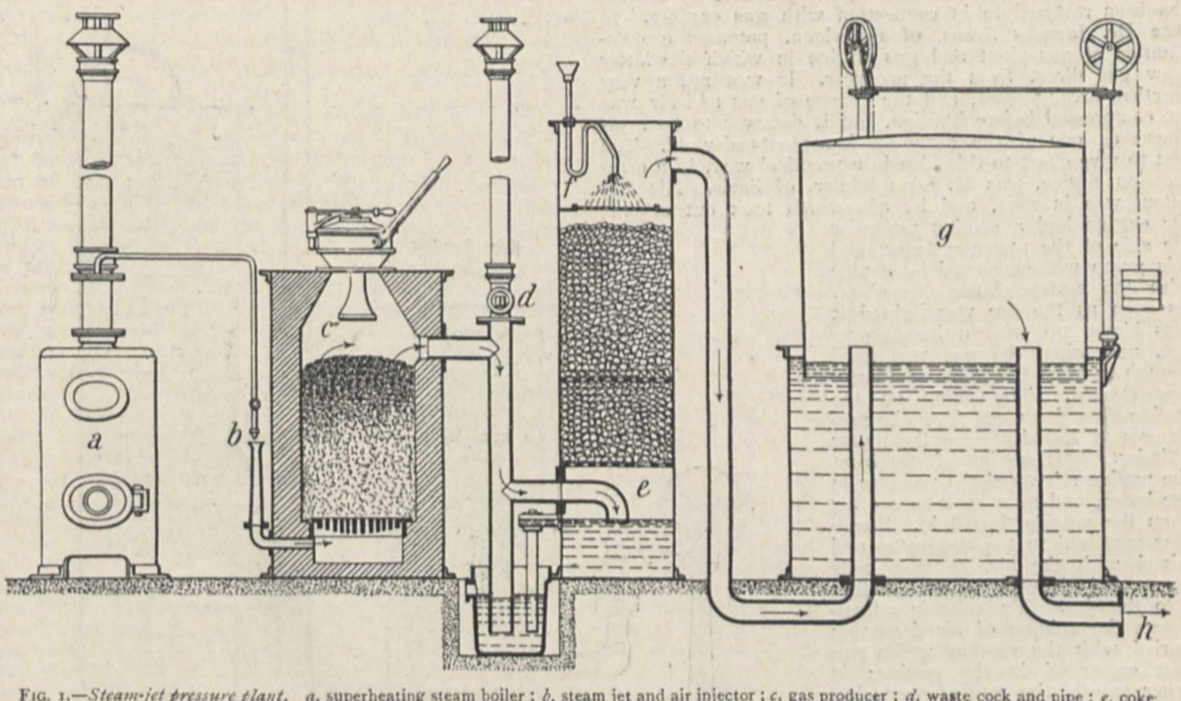


FIG. 1.—*Steam-jet pressure plant.* *a*, superheating steam boiler; *b*, steam jet and air injector; *c*, gas producer; *d*, waste cock and pipe; *e*, coke scrubber with water seal; *f*, water sprayer; *g*, gas-holder and tank; *h* gas outlet.

We are therefore led to consider how steam reacts with the carbon with which it comes in contact. If the carbon is at a sufficiently high temperature, the steam (H_2O) is decomposed, and an equal volume of hydrogen is produced; the oxygen of the steam combines with the carbon to form either carbon monoxide or carbon dioxide, according to the conditions under which the reaction takes place. When hydrogen combines with oxygen to form water vapour heat is liberated, and when this water vapour is decomposed by the reaction of highly heated carbon (or by any other means) an equal amount of heat is absorbed. The combination of the oxygen of the steam with the carbon is accompanied by the evolution of heat, but the quantity of heat thus evolved is much less than the quantity of heat absorbed by the decomposition of the steam, and this is why the addition of small quantities of steam to the air going into the producer reduces the working temperature. Part of the sensible heat is absorbed by the reactions which take place between the steam and the incandescent carbon, so that the gas leaves the producer at a lower temperature than is the case when air alone is used; the heat so absorbed is stored up in the gas, and is again set free when the gas is burnt.

therefore be regarded as producer gas obtained from carbon, mixed with the volatile substances given off by the distillation. The actual composition of the gas depends a good deal on the nature and amount of these volatile substances, and they vary considerably, the fuels used being chiefly anthracite, coke, and bituminous or semi-bituminous coal. Both these coals give off a considerable quantity of tarry matter, which may represent as much as 8 per cent. or 9 per cent. of the total heat value of the fuel. When the gas is cooled and scrubbed before use, the tar which is removed has little value; it is therefore desirable that producers should be designed to burn the tar in the producer itself, or to decompose it and convert it into combustible gases which will not condense at ordinary temperatures. Even anthracite when heated yields both hydrogen and methane, and this is why it makes a better gas than coke.

In Fig. 1 we give a typical example of a gas plant in which the producer is worked with a jet of superheated steam which injects the air required.

In some plants the steam required is produced by the sensible heat of the gas after it has left the producer, and this effects a certain saving; but even then the gas must leave the steam-raising apparatus at a higher temperature than that of the steam, and there is still a considerable loss of heat when the gas is cooled for use in an engine. There is also the loss due to radiation from the producer. Other conditions which have to be considered are the depth of fuel, its porosity, the size of the pieces used, and the velocity of the air blast—all are interdependent; for example, the depth of fuel required to give the best results will depend on the nature of the fuel, its size, and the velocity of the currents passing through it. It is obviously desirable that this velocity should not be excessive, and the producer should have a sectional area large enough for a given maximum rate of production.

The fuel consumption and the cost of repairs with a gas engine worked with a pressure plant, as shown in Fig. 1, have been much lower than can possibly be obtained with the best steam engines and boilers of the same horse-power; but in recent years the modification called a suction plant has given even better economical results for moderate powers. In some of the early gas producers for furnace work air was drawn into the producer by suction, instead of being forced in under pressure, and the idea of working the producer by suction has been reverted to in connection with gas engines. In 1862 Dr. Jacques Arbos, of Barcelona, patented a combination of gas plant and gas engine in which the latter drew gas direct from the producer. It was not a very practical arrangement, and the charge of gas and air was not compressed before ignition, but it deserves to be mentioned as one of the early suction plants devised. The first to give effect to this idea in a practical way, in a compression engine, was M. Léon Bénier, of Paris. His first patent was in 1891, and he afterwards took out others; the engine had a suction pump by the side of the motor cylinder, and this pump was connected by a pipe with the outlet of the gas plant. As soon as the fire was lighted it was blown up with a hand-power fan, and when the gas was good enough to work the engine the latter was started. The pump on the engine then drew gas from the producer and forced it into the motor cylinder. This suction of gas from the producer lowered the pressure in the latter, and as a consequence air from the outside flowed in. Steam was produced in the apparatus and mixed with the air, so that both steam and air were drawn together into the fire. By suitable adjustments the volume of air drawn in varied with the rate at which gas was consumed in the engine; in other words, the rate of producing the gas was governed automatically by the engine itself, and the gasholder and the independent boiler used in a pressure plant were dispensed with. As this plant, and those of which it is the type, work by suction, they are now generally known as suction plants, to distinguish them from pressure plants worked by air and steam at pressure.

The results obtained with this combination of gas plant and engine were disappointing, and the fuel consumption with a full load was greater than with a pressure plant; with a low load it was relatively worse. The gas was poor in quality compared with that made in a pressure plant, and there were other drawbacks; but the idea was an ingenious one, and it was seen that the working of a plant by suction, in combination with an engine, would have distinct advantages if the practical details could be worked out satisfactorily. Several engineers gave their attention to the subject, and the next step of importance was to do away with the pump on the engine and to use the suction of the engine itself, *i.e.* the suction caused by the out-stroke of the piston in the motor cylinder, to draw gas from the gas plant. This reduced appreciably the loss from friction. Various methods have also been devised for producing the steam required and for removing the clinker formed in the producer, as those adopted by M. Bénier were not satisfactory. In Fig. 2 we give a typical example of a modern suction plant.

The production of the steam required to make gas of good quality and to keep the temperature of the fire low enough to prevent the formation of an excessive amount of clinker, presents many difficulties. Steam at pressure is not needed, and some makers have a water vapouriser inside the producer, sometimes near the bottom of the fire, but more often near the top. They heat it by the fire or by the hot gas which leaves the fire, and in some cases both these sources of heat are used. On the other hand,

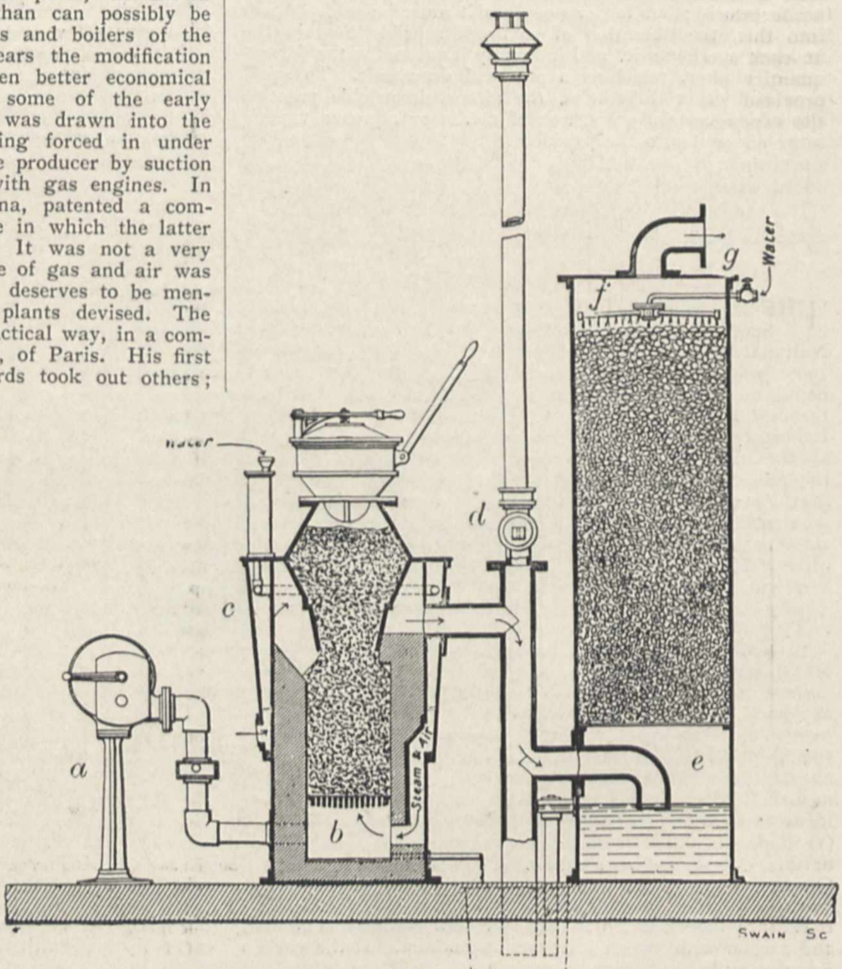


FIG. 2.—*Suction plant.* *a*, starting fan; *b*, gas producer; *c*, water vaporiser; *d*, waste cock and pipe; *e*, coke scrubber with water seal; *f*, water sprayer; *g*, gas outlet.

some makers prefer to have the vapouriser outside the producer, and to heat it by the sensible heat of the gas after it has left the producer. The latter system has the advantage of cooling the gas more, but the amount of steam raised is less than in other systems, and there is the risk that gas will not always be hot enough to make the full quantity of steam required. This not only affects the percentage of hydrogen, &c., in the gas, but has an important bearing on the formation of clinker.

Apart from producing a sufficient quantity of steam when the maximum volume of gas is required, there is the further necessity for regulating the quantity of steam drawn into the fire when the load on the engine is variable. By some it has been supposed that when less gas is produced, *i.e.* when less air is drawn into the fire, the lowering of the temperature which follows causes less steam to be produced, and that in this way the quantity of steam produced is proportional to the quantity of gas required. This is only partly true, as actually the temperature of the fire does not vary as quickly as the load on the engine may vary, and although there may be a considerable fall in the load, there is usually heat enough in the fire to produce more steam than is then desirable. If this excess of steam continues, it not only causes an excess of carbon dioxide to be formed, but it damps down the fire. Then, when the load is increased suddenly, the temperature of the fire is not high enough to develop the power required. Some makers of suction plants try to get over this difficulty by having regulating valves worked by the engine, by means of which the admission of steam to the fire is governed by the engine. Some merely allow a vent in the vapouriser for the excess of steam to escape when the load is reduced, some make no special provision at all, while others use the suction of the engine to draw water into the vapouriser in very small quantities, just enough at each suction-stroke to give the steam required for the quantity of gas to be consumed. This can only be done provided the vapouriser flashes the water into steam; if the vapouriser holds a body of water, as in a boiler, steam is given off continuously, and although there might be a governing of the feed-water, the quantity of steam produced would not be governed. J. EMERSON DOWSON.

(To be continued.)

THE SCOPE OF EUGENICS.

THE first edition of the Robert Boyle lecture "On the Scope and Importance to the State of the Science of National Eugenics," delivered by Prof. Karl Pearson in 1907 before the Oxford University Junior Science Club, being out of print, the author has re-issued the same through Messrs. Dulau and Co. as the first of a "Eugenics Laboratory Lecture Series," intended to place the purport of the investigations conducted in that laboratory before the public in a simple form. The series should serve a useful purpose, as many of the original memoirs are somewhat repellent even to a reader of rather more than average intelligence owing to the use of highly specialised statistical methods. A translation of the lecture into German, by Dr. H. Fehlinger, has been published by the firm of Teubner (Leipzig and Berlin) in the *Archiv für Rassen- und Gesellschafts-Biologie*.

In the present lecture Prof. Pearson gives in brief the whole eugenics argument. "The Darwinian hypothesis asserts that the sounder individual has more chance of surviving in the contest with physical and organic environment. It is therefore better able to produce and rear offspring, which in their turn inherit its advantageous characters. Profitable variations are thus seized on by natural selection, and perpetuated by heredity." If these ideas apply to the case of man, "we must have evidence (1) that man varies; (2) that these variations, favourable or unfavourable, are inherited; (3) that they are selected." On the first head special evidence is hardly necessary; our own eyes afford evidence day by day that man varies, but there is plenty of definite knowledge also as to the amount and magnitude of variation. There is similarly a growing mass of evidence that such variations are not mere individual fluctuations, but are heritable. On the third head, however, the evidence is weaker and somewhat conflicting. In the population at large, natural selection appears to be operative to a greater or less extent, as we find that the age at death is inherited. It would be quite possible, however, for that selection to be ineffective if the weaker stocks nevertheless survived to a sufficient age to reproduce their kind as freely as the stronger stocks, and this seems to be the case to a large extent. The families of deaf-mutes, the tuberculous, and the mentally defective are as large as those of normal individuals, and the lower we go from one social grade to another the higher does the fertility rise. In these facts lies the stimulus to possible action directed towards the betterment of the race, negatively by placing hindrances in the way of the reproduction of the hopelessly unfit, positively by creating an altered tone and public spirit which may lead to a more normal and less restricted reproduction of the prosperous and the intellectual classes.

If one sentence may be cited with special approval, it is a statement near the commencement of the lecture:—"Our science does not propose to confine its attention to problems of inheritance only, but to deal also with problems of environment and of nurture." The improvement of the environment is as much a method of improving the qualities of future generations as the method of selection, not, of course, because somatic variations are heritable (which we do not believe that they are), but because the improvement of the environment endures. In so far as housing, education, and the treatment of the diseased are improved in this generation, the next starts from a fresh basis. Eugenic and eugeic methods should aid each other, and racial improvement be based on care of both the seed and the soil. Hitherto the methods have been too often treated as if they were opposed.

SCIENTIFIC WORK OF THE LOCAL GOVERNMENT BOARD.

THIS report[1] of the Local Government Board is the first to be submitted by Dr. Newsholme, and in the introduction he pays a graceful tribute to the work of the retiring principal medical officer, Sir William Power.

The vaccination returns show a slight increase in the percentage of births vaccinated and of infants exempted under certificates of "conscientious objection."

In the appendix on auxiliary scientific investigations carried out for the Board, Dr. Klein has continued his studies on immunity in plague, and shows that a watery extract of the liver and spleen of a rabbit which has recovered from an attack of plague possesses curative properties.

Drs. Andrewes and Gordon contribute a report on the defensive mechanisms of the body against infection by the pyogenic cocci, and, while admitting that the chief means of defence is a phagocytic one, conclude that the bacteriolytic power of the body fluids is by no means negligible.

Dr. Andrewes has also investigated the micro-organisms present in sewer air, with the result that the bacteria of sewage are to be found in the air of sewers and drains, and that therefore sewage in certain circumstances gives up its bacteria to sewer and drain air, though such bacteria ordinarily form but a small proportion of those present in sewer air. So far, the organisms detected are not in themselves known to be prejudicial to health, but their presence suggests that the more harmful sewage-borne microbes may likewise gain access to sewer air.

Dr. Savage submits a report dealing with the bacterial contamination of milk as obtained from healthy cows, and with the examination of milk samples obtained from cows suffering from an inflammatory disease, garget (mastitis), of the udder. In another report he details the results obtained in an examination of the intestinal contents of domestic animals for bacteria belonging to the Gaertner group—organisms which cause certain outbreaks of meat poisoning. From three bullocks and six pigs the results were negative, but from a calf numerous organisms belonging to this group were isolated.

Of late the view has been gaining ground that acute rheumatism is a microbial disease, and various organisms have been described by investigators. Dr. Horder contributes a report on the subject, but his results are mainly negative, and further research is evidently called for.

The action of the *Streptococcus faecalis* and of its chemical products has been investigated by Dr. Sidney Martin. The organism is capable of producing various disease conditions in man, such as cystitis and septicæmia. Preliminary experiments on the toxin of the microbe suggest that the main poisonous product is an endotoxin.

In an appendix Dr. Blaxall and Mr. Fremlin record experiments on the effect of cold on the potency of vaccine lymph, and show that a temperature of $-180°$ C. has no effect, and that lymph stored at $-5°$ C. for a year suffered no diminution in potency.

It will thus be seen that the volume contains papers of considerable importance in scientific medicine and hygiene.

R. T. H.

[1] Thirty-sixth Annual Report of the Local Government Board, 1906–7. Supplement containing the Report of the Medical Officer for 1906–7.

GERMAN ANTHROPOLOGICAL PAPERS.

THE two volumes, xciii. and xciv., of *Globus* for 1908 are especially interesting for the numbers of papers dealing with South American ethnography. The more important of these are:—Dr. T. Koch-Grünberg's articles on fishing and hunting among the natives of north-west Brazil, in which the implements employed are fully and carefully illustrated; the arrow release is described, and details given of large communal fish-traps and private tackle, the blow-pipe, arrow-poison, and a variety of weapons in use on the Upper Amazon tributaries. G. von Koenigswald's series of papers on certain tribes of southern Brazil deal somewhat briefly with the Botocudos, and more exhaustively with the Cayuas, a nomadic hunting tribe of the Guarani family. Weapons, lip-ornaments, physical types, and other points are figured. Freiherr von Nordenskiöld contributes an account, with carefully executed figures, on tobacco-pipes of South America. He concludes that they occurred sporadically before the *Discovery*. The tubular pipe, the most primitive form, is discussed and compared with the North American varieties. H. Beyer gives an account of the Mexican "dragon," in which he states that the god Quetzalcoatl, who is identical with Xiuhcoatl, is represented not only as human, but as a feathered snake. He is the most important deity in Mexico. The feathered snake was probably a sign of the ecliptic or of the zodiac, and Quetzalcoatl would thus be not only the deity of time, but also, like Xiuhcoatl, the symbol of the year.

T. von Koenigswald's series of articles is continued in vol. xciv., valuable and copiously illustrated descriptions being given of the Corôados and Carayas, hunting, fishing, and agricultural tribes who have resisted European influence to a very large extent. Prof. V. Giuffrida-Ruggeri, of Naples, gives an account of Florentino Ameghino's discoveries in Patagonia, which point to South America as the home of the "half-apes." He discusses the remains of the various strata, but says that the question must now be left for geologists to decide. He defines the genus Homunculus, and figures the skull of *Homo pampaeus ameghinoi*.

The German colonies are represented in vol. xciii. by well-illustrated papers by Dr. R. Pöch on New Mecklenburg (New Ireland) and Kaiser Wilhelm's Land. As regards Africa, negro music and musical instruments in Togo are described in two papers by Smend, in which variations in the musical bow, primitive harp, drum, and trumpet are described and figured. An account is given by Missionary B. Gutmann of curses and blessings of the Wadschagga. Dr. H. Krauss contributes an illustrated article on the household utensils of the German East African coast negroes. Vol. xciv. contains a brief description (with figures) by Missionary C. Spiess of the secret Yevhe and Sẽ cults among the Evhe of the Guinea Coast. The origin of these mysterious objects, possessed of magical significance, has not yet been ascertained. B. Struck describes and figures some of the really able topographical efforts of King Ndschoya, of Bamum, West Africa. The Jabim shields of German New Guinea are described by B. Geisler, with illustrations of the method of giving a permanent warp to the shield and of the ornamentations on it. The hitherto uninvestigated natives of the Tanga Islands, off New Mecklenburg, are the subject of a short illustrated paper by Dr. O. Schlaginhaufen.

Europe is not neglected. To vol. xciii. Dr. A. Baldacci contributes an account of the Slavs of Molise (central Italy), and Dr. M. L. Wagner gives notes of a trip in Sardinia (continued in vol. xciv.). An appreciation is given by H. Seidel of Robert Townson, an eighteenth-century traveller in the Tatra, Hungary.

Vol. xciv. contains a beautifully produced copy of Sebastian Münster's map of Germany, recently brought to light after long oblivion; Dr. A. Wolkenhauer gives a most interesting explanation of the astronomical devices with which the sixteenth-century topographist and astrologist accompanies his map. In the same volume Dr. V. Lazăr contributes an account of marriage customs among the southern Roumanians.

As regards Asia, in vol. xciii. F. Grabowsky gives an interesting account of rice-culture among the Dayaks of south-east Borneo. In vol. xciv. we have a description by Prof. G. Behaghel of his travels in the Chinese province of Fokien. Dr. Ten Kate furnishes further points of Japanese popular belief in regard to omens, dreams, astrology, and mythology. Dr. M. Moszkowski gives a short illustrated account of the modified Danigala and Hennebedda Veddas, and a more detailed description of the inland tribes of east Sumatra.

Among the folk-lore articles in vol. xciii. mention must be made of Dr. Emil Fischer's description of the Paparudă procession among the Roumanian peasants, which takes place on the third Tuesday after Easter or after continued drought, when girls go round the village singing the rain-song. He cites another instance of southern Slav influence in the Scaloian procession, when children, mostly girls, form a mock funeral procession about a clay figure in a coffin, singing a dirge; the Scaloi, of which an illustration is given, is supposed to personify the drought which will end with its funeral. Prof. Mehlis describes the "Hexenhammer" of Dörrenbach (Palatinate) and other Neolithic implements still associated with thunder and magic by the peasants of those parts; he also alludes to the nomenclature of these objects in the Greek and Roman authors.

For Africa other than the German colonies, reference must be made to F. J. Bieber's paper in vol. xciii., on the political organisation of Kaffa, which lies in the south-west corner of the north-east African highlands, north of Lake Rudolf. With regard to Australia, vol. xciv. contains an account, by Frh. v. Leonhardi, of dog-figures of the Dieri tribe in central Australia; they are painted red and black, and are thought to represent the dogs of various tribal ancestors. These animal figures are apparently unknown among the neighbouring Aranda and Loritja tribes.

Of general interest are Dr. J. H. F. Kohlbrugge's discussion of red hair and its significance in vol. xciii. He compares the occurrence of erythrism and albinism in mammals and man, and discusses the question of pigmentation. In conclusion, he expresses the hope that the question may be more thoroughly investigated in the future, and alludes to E. Fischer's work on the subject, published after his article was written. In vol. xciv. Dr. C. Kassner gives a number of illustrations, with brief descriptions, of Bulgarian clapping-boards, salt-mill, wells, church taper-stand, and a variety of objects of antiquarian interest. Dr. S. Weissenberg discusses the problem of growth in human beings according to age, sex, and race. Tables are given illustrating the comparative annual growth of both sexes, of Jew and Jewess, Russian boy and girl, English boy and girl, Belgians, also of annual increase in weight, height, and size according to external circumstances. In conclusion, he points out that the third period of life, from ten or twelve to seventeen or eighteen years of age, is the crucial time of development, as it is then that racial, sex, and individual differentiation sets in.

NEW CRUCIBLE SUPPORT AND FURNACE.

MESSRS. J. J. GRIFFIN AND SONS, LTD., have sent us for examination a universal crucible support. It consists of three iron rods, which pass obliquely through the legs of an iron tripod and are held firmly in the correct positions by the action of brass springs. The three rods have fitted over them quartz tubes drawn out into pointed ends. By simply pushing in or drawing out the rods can be adjusted to take either small or large crucibles—up to three inches in diameter. Quartz fusing at a higher temperature than platinum, this crucible support is very handy, and is much cheaper than using a platinum tripod. The heating of the crucible is also more uniform, as it is held in position simply by the pointed ends of the quartz tubes. There is therefore no necessity to turn the crucible about in order to make sure that the whole of its contents are completely and uniformly ignited.

We have received from the Cambridge Scientific Instrument Company a small crucible furnace heated with a Méker burner, and called the Méker furnace. We have tested the furnace and find it very efficient, as within a few minutes there is no difficulty in melting copper. The main features of the new burner are the careful and exact proportioning of the size of the air inlet holes and of the gas injector, thus causing a perfect mixing of the air and gas for combustion. The lower part of the burner is constricted and the upper part enlarged so as to allow a thorough mixing of the gas and air before combustion. The top part of the burner is furnished with a deep nickel grid to prevent back-flashing of the flame. This nickel grid is of very stout make, and is about 1 cm. deep, thus making it practically impossible for the flame to flash back. Although the burner gives a very hot flame, the amount of gas used is by no means excessive, and as metals are very rapidly melted, and other operations, such as fusion and reduction, carried out very quickly, the gas consumption for a given operation is less than with other burners.

One of the greatest advantages is that, by using the Méker burner, operations which used to require a large amount of leg-work with the blow-pipe can now be carried out without employing a blow-pipe at all. In order to obtain very high temperatures another form of the Méker burner is arranged for use with the blow-pipe or compressed air.

These burners are made in a large variety of sizes and shapes, and from our experience with them we shall expect to see them largely employed in the future.

THE DEFECTS OF ENGLISH TECHNICAL EDUCATION AND THE REMEDY.[1]

WHEN writing the paper which I am going to read to you I have rarely been free from the oppressive thought that many of my audience will justly consider it forwardness, bordering even on arrogance, on my part to lecture to an association of English technical teachers on the defects of English technical education. Not only have I been interested in this subject merely for a few years, whereas many of my audience have spent a lifetime in it, but I am not an Englishman myself.

Your secretary, however, insisted that the exceptional opportunities which I have had of becoming acquainted with technical education as it affects, not only the lecturer and the student, but also the employer of labour, in this country as well as in Germany, would carry weight with you and would assure your serious consideration of my views; but further, standing as I do outside the teaching profession, and having no private interests to serve, I thought that, whatever criticism I might experience, I should not be suspected of any ulterior motive if I came forward to point out what, to my mind, are the weaknesses and faults of our present system, and to advocate what appears to me the only right course to adopt. So I accepted your secretary's invitation, and will, with your permission, now proceed to place my somewhat unconventional views before you.

The importance of technical education for any modern nation, but most particularly for England, cannot easily be overestimated, a fact which is being pointed out so frequently and acknowledged so generally that I need not dwell upon it at any length. There is not a student of national economy who fails to realise that Germany and the United States, now serious rivals to English trade, owe their rapid industrial and commercial development largely to the magnificent system of technical education which they have established.

Indeed, the recognition of this fact by all thoughtful men has led to vigorous efforts being made during the last ten years or so, and to a prodigious amount of money now being annually spent in this country for the purposes under discussion.

No one will deny that a very great deal has been accomplished, and personally I should be the last to underrate the value of the work now being done in numerous institutions, or to belittle the services of so many pioneers, to whom, indeed, the nation owes a debt of gratitude. Nevertheless, it must be, and is, widely recognised that technical education is only in its infancy, that it is as yet far from exercising to the full and in an efficient manner that propelling influence on the industries of the country which is its aim and duty.

Almost invariably, however, when this fact is recognised and pointed out, on whatever occasion it may be, the conclusion is drawn from it that the people of England must be prepared to spend more money in erecting and thoroughly equipping technical colleges and universities.

The main object of this paper is to prove the fallacy of that conclusion, and that every new college erected is another stone round the neck of technical education. It is, in my opinion, certainly not lack of money which is to blame for the admittedly unsatisfactory state of affairs. From the statistical data contained in the Government Blue-books and Budgets I have made a calculation as to the total expenditure of public money in England and Wales as compared with Prussia. The two countries are similar in industrial activity and in the character of their population. Prussia, with its highly efficient educational system and its technical institutions admired by all the world, spends roughly 600,000*l.* per annum on current expenditure. The statistics available for England, particularly as to local contributions, are rather scanty, but from a very moderate estimate I find that at least 1,000,000*l.* is annually spent for equivalent purposes. Taking into account the larger population of Prussia, we arrive at the result that England already spends about twice as much money as Prussia, reckoned per head of population, with educational results which—I say it without hesitation—will not bear any comparison. If one would compare the extraordinary expenditure incurred in building and equipping new institutions, the result, I believe, would be even more unfavourable to England.

Neither lack of money nor of effort is the fault, but the fundamental principle is wrong on which rests the whole structure of technical training in this country.

Technical education is not a private or local, but by its very nature a national affair, and the most essential condition for efficiency and economy is that it should be established on the basis of systematic national organisation, and that it should be nationally managed.

The numerous objections raised by employers and the general public against technical colleges, and the still more numerous grievances of those actively engaged in technical training, are largely, if not solely, connected with the present unsound foundation.

With the object of proving the truth of these sweeping statements, let us briefly consider what are the complaints I refer to.

(1) The number of day students in all institutions, and consequently the attendance at the majority of classes, is far too small. Taking the figures given by the British Education Section of the Franco-British Exhibition for 1908, there were in England and Wales forty-five technical and agricultural colleges, with a total attendance of 3344 day students. This corresponds to an average of seventy-five students per college, or approximately six students per class. These figures do not include the technical students of universities and university colleges, but, nevertheless, the facts are even worse, because the large number of smaller technical institutions providing for day instruction is omitted from the list, and the preponderance of students in the first-year courses must also be kept in mind; and, further, even in the largest colleges, in such institutions as the Birmingham University and the Manchester Municipal School of Technology, the attendance of day students bears no proportion to the cost of their beautiful equipments. Manchester, for instance, reports a total attendance in all departments of 165 full-course day students during the present session. In numerous institutions it is by no means an exception to find classes, especially in more advanced subjects, consisting of two or three students, and many classes only exist on paper, there being no students at all to take advantage of the facilities offered to them.

(2) The average education of day students entering for technical instruction is poor, and the diversity of their previous training so great, that the gravest educational difficulties result. This is only partly due to the unsatisfactory state of primary and secondary education. The

[1] Paper read before the Association of Teachers in Technical Institutions (West Yorkshire branch) in Huddersfield, on March 27, by Dr. Robert Pohl.

chief reason is the scarcity of students, which leads to little regard being taken of the previous education of a would-be day student.

(3) The undue importance attached to external examining bodies, and the consequent variety of examinations to which the training must be adapted, detract from a concentration of effort and uniformity of purpose.

(4) The usual management of municipal institutions by a committee, the constitution and policy of which may change every year, and which only too often consists of a number of private gentlemen more or less strangers to technical education, is unsound and wasteful. It often stultifies the really enthusiastic teacher by delaying necessary and urgent improvements.

How long will this country continue to leave the management of so vital a matter as day technical education largely in the hands of amateurs?

(5) The equipment provided in individual institutions cannot be kept up-to-date, owing to lack of funds and of students.

All these serious obstacles result in financial wastage as well as educational inefficiency, the latter all the more, as they make it exceedingly difficult for a teacher to find that amount of satisfaction in his work necessary to keep alive his enthusiasm and that of his students.

Coming to the attitude of the employers of labour toward technical education, it is not altogether surprising to find that little importance, as a whole, is attached to college training.

A comparison of the advertisements for vacant posts appearing in English and German technical papers will prove this better than anything else.

Generally speaking, there appears to be amongst employers a lack of interest in technical education, and not much willingness to cooperate with technical institutions. This impression I have received in numerous conversations and inquiries concerning this subject. Specific complaints there are few; I have occasionally heard it stated that day technical training is not of a sufficiently practical character, that day colleges not rarely fail sufficiently to impress on the minds of the students the importance of practical experience, and that, thereby, they indirectly make them look down on shop-trained men and unwilling to adapt themselves to the routine of the workshop and to acquire practical knowledge and skill; that technical teachers are often recruited from the ranks of those day students who have found it too difficult a task working themselves up to a good position in practical life; this, in turn, is said to be the cause of the colleges remaining alienated from practice. Finally, the statement is sometimes made that too little original work, especially such as requires experimental research, is carried out by the staffs of day colleges.

My personal opinion as to these points is that none of them is quite without justification, though specific cases are often exaggerated and unduly generalised. It is certainly a great mistake permitting students to remain as assistants in the college after their final examination, and gradually to work themselves up into the position of lecturers in technical subjects, without having ever entered into practical life.

The main cause for such complaints, however, lies in the fact that even in the technical universities the number of students is not sufficient to permit of a number of specialised experts being appointed in each department, as is the practice in Germany. The professor or lecturer in an English college is expected to deal with a variety of subjects, each of which is a science in itself, and his spare time is very limited. Personally, I think it is surprising that so much original work is done in spite of such adverse circumstances.

Evening classes stand in greater favour with employers, being considered a necessary complement to the day-work of apprentices. Complaints are made, however, on account of the heavy nervous strain imposed on youths. Only quite recently two cases of nervous collapse have come to my notice which, according to the doctor, were without doubt due to excessive strain imposed by the college work, which consisted of lectures on three nights a week and a large amount of home-work. Proper cooperation between the employer and the college would have secured the amount of relief during daytime necessary for the physical and mental well-being of the boy. Such cooperation is absolutely necessary in connection with all evening work.

Coming, finally, to the general public and its attitude towards technical education, I need hardly refer to the cry heard throughout the length and breadth of the land that the technical schools impose a far too heavy burden on the ratepayer, a burden altogether out of proportion to the work accomplished, both qualitatively and quantitatively. We hear that cry every day. I am afraid, however, of losing your sympathy altogether when I state it as my opinion that these complaints of the ratepayer are fully justified. I consider some of the figures which were recently published as to the cost of technical education per student-hour are absurdly high, and a conclusive proof of the inefficiency of our present system; but, apart from that consideration, the ratepayer contributes about 75 per cent. of the cost of technical education, whereas it is only just that the bulk of it should come from national sources.

This list of defects of technical education could be still further extended, but I have only referred to the most important ones, the majority of which are felt in all technical schools and colleges, and on which I believe we are agreed.

Now, I venture to submit to you that all these defects could be removed by placing technical education on a national basis.

Day technical teaching, to be efficient, must, in my opinion, be thoroughly organised all over the country, so that a limited number of excellently equipped colleges, with a very large number of students and a corresponding number of specialised lecturers in each department, will satisfy the needs of their correspondingly large districts. That is the secret of Prussia's success; and though many English people, justly proud of their free institutions, may look down on Prussia as a State governed by army officers and policemen, so much they will have to admit, that England not only can, but must and will, learn a good deal from Prussia in regard to the organisation of education.

May I, for example, refer to the Charlottenburg College, about which so much was said and written in connection with the founding of the Imperial College of Science and Technology? Very rarely have I found that the English admirers of Charlottenburg understood the real difference between the German and any corresponding British technical college. It is this: technical education being nationally organised in Prussia, there exist only four technical universities in the whole country, with a population of 38,000,000 people. The average number of day students is about 2500 per day. Charlottenburg, the largest of them, is the technical university, not only for the whole of Berlin, but in addition for a district of some 40,000 square miles. The number of its students, which, of course, are all day students, is about 5000, and the most stringent regulations as to their previous training are in force. With such an attendance the State can afford to appoint for each department a number of professors, each of whom is a recognised authority in some branch of that department. As an example I may mention that there are at Charlottenburg not less than seventeen professors and lecturers in electrical engineering subjects alone.

Instead of this, what do we find in England? The British Government has chosen the easier course of leaving the founding and management of technical institutions to the enterprise of charitable private persons, corporate bodies, and the local authorities. As a result, there are—not in greater London, but in the administrative County of London only—at least six colleges of university standing and six day colleges recognised by the Government as technical institutions competing with one another, not to mention ten other institutions with day technical classes and eighteen schools of art. Similarly, in the provinces quite a number of lavishly equipped university colleges have been founded, and technical day schools have sprung up like mushrooms, their number now being many times in excess of the well-understood needs of the country. Many of these institutions are in close proximity to and competing with one another.

The educational consequences require no repetition. You may go through all the defects which we have considered, and you will easily see that every one of them is directly attributable, not to lack of energy or ability on the part of the technical teacher or to unwillingness of the British rate- and taxpayer to part with his money, but to the absence of national organisation and the consequent disastrous competition between the existing schools.

Money can build the most beautiful edifices and buy the most excellent equipments, but it will not cure this evil. Technical education will, in my opinion, never to the full exercise its highly important functions in the life of the nation until the Board of Education awakens to its duty and establishes a sound national system of technical education; and such system will require to be enforced, as the petty jealousies invariably found to exist between neighbouring corporations do not permit of any hope that a similar result may be obtained by voluntary cooperation.

To this you will reply that the establishment of a national system of technical education would be a revolutionary and almost impossible step in England. I beg to disagree, and to believe that technical education can be far more easily organised on the basis of a national system than, for instance, primary education. In fact, I even doubt as to whether any new legislation would be required for the purpose. The pressure which the Board of Education, by means of the grant alone, can bring to bear on the governing bodies will prove sufficient to bring the majority, if not all, of the existing schools into line with a national scheme, and to make them take up the position assigned to them in it. I will go further, and venture to prophesy that before many years have passed the Government will have to take this matter up, under the combined pressure of the two parties chiefly interested in efficiency and economy, *i.e.* the technical teacher and the ratepayer.

It will, on this account, not be a waste of time to consider briefly the question as to an ideal system for England. I am well aware that any such system could only very gradually be developed out of the present chaos. A definite, practical scheme, however, even if not fully attainable, always serves as an invaluable and unfailing guide.

Naturally, opinions on this question will differ very greatly, and all I have to say must be taken merely as a suggestion towards a very careful and exhaustive investigation of the subject, which, I think, this association ought to carry out.

Let me state, first of all, that I should not recommend an imitation of any existing foreign system, not only because I am unaware of any system that could not be materially improved upon, but chiefly because the educational system of any country must, of course, be adapted to its particular industrial and educational conditions; and, again, far from condemning the present English system root and branch, I consider that some of its features are most excellent, and should be maintained and further developed—features which are entirely absent, for instance, in the Prussian system. I refer, first, to the evening courses, which are doing exceedingly good work, and are deserving of the highest praise, and, secondly, to its democratic spirit, which shows itself in the low fees for evening instruction and in the extensive system of scholarships. I am well aware that complaints are often voiced against the methods now adopted in the awarding of scholarships, to the effect that they do not effectively prevent the tremendous leakage in the nation's brain resources. Still, I think it will be possible to modify it in such a manner as really to detect the very best brains of the whole country, wherever they may be found, and to lead them up to the highest possible development, to the benefit, not only of themselves, but of the whole nation. These factors, I suggest, should form two of the corner-stones of a national system.

However, in discussing these matters we are really taking the second step before the first. Before erecting corner-stones we ought to remember that no superstructure, however well designed, can stand erect unless it rests on sound foundations; and this leads me to what is perhaps the most important consideration in connection with this subject.

Unless English primary education is put into a much more satisfactory condition, technical education must remain severely handicapped. Does it not almost amount to a national crime that many thousands of children are permitted to leave school when only twelve years of age, and when the instruction is just becoming most valuable? Words fail in face of such overwhelming evidence as is contained, for instance, in a report of the Huddersfield Education Committee, issued a few months ago, of which the following is an extract:—"His Majesty's Inspector conducted a labour certificate examination. 162 candidates were examined, 136 passed and 26 failed. Of those who passed, 125 were between the ages of twelve and thirteen, and only 11 were over thirteen years of age." It is the duty of this association and of all individual technical teachers to work for the final abolition of the half-time system, the extension of the age limit for compulsory school attendance to fourteen years, and also for the stopping of street hawking and other exploitations of child labour. All men interested, not in cheap labour, but in the well-being of the nation, are agreed upon the desirability, and even the absolute urgency, of these reforms. Surely if other and less wealthy nations can afford carefully to educate every future citizen until he or she be at least fourteen years of age, England would not overtax her resources by doing likewise; indeed, she would make a step towards true economy.

A Children's Bill was passed during the last session of Parliament containing, I admit, some excellent provisions; but it passes my comprehension how the Government can be as proud of its "Children's Charter" as it seems to be so long as no attempt whatever is made towards the above indicated reforms, so highly important and so long overdue.

In addition to the extension of the school age, primary education should, in my opinion, be rounded off by compulsory attendance at evening continuation schools for three years.

On the basis of sound primary education, the structure of technical training which I wish to suggest is as shown in the following diagram, which indicates the various ways leading up to the technical university:—

Years of age	—	—	—	—
20	Technical University	Second year Technical University	Technical University	
19 18 17	Apprenticeship and Evening Technical School	Apprenticeship and Evening Technical School	Pupilage	Pupilage
16 15 14	Apprenticeship and Evening Continuation School	Trade School	Trade School	Grammar School or Equivalent Secondary School and Primary School
13 12 11 10 9 8 7 6	Primary School			

A boy of fourteen, leaving the primary school and wishing to go in for a technical trade, has two courses open to him. If his parents cannot afford to let him continue in the day school, he should be apprenticed and should attend the evening continuation school up to his seventeenth year. He may then obtain a more specialised technical education, according to his requirements, by attending the technical evening classes for another three or four years, proper cooperation with the employers being an essential condition if success is to be obtained; and should his teachers find that his is a brain of exceptional ability, deserving and desiring to be developed as highly as possible, I suggest that an extensive system of national maintenance scholarships should enable him then to enter the technical university.

This is not the place to discuss the details of conditions and requirements. I only wish to emphasise that the son of even the poorest parents should not, by reason of his leaving school at fourteen, lose his opportunities of reaching the very top of the educational ladder; and I am anxious to lay the greatest stress on the desirability of extensively drafting the very best evening students into the technical universities.

The second alternative for the boy of fourteen is to continue his school life in a trade school to his seventeenth year, when the final certificate will give him access to the technical university after an apprenticeship or pupilage of at least one, better two, years. This would be the easiest and the more general road to the technical university; but, again, on leaving the trade school the student may be apprenticed for three years, attending also the evening classes, and he may qualify for the second year of the technical university, or even obtain a maintenance scholarship.

The third way of reaching the technical university would be through the grammar school or equivalent secondary schools. The certificate of having passed a certain standard either on the modern or the classical side would, again, without further entrance examination, be accepted as sufficient proof of adequate education, though for engineering, building, and textile departments at least one, but preferably two, years' practical work should precede the university studies.

The above forms an outline, though a very rough and compressed one, of my ideas. Let us, in conclusion, consider the most important question as to how the general introduction of any such national scheme would affect existing schools, and also the position of the technical teacher.

The majority of the existing technical day institutions would cease to exist as such; they have given conclusive proof that they have no right of existence. They would be transformed into trade schools for the daytime. The evening technical classes, however, would not only be maintained, but further developed, as they would grow enormously in general importance.

A number of the existing colleges and universities, spread at sufficiently large intervals over the country, would be developed into technical universities of the highest order, challenging comparison, not only as regards equipment, but in every other respect, with the very best institutions of other nations. According to the nature of the district, such technical university might be split up, where necessary, and an engineering college be established in one centre, a textile college in another, a mining college in a third, &c. Thus regard could be paid to local requirements to a considerable extent, while at the same time abolishing the present disastrous multiplication of efforts. The technical university should in its management be independent of local authorities; it should be entirely self-governing, and be under the direct control of the Board of Education. It should be permeated by a thoroughly democratic spirit, and those recruited from the technical evening classes by means of maintenance scholarships should form a very large percentage of its students.

Now, as to the position of the technical teacher, will it suffer or improve under such a scheme?

The answer is obvious if we will only consider what it is at present. The technical teacher is overburdened with day and with evening work, in addition to which, as is well known, he must spend a great deal of spare time in private study if he wishes to keep up to date in his rapidly progressing subjects; but, in spite of this, his salary, on the whole, is hardly better than that of the elementary teacher. In the endeavour to economise at all costs, corporations seem more and more inclined to consider the salaries of technical teachers as the most appropriate subject for curtailment; and, further, it seems to me, the technical teacher does not stand very high in the estimation of either the general public or the employer of labour.

Summing up, I find that his position is far from being in accordance with the importance of his work with regard to the life and development of an industrial nation. The reason is obvious. As yet technical education itself occupies a position far below that which is its due, and, of course, the technical teaching profession is inseparably connected with it. By lifting technical education up to its proper level and making it a national affair you would make the technical teacher a national or, to use the ordinary term, a Civil Servant, and the technical teaching profession would receive the recognition which it deserves, and which it receives in other countries.

That is, in my judgment, the only way in which English technical Education may be enabled to exercise that amount of guiding and enlightening influence which it must possess if this industrial country wishes to maintain its front seat in the council of the nations.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

AT a meeting of the East Lancashire Branch of the Association of Teachers in Technical Institutions on April 17 at the Municipal School of Technology, Manchester, Prof. W. W. Haldane Gee will open a discussion on "The Optical Lantern and the Microscope, with Special Reference to their Educational Uses."

DURING the last three years an investigation has been in progress in the United States to trace the cause of the failure of the physics teaching in the secondary schools of the country, and the educational journals have devoted much space to the question. It now seems possible to give a summary of the most important facts which the inquiry has brought to light. When physics was first introduced into American secondary schools, a distinct effort was made to present it as a means of explaining the various natural phenomena witnessed by the pupil in his daily life. Few experiments were performed, and those by the teacher with the simplest possible apparatus. Then came the decree that methods must be changed so as to meet the requirements of college entrance examinations, and, as a result, pupils were on the one hand forced into "inductive" or first-hand work, for which they were quite unsuited, and on the other were overwhelmed with mathematical formulæ, in which the physics was buried past disinterment. Now there is a strong desire to return to the ideals which prevailed in the past, to sever the school teaching from college control, to reduce the emphasis now laid on mathematical formulæ and on extreme accuracy in experimental work, and to base the subject on the daily experience of the pupils. The national commission has our cordial support in its efforts at reform.

THE March number of the *Psychological Bulletin* is devoted to child and educational psychology. Prof. O'Shea writes of progress in this field, and puts his finger definitely upon the necessity for the establishment of institutions for educational research in which children of every age will be available for observation and experiment. There are many psychological laboratories, but no institution in which the resources of the experimental psychologist are solely devoted to the problems of the teacher. Perhaps the nearest approach to this ideal is to be found in Leipzig, where the enterprise of the teaching profession has established a centre for scientific research into those unknown forces with the behaviour of which the schoolmaster is expected to have expert knowledge. Prof. Bagley's article, on the psychology of school practice, gives an excellent summary of recent work in this field, and admits the importance of the evidence, which is steadily accumulating, in favour of the doctrine of formal training, albeit in a form less crude than that against which the Herbartian has always tilted. The survey of work in Germany, France, and elsewhere is useful, though the omission of the name of Binet from that part which deals with French activity in this direction is surprising. Prof. Earl Barnes writes of England, and finds our national activities taking traditional forms—Royal commissions, congresses, interdepartmental committees. Public interest in psychological questions is steadily growing in our country, forced upon us "by a disorganised school system, by industrial stagnation and an army of unemployed people, by the agitation for woman's suffrage and by the unrest in India." Truly outsiders see most of the game!

SOCIETIES AND ACADEMIES.

LONDON.

Faraday Society, March 30.—A new electrical hardening furnace: E. **Sabersky** and E. **Adler.** The furnace consists of a fireclay crucible containing a bath of metallic salts. By means of an electric current these salts are melted and kept at any desired temperature up to 1400° C. An alternating current of a voltage not exceeding 70 is employed. The process consists in heating the steel to a temperature above the transition line and then rapidly cooling it down. The cost of operating this electrical furnace is lower than that of gas-fired muffle or bath furnaces.—The relation between composition and conductivity in solutions of *meta-* and *ortho*-phosphoric acids: Dr. E. B. R. **Prideaux.** The results of simultaneous determinations of amounts of HPO_3 and H_3PO_4 and of the electrical conductivity show that the conductivity of the changing solution decreases at first slowly and then more rapidly, and then more slowly again.—The electro-analysis of mercury compounds with a gold kathode: Dr. F. Mollwo **Perkin.** The results obtained were always slightly too high, from 0·5 per cent. to 1 per cent. This was at first attributed to occluded hydrogen, but this was finally not considered to be the cause, and no good explanation could be found. With silver kathodes similar results were obtained. Two new quartz vessels for depositing mercury on a mercury kathode were also described. It is considered that for mercury determinations a mercury kathode with rotating anode should be employed.

Royal Astronomical Society, April 7.—Prof. H. H. Turner, F.R.S., vice-president, in the chair.—Description of a Chinese planisphere: E. B. **Knobel.** This planisphere had been exhibited at the Franco-British Exhibition as "a bronze compass," believed to be Japanese. It was undoubtedly Chinese. The stars are shown by raised dots, linked together in groups, forming the Chinese asterisms, each of which consists of one or more stars. These asterisms do not represent areas of the heavens like our constellations, with which they have no relation. The Chinese "siou," or lunar mansions, were explained and described.—The 60-inch reflecting telescope of the Mount Wilson Observatory, California: Dr. G. W. **Ritchey.** The mirror was successfully cast in France, and figured and polished at Pasadena, in the observatory workshops, where the Cassegrain mounting was also constructed. Details of the whole work were given and illustrated by lantern-slides. The great difficulties connected with the transport of the mirror and mounting to the summit of Mount Wilson were overcome, and the telescope is now mounted in a 50-feet dome erected for it. Dr. Ritchey is now on a visit to Europe arranging for the casting of the disc for a still larger reflector, 100 inches in diameter, which has presented considerable difficulties.—Photographs of comet Morehouse: S. S. **Hough.** These have been taken at the Cape after the comet's perihelion passage, and show that the remarkable changes of form exhibited by the comet from September to November have continued after its perihelion passage.—Astronomy in Australia: W. E. **Cooke.** An account was given of the conditions for astronomical research, and the difficulties experienced in maintaining the efficiency of the public observatories.—Photographs of Jupiter taken at the opposition of 1908–9: J. H. **Reynolds.**—The number of faint stars with large proper motions, and further note on the position of the sun's axis of rotation: H. H. **Turner.**—The orbit of the eighth satellite of Jupiter: A. C. D. **Crommelin.** The orbit, as determined by Messrs. Cowell, Crommelin, and Davidson, was in good agreement with the observed positions of the satellite, but must at present be considered as provisional, and did not form a closed curve.

MANCHESTER.

Literary and Philosophical Society, March 23.—Prof. A. Schuster, F.R.S., in the chair.—The moving force of terrestrial and celestial bodies in relation to the attraction of gravitation: Dr. H. **Wilde.** Reference was briefly made by the author to the historic controversy which exercised the minds of distinguished men of science and learning for more than two centuries as to whether the force of a body in motion by the free action of gravity is simply as the velocity, according to Descartes and Newton, or as the square of the velocity in agreement with Leibnitz and proved experimentally by Smeaton, Wollaston, Ewart, Dalton, Joule, and others; but no attempts have been made to extend the results of these experiments to the motions of celestial bodies. The author has demonstrated that the moving force, and the attraction of gravitation, are alike inversely proportional to the square of the distance, and are correlated equally in amount to maintain and retain the moon and other celestial bodies in their orbits during their revolutions round their primaries.—The action of hydrogen on sodium: A. **Holt,** jun. Some experiments were described on the action of hydrogen on sodium which, when considered with the work of Moissan and of Troost and Hautefeuille, point to the conclusion that the hydride Na_2H described by these latter authors should probably be regarded as a solid solution of the hydride NaH in sodium, and not as a definite compound.—Differences in the decay of the radium emanation: Prof. E. **Rutherford** and Y. **Tuomikoski.**

PARIS.

Academy of Sciences, April 5.—M. Bouchard in the chair.—Observations on *Lepidostrobus Brownii*: R. **Zeiller.** The specimen, a detailed study of which is given in the present paper, was collected at Cabrières by M. l'Abbé Théron.—Remarks by M. **Carpentier** on a set of standards of length, presented by M. Johansson. These standards are in the form of parallelepipeds, two faces of which are rigorously plane and parallel, and the distance between these two faces is known to 1/100,000th of its value. Any length between 1 mm. and 200 mm. can be built up, the error being less than 1 micron. A smaller set of standards have an accuracy of 0·1 micron. These standards are manufactured on the commercial scale, and represent a surprising advance on any test-pieces hitherto obtainable.—A new general method for the preparation of the alcoholic amines: Paul **Sabatier** and A. **Mailhe.** In a previous paper the authors have described the catalytic decomposition of alcohols by certain oxides, such as alumina, thoria, and the blue oxide of tungsten. If, in this experiment, the alcohol vapour is replaced by a mixture of dry ammonia and alcohol vapour, no ethylenes are produced, but the action which predominates is the formation of the amine. Details are given of the method, which is extremely simple, the reaction product containing unchanged alcohol, ammonia, primary amine, secondary amine, and a little tertiary amine.—M. Wiesner was elected a correspondant in the section of botany in the place of the late M. Clos.—Contact transformations: S. **Lattès.**—The representation of the solutions of a linear equation of finite differences for large values of the variable: M. **Galbrun.**—The radiation and temperature of the flame of a Bunsen burner: Edmond **Bauer.** Two methods of measuring the flame temperature, the measurement of the ratio of emission to absorption and the reversal of the D ray, gave identical results, about 1760° C., for the Meker burner. The author comes to the conclusion that temperature is the essential factor in the emission of line spectra by flames.—The radiation of potassium salts: E. **Henriot.** It has been shown that potassium salts possess a distinct, although very small, radio-activity. It has not yet been settled whether this radio-activity is due to the presence of traces of one of the radio-active bodies already known. From the experiments described in the present paper, it would appear that this is not the case; the observed radio-activity must be either due to the potassium itself or to an unknown body associated with it.—A new type of magnetic decomposition of the absorption bands of crystals. The simultaneous production of systems circularly polarised in opposite senses: Jean **Becquerel.** The line 625 $\mu\mu$ of tysonite, at the temperature of solid hydrogen, −253° C. to −259° C., gives a quadruplet formed of two doublets polarised in opposite senses. The effects observed can be explained by the hypothesis of the existence of both negative and positive electrons, and the author replies to some objections raised by M. Dufour concerning the theory of positive electrons.—The determination of the constant of Stefan's law: C. **Féry.** In a preceding note it has been shown that in measurements of radiation it is absolutely essential to use an integral receiver. In the present paper a form of receiver is described satisfying the necessary conditions, and with this apparatus the exactitude of Stefan's law has been proved. The constant found is $6{\cdot}30\times10^{-12}$ watt/cm.^{2}, as against the earlier figure of 5·32, for πa, from which a is 2×10^{-12} watt/cm.^{2}—The atmosphere of rooms for the inhalation of mineral water in the form of fine spray. The identification of the mineral water spray with the water of the spring: M. **Cany.**—The formation of graphitic oxide and the definition of graphite: Georges **Charpy.** Brodie's reagent, fuming nitric acid and potassium chlorate, may be replaced by other oxidising mixtures, such as concentrated sulphuric acid and potassium permanganate or chromic acid. The reaction is accelerated by a rise of temperature, but with loss of carbon as carbon dioxide. The definition of graphite based on the action of such oxidising mixtures is unsatisfactory.—The preparation of pure iodic anhydride: Marcel **Guichard.** The iodic acid prepared by the action of sulphuric acid on barium iodate is not pure, containing either barium iodate or barium sulphate, according as the salt or the acid is in excess. Iodic acid is very soluble in water (187·4 per 100), but is much less soluble in nitric acid (S.G. 1·4), and advantage is taken of this fact for the purification of iodic acid. A better method is the oxidation of iodine with nitric anhydride; a yield of 40 per cent. of the theoretical is thus obtained.—The complete synthesis of laudanosine: Amé **Pictet** and Mlle. M. **Finkelstein.** This synthesis of laudanosine (methyltetrahydropapaverine) is the first artificial preparation of an opium alkaloid.—The catalytic preparation of the ketones: J. B. **Senderens.** The catalytic production of ethers by the action of alumina on the alcohols has been found to be limited in practice to methyl and ethyl ethers, other condensation products appearing with the higher alcohols. The corresponding reaction for the production of ketones, on the other hand, is much more general. Anhydrous thoria is used as the catalytic agent, and the fatty acid is found to give good yields of ketone at a temperature of about 400° C. A description is given of the preparation of diethylketone, dipropylketone, and di-isopropylketone by this method.—The formation of peroxides in the oxidation of the organo-magnesium compounds: H. **Wuyts.**—The tetrahydronaphthylglycols (*cis* and *trans*) and their combination: Henri **Leroux.**—A new region with sodic rocks in Auvergne. Tephrites and nephelinites in "la Comté": J. **Giraud** and A. **Plumandon.**—The composition of bauxite: M. **Arsandaux.**—Some variations of *Monophyllaea Horsfieldii*: M. **Chifflot.**—The sexual reproduction of *Endomyces Magnusii*: A. **Guilliermond.**—The exact estimation, by gasometry, of urea and urinary ammonia: M. **Florence.**—New analogies between the natural and artificial oxydases: J. **Wolff.**—Animal invertins and lactases: H. **Bierry.**—Bovine piroplasmosis in the neighbourhood of Algiers: H. **Soulié** and G. **Roig.**—The calcification of tuberculous lesions in bovine animals: their richness in Koch bacilli: M. **Piettre.** Calcification of tuberculous lesions is no sign of cure, and any therapeutic method based on the introduction of calcium salts into the economy is illusory.—The palleal cavity and its attachments: Rémy **Perrier** and Henri **Fischer.**—The fossil Bryozoa of the Middle Miocene of Marsa-Matrouh: Ferdinand **Canu.**—The cause of the heat developed in the terrestrial rocks: J. A. **Le Bel.** The effect observed appears to be due to radiation, and not to radio-activity.

DIARY OF SOCIETIES.

FRIDAY, April 16.

Malacological Society, at 8.—Description of *Pomatias Harmeri*, n.sp., from the Red Crag of Essex: A. S. Kennard.—Fossil Pearl Growths: J. Wilfred Jackson.—The New Zealand Athoracophoridæ, with Descriptions of Two New Forms: Henry Suter.—On the Family Ampullariidæ, No. 1, Ampullarina (*sensu stricto*), List of Species, Varieties, and Synonyms, with Descriptions of New Forms: G. B. Sowerby.

TUESDAY, April 20.

Royal Institution, at 3.—The Brain in Relation to Right-handedness and Speech: Prof. F. W. Mott, F.R.S.

Institution of Civil Engineers, at 8.—The *New York Times* Building: C. T. Purdy.

Royal Society of Arts, at 4.30.—South Africa: Hon. C. G. Murray.

Royal Anthropological Institute, at 8.15.—The Blackfeet Indians of Montana: W. MacLintock.

WEDNESDAY, April 21.

Royal Meteorological Society, at 7.30.—Percolation, Evaporation, and Condensation: B. Latham.—The Meteorological Conditions in the Philippines, 1908: Rev. José Algué, S.J.

Royal Microscopical Society, at 8.—On the Recent and Fossil Foraminifera of the Shore-sands of Selsea Bill, Sussex: E. Heron-Allen.—The Disappearance of the Nucleolus in Mitosis: E. J. Sheppard.

THURSDAY, April 22.

Royal Society, at 4.30.—*Probable Papers*: Dynamic Osmotic Pressures: The Earl of Berkeley, F.R.S., and E. G. J. Hartley.—(1) The Theory of Ancestral Contributions in Heredity; (2) The Ancestral Gametic Correlations of a Mendelian Population Mating at Random: Prof. Karl Pearson, F.R.S.—The Intracranial Vascular System of Sphenodon: Prof. A. Dendy, F.R.S.—On the Graphical Determination of Fresnel's Integrals: J. H. Shaxby.

Mathematical Society, at 5.30.—The General Principles of the Theory of Integral Equations: F. Tavani.—The Equations of Electrodynamics and the Null Influence of the Earth's Motion on Optical and Electrical Phenomena: H. R. Hassé.—The Solution of a Certain Transcendental Equation: G. N. Watson.

Institution of Electrical Engineers, at 8.—The Electrical System of the London County Council Tramways: J. H. Rider.

FRIDAY, April 23.

Royal Institution, at 9.—Tantalum and its Industrial Applications: A. Siemens.

Physical Society, at 5.—On a Want of Symmetry shown by Secondary X-Rays: Prof. W. H. Bragg, F.R.S., and J. L. Glasson.—Transformations of X-Rays: C. A. Sadler.—Theory of the Alternate Current Generator: Prof. T. R. Lyle.

Institution of Civil Engineers, at 8.—The Development of Hydro-electric Power Schemes; with Special Reference to Works at Kinlochleven: J. M. S. Culbertson.

Institution of Mechanical Engineers, at 8.—Presidential Address: J. A. F. Aspinall.

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