THURSDAY, MARCH 18, 1909.

NEW LIGHTS ON PROTOPLASM IN PLANTS.

(1) *Einleitung in die experimentelle Morphologie der Pflanzen.* By Dr. K. Goebel. Pp. viii+260. (Leipzig and Berlin: B. G. Teubner, 1908.) Price 8 marks.

(2) *Parthenogenesis und Apogamie im Pflanzenreiche.* By Dr. Hans Winkler. Pp. 166. (Jena: Gustav Fischer, 1908.) Price 4.50 marks.

(1) THE study of botany has passed through many different phases, but it has tended more or less steadily towards the fuller recognition of plants as living beings, to be studied in the whole cycle from their beginnings through their maturity to their decay, including their provision for the continuance of the race despite the death of the individual. For a time the motive for the study of plants was naturally the desire to find out the uses to which they could be put, and the keenest students were usually the physicians in their search for useful drugs. After the awakening of interest in such study for its own sake, it passed necessarily through a period of description of forms previously unknown, followed by efforts to bring order into the knowledge already accumulated, and to discover some system by which the various forms could be accurately identified.

The invention of the microscope and of the methods suitable for its employment as an instrument of research opened up new fields to the student of living things, but the living substance was not recognised as the builder of the framework of cell-walls and vessels until near the middle of last century. The recognition of protoplasm as the "physical basis of life" necessarily directed attention to the importance of gaining a knowledge of its properties, of its relations to its environment, and of its response to stimuli. Improvements in the microscope and in the technique of research, while helping to solve some problems, have opened up new lines of inquiry, and this has been peculiarly the case in recent years. A considerable new literature has grown up dealing with the questions that arise, and it is very desirable to have the lines of inquiry and the results attained presented in a clear and effective form, whether these cover the whole field or relate to only a part of it. The two works named above will be found most useful guides, the first to the knowledge gained by experimental researches into alterations in structure induced by action of external stimuli, or environment, and into regeneration when parts are injured or removed, and the second to the production of new individuals by the processes known as apogamy and parthenogenesis, and the relation of these processes to the normal production of the embryo from the fertilised ovum.

Prof. Goebel speaks with the authority of an adept on all questions of morphology; and in this new book (based on a course of lectures delivered in the winter of 1906, and issued as the first volume of a series of handbooks on the methods useful in the study of the natural sciences and of technology) there is presented a most useful guide towards a clear view of what has been accomplished, along with indications of promising subjects of investigation. The division into lectures has not been adhered to, the clearness of exposition alone suggesting the work of a skilled teacher; and, where desirable, the matter has been treated with greater fulness than would have been suitable in the original form. Numerous footnotes refer the student to all important sources of information.

Vascular plants supply by far the greater part of the material dealt with, mosses and thallophytes being referred to now and again by way of comparison. The necessity of studying the plant throughout its development as a condition of understanding its true nature and affinities is illustrated by examples that show great diversity between the corresponding parts of the young and of the adult, and the differences are traced to causes the action of which can be tested by experiment. The normal course of development is analysed into periods, each with a distinctive character, these being successively *morphological*, during which the members appear and cells are rapidly multiplied, and *physiologico-biological*, when the members attain their full size and maturity, and fulfil their part in the plant's well-being. Experiments prove that the action of environment depends largely on the period during which it has acted, and that the characters of the earlier period may be retained in the normally later stage, or may be reproduced in that stage by the influence of an environment appropriate to the earlier. The *Campanula rotundifolia* ("harebell" of England, "blue-bell" of Scotland) is found to be very well suited for these instructive experiments, the forms of its leaves showing very quickly the influence of changes in environment, and also that similar results may follow apparently very different causes, such as diminished light, lessened supply of water, or increase of the salts in solution in the water. Prof. Goebel is led to the generalisation that these external influences act indirectly by their altering the amount and kind of the food formed by the plant, and required to permit of the normal course of development, the external forms being conditioned by the vital activities of the plants, and by the food-supply to each part of it. Thus also he accounts for the phenomena of regeneration where the injury is not very great, or replacement by new parts of a similar kind if the parts removed were too extensive or too specialised in their structure to be regenerated simply. The same generalisation is used to explain the different behaviour of primary and lateral axes and appendages, when uninjured, and when lateral parts are modified to replace primary members that have been destroyed.

The quality of the food is held to explain the nature of the parts formed. Thus stolons (as in Circæa) are attributed to the amount of organised food, relatively to the inorganic, or ash, supplied to the growing-point of the stolon being greater than that supplied to the leafy shoot. Potato tubers afford very favourable subjects for experiments; *e.g.* if tubers are kept at not

more than 7° C., few roots or leafy shoots are formed, but new tubers develop readily, though, of course, remaining small. If the parent tubers are then cultivated at 25° C., leafy shoots are freely formed, the younger tubers of the new growth often being continued into leafy shoots at the tip.

The relations between leafy shoots and inflorescences are discussed as conditioned by the relative amounts of organised and mineral supplies to each; and the well-known effects on trees of root-pruning and overfeeding are brought under the general law. Certain plants (*e.g. Veronica Beccabunga*) show that their inflorescences may readily be caused to grow into leafy shoots. Space will not permit of more than a passing reference to the very interesting discussion of the changes that can be induced in the colours of certain flowers and the structure of others by alterations of environment and food and of the conditions under which cleistogamous flowers are normally produced. The production of buds in abnormal situations, either as a usual occurrence, as on the leaves of *Cardamine pratensis* in autumn, or following the partial or entire separation of the part from the plant, so largely utilised in the multiplication of begonias, hyacinths, and certain other plants, is treated at considerable length, and is summed up as closely akin to regeneration, both being especially active at the growing-points of axes or leaves; but adult tissue in certain areas may revert to the embryonic state, these areas being along the veins; and the impulse to development, apart from external stimuli, is conditioned by the presence of the necessary constituents of the food, brought about in leaves, when the petiole is cut or broken, by the retention of the leaf's products within itself. The book, though not large, does not lend itself to a brief review, as it is conspicuously free from irrelevant or useless matter. The student will find in it much information of high value, and much to suggest new aspects of the life of plants and of how experimental methods may be usefully employed in the search after the laws that govern them.

(2) Dr. Winkler's work on parthenogenesis and apogamy is one of the excellent monographs that have rendered "Progressus Rei Botanicæ" indispensable in every botanical library. It deals with one aspect of the activity of protoplasm, as manifested in reproduction of the species by methods very different in some respects from the normal, and the possibility of which was scarcely suspected until comparatively recent years. But though of recent development, this field of research has had much attention directed to it, and a copious though rather scattered literature has appeared, rendering this review of the whole field most timely and helpful both in itself and as a guide to the original papers. It is no mere compilation, but is an excellent contribution to a difficult subject. A brief sketch of the history of the discovery of the methods of reproduction in plants up to the recognition of true sexual reproduction as normal in them forms an introduction to the later history of the discoveries that in some plants the sexual method is not followed, that the embryos result from a vegetative growth of some other cell or cells than the ovum, and that the unfertilised ovum may develop as an embryo. These abnormally produced embryos have been studied in their origin and growth in numerous species (from widely different groups of plants) both as they occur naturally and as they result from external stimuli, such as injuries to the parts that produce them, various salts in solution, or differing concentration of food-solutions.

The terminology in use for these methods of reproduction has varied as employed by different investigators, and the terms are reviewed and defined clearly. The methods of production of new individuals are recognised as of three types, viz. *amphimixis*, the embryo resulting from the union of two clearly distinct cells, the ovum and sperm, or their equivalents, this being true sexual reproduction; *pseudomixis*, the embryo being developed, directly or indirectly, from a union of two cells not the equivalents of the ovum and sperm, as has been observed to occur in certain ferns (in which a cell of a prothallus after entrance into it of the nucleus of a neighbouring cell, and union of the nuclei, produces a new fern plant), and probably also in the reproduction of various fungi (while similar nuclear fusions, unconnected with reproduction, have been found to occur as an effect of chemical agents, *e.g.* of chloral on roots of Vicia); and *apomixis*, where the production of the new individual has not been preceded by fusion of nuclei, either sexual or asexual, and is evidently asexual.

The term apogamy was first used by de Bary (in 1878) to signify the replacement of sexual reproduction by any other method, *i.e.* as almost equivalent to *apomixis*; but it has been used by others with meanings a good deal different from this. Dr. Winkler therefore defines his own use of the terms, thus:—Apogamy is the apomictic formation of sporophytes from vegetative cells of the gametophyte; Parthenogenesis is the apomictic formation of a sporophyte from an ovum. Each is distinguished into two types by the number of chromosomes in the nuclei of the cells giving origin to the new plants, viz. somatic with diploid, and generative with haploid nuclei. With these restrictions, the conditions that lead to, or favour, the occurrence of one or other of these modes of reproduction, their relations to the more usual sexual and asexual types, and their biological significance are treated in a very full and thorough manner, supplemented by a bibliography including 239 titles.

Before describing more fully the ascertained cases of apogamy and parthenogenesis, a careful analysis is made of many recorded cases in which the conditions are uncertain, or too insufficiently observed to allow of determining to which type they belong. Among these are examlpes of algæ such as Protosiphon, shown by Klebs to be capable of facultative parthenogenesis, or of union of gametes, under definite changes of food-solution or of temperature, but in which the number of the chromosomes in the plant developed in each case has not been ascertained. Other cases insufficiently determined in this respect

are met with among fungi, as in *Mucor racemosus*, possibly among Bryophyta, and in one or two gymnosperms. A considerable number of angiosperms have been recorded as producing embryos otherwise than from the fertilised ova, but in a large proportion of cases doubt exists as to the true origin of such embryos and as to the behaviour of their chromosomes, while other reported cases are much in need of re-investigation of the alleged facts.

Having set aside all doubtful cases, there remain several in which the whole course of formation of the new individual has been followed out and made known in its details. Apogamy was first studied in the outgrowth of a fern plant directly from the prothallus. Occurring in certain varieties of different species, the details of the process have been found to differ widely; *e.g.* pseudomixis prevails in *Lastrea pseudomas*, var. *polydactyla*; somatic apogamy in *Athyrium Filix-foemina*, var. *clarissima*, and generative apogamy in *Nephrodium molle*. Somatic apogamy is not common among phanerogams, but has been shown to occur in *Alchemilla sericata*, one of the helper-cells giving rise to an embryo along with the parthenogenetic ovum, while in *Balanophora elongata* somatic apogamy leads to an embryo being formed from a cell of endosperm.

Generative apogamy is illustrated in the development of embryos from antipodal cells in *Allium odorum*, but it also is in want of further study among phanerogams.

Generative parthenogenesis has been observed among a few algæ (*Spirogyra mirabilis*, *Cosmarium Botrytis*, &c.), chiefly under artificial stimuli, and possibly also among fungi, but not among other plants. Somatic parthenogenesis, on the other hand, has not been proved to exist among the purely cellular plants, while it has been met with in true ferns (*e.g. Ath. Filix-foemina*, var. *clarissima*) and *Marsilia Drummondii*, and in several dicotyledons, especially among Compositæ (*Antennaria alpina* and other species, *Taraxacum*, sps., *Hieracium*, sps.), in *Alchemilla*, sps., in *Thalictrum*, sps., &c. In all these flowering plants the pollen of the parthenogenetic species is ill-developed or useless. Parthenocarpy or the formation of apparently fully developed fruits from unpollinated or unfertilised carpels is a well-known fact, especially among cultivated plants, and has led not infrequently to the assumption of parthenogenesis, but in these cases the fruits are often sterile, as in bananas and other seedless fruits.

The latter part of the monograph is devoted to such speculative questions as whether the parthenogenetic ovum is a somatic or a truly generative cell; whether apogamy and parthenogenesis lead to the suppression of alternation of generations in plants in which it normally exists; the origin and mutual relations in the cycle of the haploid and diploid types of cells; and the possible advantages of their intercalation in the cycle; the causes and explanations of parthenogenesis and apogamy, and the information on these derived from experiments. The discussion of these topics is suggestive and full of interest, but the reader must be referred to the work itself, as it is not possible to summarise fairly the views stated. It may be said that there is still much to be done before the way is clear.

The biological value to plants of parthenogenesis and apogamy is evidently, like that of increase by tubers, stolons, bulbs, and other purely vegetative methods, the multiplication of the species by seeds, or other readily dispersed bodies, in which the embryo is produced without dependence on access of male cells, whether sperms or pollen-nuclei, thus securing the reproduction even from isolated female plants. The disappearance of the pollen-bearing plants in habitually parthenogenetic species is regarded as a consequence, instead of as the cause, of parthenogenesis. It has been observed that among the genera that show the most marked tendency to this condition are several (Hieracium, Alchemilla, &c.) peculiarly rich in closely allied forms, regarded by some as species, by others as varieties; but, on the other hand, other polymorphic genera (Rubus, &c.) show sexual reproduction of the normal kind. There are very evidently many problems in these and other fields relating to protoplasm still waiting to reward research.

ADMISSIONS OF AN ANTI-VIVISECTIONIST.

The Vivisection Controversy. Essays and Criticisms. By Dr. Albert Leffingwell. Pp. vi+251. (London: The London and Provincial Anti-vivisection Society, 1908.) Price 6*s*.

DR. ALBERT LEFFINGWELL is an American doctor who, as we gather from his title-page, has written on the "Morality of London" and on "Rambles in Japan without a Guide"; and who, "having witnessed experiments on animals by some of the most distinguished European physiologists, such as Claude Bernard, Milne Edwards and Brown Sequard, began to contribute to the vivisection controversy twenty-eight years ago." He is contributing still, and he is no exception to the rule that when an anti-vivisectionist arrives at the controversial stage the impression he makes on a logical mind is not a favourable one. That is because anti-vivisectionists, by addressing themselves continually and solely to audiences of convinced sentimentalists, acquire the habits of rhetoric and over-statement, and become incapable of stating any fact regarding the use of animals in experiment except in a controversial relation. Thus Dr. Leffingwell will not allow to experiments on animals any of the credit for antiseptic or aseptic methods in surgery; he denies, as most anti-vivisectionists do, any reduction in diphtheria mortality, or virulence, by the use of antitoxin; he minimises, so far as he can, the use of antitetanus and antivenous serums. He says nothing about bacteriological research in plague, typhoid, Malta-fever, or malaria; but that is partly because the bulk of his essays were published before those researches were undertaken. It is also because the essays are filled so largely with appeals to the emotions, with quotations from Mrs. Barrett Browning's "Cry of the Children," and with long references to the iniquities of the slave trade, that there is very little room even

for a controversial consideration of the questions at issue.

This resurrection of obsolete tracts and essays is part of the anti-vivisectionist's stock-in-trade. It enables him to repeat in a book published in 1908 the details of experiments made more than half a century ago, and to quote the utterances of a Mantegazza or a Magendie in a volume dealing with the work of physiologists and bacteriologists to-day. If speaking as avowed vivisectionists we characterised such experiments of Mantegazza, we should admit without hesitation that they were cruel. We have advanced in humanity since those days. Even in England, Boyle and his fellow members of the Royal Society approached the subject of experiments on animals—by asphyxiation—without any suspicion that they were employing cruelty in their methods.

But what have these instances to do with the question of experiments on animals as practised in English physiological laboratories to-day? A remark by Dr. Leffingwell himself may be commended to the attention of the secretary of the anti-vivisectionist society which publishes his collection of essays. In the first essay, Dr. Leffingwell says :—

"In America our physiologists are rather followers of Magendie and Bernard, after the methods in vogue at Paris and Leipzig, than men who are governed by the cautious and sensitive conservatism which generally characterises the physiological teaching of London and Oxford."

That was written by Dr. Leffingwell in 1880.

If the practice of English physiological laboratories was cautious and sensitive twenty-nine years ago, what is the object of re-publishing in England as a contribution to the "Vivisection Controversy" a series of attacks on vivisection as practised in other countries a generation, or more than a generation, ago? What, also, is the object of adding an essay on the "Royal Commission of 1906"—except to give to the book an appearance of being up to date? The only serious argument in the essay is that "A. C. E." mixture—which is commonly employed on human beings as a very good anæsthetic—ought not to be employed in experiments on animals. This essay is in keeping with the rest of the book in being an appeal, not to facts, but to prejudice, and not to humanity, but to ignorance. E. S. G.

STRENGTH OF STRUCTURES AND MATERIALS.

(1) *The Theory and Design of Structures.* By Ewart S. Andrews. Pp. xii+589. (London : Chapman and Hall, Ltd., 1908.) Price 9*s.* net.

(2) *The Strength of Materials.* By Prof. Arthur Morley. Pp. ix+487. (London : Longmans, Green and Co., 1908.) Price 7*s.* 6*d.* net.

(1) THE soundness of this work as regards the theory of the subject is guaranteed by the fact that the methods adopted by the author in dealing with the more difficult problems are based upon lecture notes taken while he was attending the graphics lectures of Prof. Karl Pearson, F.R.S., at University College, London. In the first chapter, which is devoted to the general treatment of the subject of strain, stress, and elasticity, the author deals not only with the case of maximum tensile or compressive and sheer stresses, but also with maximum strain. It is too often forgotten in dealing with complex stresses that the maximum strain does not occur on the same plane as the maximum stress; it is, therefore, advisable to investigate the question of the maximum stress produced in a body when subjected to combined tensile or compressive and shear stress from this point of view. This method of maximum strain, which the author terms the French method, is comparatively little used by engineers in this country, but it is important that designers and students should realise that there is another method of treating the problem other than that ordinarily expounded in English text-books.

In the section of the book which treats of areas and moments, ingenious graphical methods are described for the determination of areas by means of sum or integral curves, and for the determination of centroids and moments of inertia by similar methods. It is perhaps desirable to point out here that throughout this book there is a large number of examples fully worked out by both graphical and analytical methods, and in many cases points which are not, or only briefly, touched upon in the general body of the book are fully discussed when solving some of the problems. These worked problems, therefore, will be found of much greater use to the student than is often the case with the examples published in engineering text-books.

Mr. Andrews, in conjunction with Prof. Karl Pearson, was the author of an original memoir on the theory of stresses in cranes and coupling hooks, and it was only to be expected that the cases where the ordinary assumptions of the beam theory are not allowable would be discussed in this book; it is to be hoped, therefore, that in future, erroneous theories of the stresses in crane and coupling hooks will disappear from engineering text-books. The correct method of solving the problem certainly involves rather more lengthy calculations, but there is no justification for the sacrifice of accuracy in the calculation of stresses in order to simplify slightly the work of the designer, especially when the results given by the simple formula are seriously incorrect.

Three chapters are devoted to the deflection of beams, simple, fixed, and continuous, and the distribution of shearing stresses in them; the author has adopted the ordinary analytical method of dealing with the problems, and also a graphical method based upon Mohr's theorem that a loaded beam will take up the same shape as an imaginary cable of the same span which is loaded with the bending moment curve on the beam, and subjected to a horizontal pull equal to the flexural rigidity. In spite of increased attention given to mathematical studies, many engineers are still unable, though they have a slight knowledge of the principles of the calculus, to reason in its terms, and such men need graphical methods in order that they shall secure a thorough grip of the problem of beam deflections and stresses.

In discussing the strength of struts, the author points out that the chief difficulty in dealing with struts lies in the choice of the safe stresses per square inch for various values of the buckling factor, and the effects of eccentric loading of stanchions illustrate how desirable it is to have the load as central as possible. In the chapter devoted to masonry structures, there is a good deal of matter not usually found in text-books, and a brief reference is given to the recent developments of the theory of stresses in masonry dams, due to the original researches of Prof. Karl Pearson; and, in deducing formulæ for the strength of retaining walls, three theories are explained—the Rankine, the wedge, and the Scheffler.

In dealing with the subject of reinforced concrete, the author points out that a great deal of experimental work is still required in this direction before the principles underlying design shall be established on a sure and certain foundation, and he points out the danger of the uninitiated using data obtained from investigations on materials quite different from those which he proposes to use in his own design. The last three chapters are devoted to designs of steel work for various buildings, roofs and bridges, and a number of excellent practical details are given, and illustrations of recent structural steel work.

This book undoubtedly marks a considerable improvement in the type of text-book which has recently been placed at the disposal of engineering students in connection with the theory and design of structures. There are original methods of dealing with problems, the theory is in all cases unimpeachable, and the numerous examples selected for illustrating these various theories have been chosen with admirable judgment. The book, however, is more than a mere text-book for students; it will be found of considerable use by draughtsmen and engineers who are engaged in constructional steel and iron work.

(2) Though this book has been written mainly for engineering students, and from the point of view of university examinations, it will undoubtedly prove most useful to practical engineers. So many text-books have now been written on this subject that it becomes extremely difficult for an author to embody anything strikingly original. Prof. Morley has, however, devoted considerable attention to several branches of the subject which are ordinarily passed over, or only briefly touched upon in most of the works dealing with the subject of strength of materials.

In chapter ii. there is a *résumé* of the theories which are held as to whether or not, in cases other than simple direct stresses, the breaking down of a bar in a machine or structure occurs for a certain value of the maximum principal stress, for a certain value of the maximum principal strain, or for a certain value of the maximum shearing stress. Throughout the book the first of these theories is generally employed, but its use has to be justified by the choice of a factor of safety which is reckoned on the ultimate and not on the elastic strength of the material, and which must be varied according to circumstances.

In chapter xii., the problems involved in the strength of rotating discs and cylinders are fully investigated, and also the bending of originally curved bars, such as crane hooks, for example. The strength of flat plates is treated in chapter xiii. in a very complete manner by means of the Bernouilli-Euler theory of bending, with such modifications as are required to allow for flexure in other than a single plane. Another useful chapter is that devoted to the subject of vibrations and critical speeds, in which is incorporated the results of Prof. Dunkerley's researches on the whirling speed of rotating shafts. In chapter xvi., Prof. Morley has given descriptions of a number of the special testing machines which have been introduced in recent years for impact and hardness tests, and copious references have been given to the memoirs which have been published dealing with researches and investigations undertaken with the aid of these special machines.

Every chapter contains a number of fully-worked-out examples, and there is a good selection of examples for practice by the student, and, in the form of an appendix, are given tables of logarithms, such as would be required in the working out of these examples.

The book is a valuable addition to the library of the engineer who has to undertake the calculation of the stresses and strains in machinery and structures.

WIRELESS TELEGRAPHY.

An Elementary Manual of Radio-telegraphy and Radio-telephony for Students and Operators. By Dr. J. A. Fleming, F.R.S. Pp. xiv+340. (London: Longmans, Green, and Co., 1908.) Price 7*s.* 6*d.* net.

La Télégraphie sans Fil et les Applications pratiques des Ondes électriques. By Albert Turpain. Second edition. Pp. xi+396. (Paris: Gauthier-Villars, 1908.) Price 9 francs.

Jahrbuch der drahtlosen Telegraphie und Telephonie. Vol i., part iv. Edited by Dr. Gustav Eichorn. (Leipzig: Verlag von S. Hirzel, 1908.)

WE have already had occasion to review in these columns Dr. Fleming's treatise on "The Principles of Electric Wave Telegraphy," and at the time we expressed the opinion that that treatise not only admirably filled a gap in the literature of the subject, but deserved to rank as the most important, if not the only, book on wireless telegraphy which students need consult. It must be frankly admitted, however, that by writing the present manual Dr. Fleming has performed another service to this branch of electrotechnology, in the exposition of which he stands, certainly in this country and probably in any country, easily first. The former treatise was possibly too exhaustive and in parts too difficult for those who had not the ability or inclination to study the subject thoroughly. It must be remembered that wireless telegraphy has become in recent years a department of applied electricity of great practical importance, offering a steadily increasing field of employment for large numbers of men. The majority

of those who are engaged or who seek engagement in this work are hardly to be expected to have any desire to pursue its study into its more difficult theoretical parts; to such the present volume will prove an adequate guide. To others it will serve as a useful introduction to its more comprehensive predecessor.

A *résumé* of the contents is unnecessary; the whole subject is discussed, both in its theoretical and practical aspects, but the treatment throughout is simple, and of such a character that any student with a good grounding in general electrical science and quite moderate mathematical attainments can follow with ease. That the explanations are lucid and the illustrations plentiful and well chosen goes without saying in reference to any book from Dr. Fleming's pen.

Of special interest in the present volume are the passages dealing with the production of continuous trains of undamped oscillations by the method of Duddell's musical arc, and in other ways, as this field was barely touched when the previous treatise was published. For the same reason the final chapter on radio-telephony will be read with particular interest. It is to be noted that articulate speech has been successfully transmitted, in more than one instance, over about 200 miles, and musical sounds about half as far again. As Dr. Fleming says, wireless telephony stands now much in the position in which wireless telegraphy stood ten years ago. Time will show whether it can be developed to be of equal utility and service to man.

M. Turpain's book does for the French student much what Dr. Fleming's does for the English. To attempt an estimation of the relative merits of the two volumes would be an ungrateful task; suffice it to say that the treatment in M. Turpain's book is somewhat less full, but is in all respects clear. In addition, M. Turpain deals with two or three subjects not falling strictly under the classification wireless telegraphy, but closely allied thereto on account of their utilisation of Hertzian waves. These are the application of Hertzian waves to the problems of multiple signalling in ordinary telegraphy with wires; to the control of moving apparatus, such, for example, as torpedoes, from a distance; and to the study of storms and atmospheric disturbances. There are also two chapters dealing with high-frequency currents and their utilisation for electric lighting. The inclusion of these subjects gives the book a special value, as, to the writer's knowledge, there is no other comprehensive *résumé* thereof in existence.

Attention may be directed to the paragraph which closes the first portion of the book which treats of wireless telegraphy alone. The opinion is expressed that wireless telegraphy is not likely to replace any of the existing means of communication, but is destined to find its special sphere in increasing the security—and may one add, the amenity?—of navigation. This view has been frequently put forward in these columns, but as, in the writer's opinion, extravagant claims still continue to be advanced for wireless Transatlantic communication, and large sums of money spent on its development which might be better utilised in less ambitious ways, there can be no harm in its repetition. How wonderfully useful wireless telegraphy has become for the purposes of navigation was strikingly demonstrated for all the world to admire in the case of the wreck of the *Republic* at the end of January.

The fourth number of the *Jahrbuch der drahtlosen Telegraphie und Telephonie* calls for no special comment. Partaking more of the character of a scientific society's journal, reviewing, in the ordinary sense, is more or less impossible. There are a number of original communications on various matters connected with wireless telegraphy, and reports on several practical developments. In addition, the number contains a reprint of the German Act regulating wireless telegraphy according to the international agreement of 1906.

MAURICE SOLOMON.

OUR BOOK SHELF.

Handbuch zur Geschichte der Naturwissenschaften und der Technik. In chronologischer Darstellung. Zweite, umgearbeitete und vermehrte Auflage. Von Prof. Dr. L. Darmstaedter. Unter Mitwirkung von Prof. Dr. R. du Bois-Reymond and Oberst. z D. C. Schaefer. Pp. x+1262. (Berlin: Julius Springer, 1908.) Price 16 marks.

THIS work is a sort of scientific dictionary of dates, in which all the most important discoveries and inventions in the world are arranged in chronological order from the year 3500 B.C. down to nearly the beginning of the present year of grace. The first important invention noted by the editors is that of the so-called Palmyra books, in which palm paper was first used for writing, the letters being pressed into the leaves by means of a graver or style, and then made visible by being rubbed over with oil and soot. This invention is ascribed to the Hindu Sage Panningrishee, of Arittawarum, on the Ganges. The latest invention chronicled is that of Count Zeppelin's airship which came to grief on August 5 of last year.

It needs 1070 large octavo pages to describe, in the shortest of paragraphs, all the more significant inventions and discoveries which have been made in the space of these 5400 years. Of course, in the earlier years the discoveries and inventions are few and far between, and centuries even elapse before anything can be discovered worth noting, and it is practically only in the beginning of the sixteenth century that each succeeding year is found to produce something sufficiently important to be set down. These great gaps are, of course, due to the imperfection of the records. No doubt many things were discovered, especially in the East, of which all traces have been lost or at least not hitherto detected, for there is good reason to believe that many inventions of later times usually credited to Europeans ought to be ascribed to the people of the East. From the year 1500 onwards practically every year furnishes discoveries and inventions which merit being chronicled.

The plan of the work leaves nothing to be desired as regards simplicity and convenience. The book has a name- and subject-index, but whether the latter is as systematically arranged as is possible is open to doubt. Anyone consulting the work with a view to ascertain the date of a particular discovery

must be prepared to do a certain amount of searching, unless he happens to remember the name of the discoverer. Still, the work will be found to be a very useful compilation, and it merits a place in the library of every technologist and man of science.

British Butterflies and other Insects. Edited by Edward Thomas. Pp. vii+127; illustrated. (London: Hodder and Stoughton, n.d.) Price 6*s*.

THIS is a pretty book, apparently intended rather as a gift-book or for the drawing-room table than for entomologists. Still, entomologists who wish for a little relaxation from their more arduous labours may take it up and find a series of chatty dissertations on various popular aspects of insect life by well-known writers. Anthony Collett writes on "Some English Butterflies," and G. A. B. Dewar on "The Bee Mind," "Ghost Moth Evenings," "The Railway Embankment," "Butterflies in Bed," "Pearl Skippers," "*Anax imperator*," and "The Sphinx Moth," while Richard South contributes "Field Notes on some English Butterflies," "Day-flying Moths," and "The Entomologist's Methods," and Alfred W. Rees and F. P. Smith, respectively, talk about "Humours of Insect Life in October" and "The Makers of Gossamer." There are about half a dozen coloured illustrations, each representing one or more insects on a flower; perhaps the best is the frontispiece, with two white admiral butterflies perched on honeysuckle, showing the upper and under surfaces of their wings; but why should the chapter on *Anax imperator* be illustrated by a rather clumsy figure of the female of *Libellula depressa*, which is not even mentioned?

A more serious discrepancy is the mention by different authors of two different butterflies under the name of the Large Heath, owing to some entomologists having been sufficiently ill-advised to transfer the name from *Epinephele tithonus* to *Coenonympha tiphon*.

The Oil and Bromoil Processes. By F. J. Mortimer and S. L. Coulthurst. Pp. 96. (London: Hazell, Watson and Viney, Ltd., 1909.) Price 1*s*. net.

THE "oil" process here referred to is a method of making photographic prints that has recently been much appreciated by those who desire to have the opportunity of altering the print during its production to suit their taste. It consists in exposing a bichromated gelatin film under the negative, washing it, and inking it up with a greasy ink. The application of the ink was originally done with a roller, but brushes are now generally used, as these permit of more control over the result. The "bromoil" process is exactly the same in its final stages, but starts with a bromide print, and as this may be an enlargement, there is no need for a full-sized negative. The authors are expert workers in these processes, and here give the results of their experience, with the most detailed instructions for every stage. The volume is issued as a practical guide, and as such is all that can be desired. We might, perhaps, point out the advantage of a little more knowledge of a fundamental or scientific kind to many of even the most able and experienced workers of photographic processes. The statement that dilute sulphuric acid should be freshly mixed, but cool, conveys the notion that the dilute acid changes to its detriment when kept for a few days. But a useless precaution such as this does no harm, and it is better for authors of practical instructions to include one meaningless precaution than to omit one that is essential.

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.*]

Suggested Effect of High-tension Mains.

I SEE in certain American papers a statement that the high-tension mains which convey 14,000 horse-power from the Grand Rapids to Michigan are worked at a voltage of 110,000 over a distance of fifty miles, and it is suggested that both agricultural and other effects may be anticipated from the visible brush discharge from these elevated mains.

I suspect that the brush discharge is most marked in the immediate neighbourhood of the metallic poles or towers which support the insulators, and is weak in between. Nevertheless, some effect might be anticipated if the potential were continuous, or of one sign; but inasmuch as it is sure to be alternating, any expectation of an influence on crops or on fog is almost bound to be disappointed. A negative result is to be expected before hand. OLIVER LODGE.

March 12.

Scientific Societies and the Admission of Women Fellows.

MR. ATKINSON'S letter under this heading in NATURE of February 25 reveals the fact that the majority of the fellows of the Geological Society, like the majority of the fellows of the Chemical Society, are desirous of following the example of the Linnean Society in admitting women to the fellowship of their respective societies. It is difficult to understand what valid reason the executives of these societies can urge for their continued opposition to the wishes of the greater number of their members. This is surely a matter in which the opinion of the majority should prevail, especially when that opinion in each case has been deliberately invited, presumably with a view to the settlement of the question.

In this connection I desire to direct attention to an utterance by the president of the Society of Public Analysts. In the course of his recent presidential address, Mr. Tatlock said:—"A little commotion has taken place lately on the question of the rights and privileges of women chemists, particularly as regards their admission to the membership of our societies, and a considerable variety of opinion has been expressed—one, I think, to the effect that if women were accorded all these, they might become formidable rivals in an already overcrowded profession. It appears to me that this amounts not only to a confession of weakness on the part of the 'party in power,' but that it is an unconscious admission that the claims of the ladies rest on a firm and solid foundation. It is not the first time, however, that men have been frightened by women. It appears to me that, having granted women the right to join our universities and educational institutions, to pay their fees, to compete with us, and, perchance, to beat us at examinations for diplomas, they are entitled to all the advantages which are, or ought to be, the natural consequences of their application and industry."

Mr. Tatlock thus voices, I believe, not only the general sentiment of the society which he represents, but of the Institute of Chemistry and of the Society of Chemical Industry in this country, and of a number of foreign chemical societies where no difficulty has been raised as to the admission of women. For the council of the London Chemical Society to continue to resist all attempts to admit women as fellows, in face of the declared opinion of the majority of the members that the time has arrived when they should be admitted, cannot, in my judgment, be justified on the ground either of justice or expediency.

I believe this question would be settled once and for all were the council to allow the society to exercise its discretion. They have only to permit the certificate of a woman chemist to go to the ballot in the usual way, and I, for one, would trust to the right feeling and good sense of the fellows to bring about her admission, if, as would be the case, her attainments justified her election. Any objec-

tion that might be urged on the ground of the charter is wholly academic, for the society cheerfully admits, unmindful of the provisions of the charter, any alien who chooses to apply, and, as the recent ballot has proved, allows him to exercise the *de facto* rights and privileges of a corporator. A British-born woman may at least plead that she, at all events, is a "loving subject." The conflict of legal opinion has made it abundantly clear that there is no practical value in the doubt that has been raised as to the ineligibility of women, but there is absolutely no room for difference of opinion as to the ineligibility of the alien to act as a corporator. Why, then, should the British-born woman be excluded and the alien be admitted? If the alien may vote, why may not the British-born woman?

T. E. THORPE.

The Isothermal Layer of the Atmosphere.

THE point raised by Mr. R. F. Hughes in NATURE of January 21 and February 11 is one that appears to deserve consideration by the investigators of the upper air. He contends, I take it, that even if the instrument records perfectly the temperature of the metal strip, it does not necessarily tell us the temperature of the upper air, but the temperature which the strip takes up in order to bring about a balance between the heat received and lost by it; and in calculating this temperature it is unfair to neglect, without investigation, the absorption and emission of radiation by the instrument and the balloon.

If we take the case of the balloon, in a night ascent, we may write for the time variation of the temperature T of the gas in the balloon, assumed to be a sphere of radius r,

$$\frac{dT}{dt} = -10^{-2}v + \frac{I}{MC} - \frac{4\pi r^2 f\rho v(T-\theta)}{MC} \qquad (1)$$

where v is the upward velocity of the balloon in metres per sec., M is the mass and C the mean specific heat of the balloon and its contents, θ the temperature and ρ the density of the outside air, and f a constant.

The first term represents the rate of decrease of temperature owing to expansion of the balloon.

The second term represents the rate of increase of temperature, assumed to take place uniformly through the balloon owing to the excess, I, of energy absorbed over energy radiated. In the lower layers I is almost certainly very small, and probably negative, but it may not be so at great altitudes.

The last term is an empirical formula to represent the rate of decrease of temperature owing to convection of heat from the balloon by the outside air.

If we assume the atmosphere to be transparent and the earth to be a perfect radiator, and write E for the intensity of its radiation per square centimetre, the balloon receives from the earth energy at the rate $2\pi r^2 E$, of which it absorbs, say, one-half, and transmits the remainder. (A very thin rubber membrane has been found to transmit 75 per cent. of low-temperature radiation.) At the same time, the balloon is radiating in all directions at a rate $\frac{1}{2}.4\pi r^2 B$ approximately, where B is the intensity of radiation of a perfect radiator at the balloon's temperature.

Thus $I = \pi r^2[E - 2B]$.

If the temperature of the earth is 280° A. (=7° C.), then E is about 0·55 gm. cal. per min., and is equal to 2B when the temperature of the balloon is 235° A. If the temperature of the balloon falls to 200° A., $B = \frac{1}{4}E$ nearly and $I = \frac{1}{8}\pi r^2 E$.

I know of no measurements of the rate of convection from a rubber balloon, but a considerable number of experiments have been made to determine this rate for metallic thermometers. According to A. de Quervain (*Beiträge zur Physik der Freien Atmosphäre*, vol. i., p. 192), the value of $f\rho v$ for $v = 5$ m.p.s, and $\rho = 1{\cdot}2 \times 10^{-3}$ is roughly equal to 0·1 gm. cal. per min.

The equation (1) therefore reduces to

$$\frac{dT}{dt} = -10^{-2}v + \frac{\pi r^2}{60MC}[E - 2B - 0{\cdot}4\frac{\rho}{\rho_0}(T-\theta)]$$

if $v = 5$ m.p.s. and E, B are measured in gm. cal. per min.

Thus if $\rho = \frac{1}{8}\rho_0$ and $B = \frac{1}{4}E$, T must exceed θ by more than 2° C. if the effect of convection is to exceed that of radiation.

If we take the balloon to be initially of 100 cm. radius, and assume that the heat capacity of the envelope is one-half that of the hydrogen, we have for MC the value

$$1{\cdot}5 \times 3{\cdot}41 \times \tfrac{4}{3}\pi . 10^6 . 8{\cdot}8 . 10^{-5} = \pi \times 600 \text{ nearly},$$

the specific heat of hydrogen being 3·41.

Also r^2 will be 2×10^4, whence $\frac{\pi r^2}{MC} = 33$, and the first term is therefore comparable with the last two in the equation (1). If the temperature is diminishing at the rate of 6° C. per kilometre, T will diminish at the same rate if it exceeds θ by about 1°·7 C. Even if convection is only one-third as efficient as Quervain found, the temperature excess is not more than 5° C.

The thermometers are of bright metal, and even if they are directly exposed to the earth radiation they will not absorb at a rate as great as one-tenth of the rate we have assumed for rubber.

The equation for the temperature variation would be

$$\frac{dT}{dt} = \frac{A[E-2B]}{10MC} - \frac{f\rho v.S}{MC}(T-\theta), \qquad (2)$$

where S is the area exposed to the air current, and 2A the radiating area, which is certainly less than S for a tube thermometer.

If we take Quervain's figures we get A = 80 cm.², and $\frac{f\rho vS}{MC} = 8.\frac{\rho}{\rho_0}$ nearly, for a Hergesell instrument, while $\frac{A}{MC} = 160$, so that for T = 200° A. we have $\frac{dT}{dt} = 4{\cdot}4 - 2{\cdot}7\ (T-\theta)$, and the excess of T over θ would be but slightly greater than 2° C.

We may, then, take it as certain that the temperatures recorded in night ascents can be but slightly affected by radiation so long as the upward velocity is as great as 5 m.p.s. The assumptions made as regards radiation and convection are, of course, only approximate, but I think they err on the side of exaggerating the radiation effect.

In conclusion, I may add that I undertook this calculation believing that it might be possible for radiation materially to affect the temperature, at least of the balloon, because I knew that even at night radiation from external sources was not insignificant. The result is, however, a complete justification of the instrumental records. The isothermal region exists, and it exists for the very reason which, in Mr. Hughes's opinion, renders useless the instrumental records—the necessity for the material air also to preserve a balance between heat received and heat lost by radiation.

E. GOLD.

Vienna, February 15.

The Promotion of Scientific Research.

PUBLIC attention was directed to the subject of scientific research by the proceedings at the annual meeting of the trustees of the Carnegie Trust, and especially by the prominence given to the promotion of original research in the speech of Mr. Balfour, reported in NATURE of March 4. The reports of the proceedings may have engendered in some minds exaggerated notions as to the extent to which philanthropic effort may succeed in solving the problem of providing incentives to original research. It will be as well, therefore, to mention, for the information of those who are unacquainted with the regulations under which monies subject to the trust may be applied in the promotion of original research, that the incomes of the beneficiaries under the trust are very limited, and the conditions which are specified in the scheme of the trustees are very restrictive. Mr. Balfour, though he spoke encouragingly of the methods adopted by the trustees, alluded to the difficulty and delicacy of the task of selecting people for original work, and to the "puzzling questions of administration" with which it is surrounded; and it seems impossible, without the aid of legislation, to devise any scheme for the application of monies to research purposes which will succeed in inspiring confidence in research workers and which will not greatly restrict the research work which it may be designed to encourage. Had inventors of patentable inventions been encumbered by conditions similar to those to which research workers who are the objects of private munificence are subjected, the progress of inven-

tion would have been immeasurably retarded. The conditions under which the invention of patentable inventions is stimulated do not necessitate an inventor relinquishing the pursuit of any trade, occupation, or profession in which he may be engaged. He is under no obligation to satisfy anyone as to the direction his labours may take, and he is free to devote his talents to the work of invention at such times as he may for himself determine. Moreover, forms of judicial procedure are made available for him by which he can defend his claim to be described as "the true and first inventor" of his invention, whether that be disputed by rival inventors, or opposed on false or fraudulent grounds, or be the subject of official objection.

My scheme for the promotion of scientific research forms the subject of an article in NATURE of January 21. The principles of the scheme, which are generally indicated in the article, admit of substantial grants being made out of public monies for discoveries prescribed by Parliament under conditions analogous to those upon which patents for inventions may be obtained, and these conditions would, it is submitted, enlist in research directed to the making of these discoveries many minds possessing the capacity and true genius for this work, which existing methods wholly fail to attract. Allocations of grants may be made, on the conditions specified in the scheme, to discoveries which advance our knowledge of physical and chemical phenomena, and in relation to the more deadly and prevalent of the diseases which afflict humanity.

Allusion is made in the report of the executive committee of the British Science Guild, of which extracts are given in NATURE of January 28, to the Duke of Devonshire's Commission, which was appointed about thirty-eight years ago to inquire into the means available for extending scientific knowledge and advancing scientific progress. We stand to-day, so far as the provision by the State of pecuniary incentives to scientific research is concerned, much in the same position as we did at the conclusion of the prolonged labours of that commission. Since that time the practical applications of physical, chemical, and medical discoveries, not of a patentable nature, and for which no rewards can under existing conditions be obtained, have greatly contributed to the advancement of commercial and industrial progress and to the national well-being. The discovery of the electric waves used in wireless telegraphy, and of the conductivity of certain substances in the state of powder or filings when these waves impinge upon them, are examples of such discoveries. By means of these two discoveries it was found possible to construct systems of wireless telegraphy. If we confine our attention to the practical applications of these discoveries alone, we must perceive that, in addition to the more general beneficent purposes that have been thereby already attained, they have been the means of greatly increasing the effectiveness of our naval power.

In face of facts such as these, it is to be hoped that our legislators will awaken to a recognition of the momentous issues involved in the promotion of research in departments of science which have an intimate connection with public interests. WALTER B. PRIEST.

1 Verulam Buildings, Gray's Inn, London, March 3.

The "Daylight Saving" Bill.

MAY I point out, in addition to the recognised unscientific nature of the proposals of this Bill, that the third Sunday in April for the putting on of the clocks is hardly consistent with the third Sunday in September for putting them back? The length of the day in the third week of April is considerably greater than in the third week of September, and it would be much more consistent if the two equinoctial months March and September were both adopted for the alteration. The fourth Sunday in March, a little after the vernal equinox, has about the same length of day as the third Sunday in September, a little before the autumnal equinox. If it be urged that the temperature of the air in March in this country is too low for summer habits of life, one may reply that it is still too low in April, and even May, despite the long days and high altitude of the sun. L. C. W. BONACINA.

Northwood, March 13.

Fireball of February 22.

THE observations of this unusual object are exceedingly numerous, but some of them are discordant, and occasion doubts as to the exact path which the meteor traversed in our atmosphere. The radiant point being inaccurately defined, the direction and height are also to some extent uncertain. Apart from the determination already mentioned in NATURE, I have worked out two others, which do not differ very materially except in the elevation at the end. Further descriptions from France of a trustworthy and precise nature will enable the real path over the English Channel to be more certainly ascertained.

Radiant point ...	$=177^\circ+13^\circ$ ...	$190^\circ+20^\circ$
Height at first ...	50 miles ...	56 miles
Height at end ...	26 ,, ...	41 ,,
Length of path ..	155 ,, ...	155 ,,
Velocity per second	25 ,, ...	25 ,,

In the event of the position at $190^\circ+20^\circ$ being the correct one, the meteor was really a Comæ Berencid, and several fairly good observations from France and the Channel Islands indicate that it is entitled to some degree of confidence. W. F. DENNING.

Bristol, March 14.

Unusual Condition of Nasal Bones in Sphenodon.

IN the osteological collection here there is a skull of Sphenodon with four nasals. In the position of the usual single nasal, right or left, are two bones side by side. As this condition appears to be unusual, it would be interesting to know if any of your readers have come across a similar case. H. W. UNTHANK.

Birkbeck College, Breams Buildings, E.C., March 15.

ENGLISH EARTHWORKS AND THEIR ORIENTATION.[1]

THIS work is based upon the recommendations of the Committee on Ancient Earthworks and Fortified Enclosures. Though "written expressly to further the Committee's aims, it has no claim to be an authorised representation of the Committee's views." Pending the completion of the task undertaken by the Committee, this work seems to be the best text-book on the subject. Though the author has "restricted himself to the discussion of earthworks with which he is personally familiar," all classes of earthworks, from the earliest period to the time of the Civil War, are dealt with.

We are too grateful to the author for the well-sifted materials he has supplied to judge the whole work by any defects, especially if those defects concern matters which the author may have considered as lying outside his proper scope of work. But there is one feature of the author's work which calls for special notice. It concerns a line of inquiry which the author has almost altogether left untried, apparently, but which, nevertheless, he submits repeatedly to the test of ridicule. Though he refers respectfully enough to Sir Norman Lockyer's work, he indulges in remarks about the astronomical inquiry which are both unwarranted and inconsiderate, without showing any appreciation of the points in question.

Beyond some vague remarks about the orientation of amphitheatres (p. 589, note), the subject of orientation is almost entirely ignored. Most of the 224 plans published in the book have the cardinal points indicated, without ever a word saying whether the bearings are magnetic or true. The student of orientation must decide the matter for himself as well as he can in each case with the aid of a protractor. Nowhere can he find the slightest con-

1 "Earthwork of England: Prehistoric, Roman, Saxon, Danish, Norman, and Mediæval." By A. Hadrian Allcroft. Illustrated with Plans, Sections, &c. Pp. xix+711. (London: Macmillan and Co., Ltd., 1908.) Price 18s. net.

sideration of the wants of the astronomical inquirer, who cannot but treat uncertified plans, so to speak, as so much waste of labour. Unfortunately, one encounters the same difficulty in most works on archæology, so much so that one wonders why any compass lines are drawn on the plans at all. Undated magnetic bearings are useless, and unexplained bearings are, if anything, still more useless.

Our author, however, employs the whole force of his ridicule in belabouring the very class of fellow-workers in the same field he has so wilfully left unprovided for. An observer ventured to say that a curiously symmetrical work on Firle Hill, Sussex, was a "Stonehenge in earth"—Fig. 181 in the book under notice. It was evidently a mistake to take the corners of the central square as of solstitial significance, that is if the bearings of the plan are true. The author, however, seems not to have noticed even that. The observer's main contention is fully borne out in the plan that a line across the centre of the three works on the spot indicates a May-day orientation. A similar work on Mount Caburn gives a line at right angles to sunrise on May-day (Fig. 180), as well as an equinoctial line. Again, a similar work on Lewes Down (Fig. 182) gives a line at right angles to sunrise at the winter solstice. But instead of submitting such observations to some scientific test, our author indulges in such remarks as the following:—"Whence it is suggested that the whole is a work (Firle Hill) dating from that 'vastly remote epoch' when the year was accounted to begin in May—an epoch when the South Downs were inhabited by an immigrant race who brought with them astronomical ideas once prevalent in Egypt and Chaldea" (p. 537). "A little further investigation would have revealed to both authorities (Pitt-Rivers and the astronomical observer) that there are quite a number of such cryptic works upon the downs about Lewes, and that, in sober fact, they are merely the sites of bygone windmills!" (*ib.*). But elsewhere he notes that "round barrows of large size have been turned to various utilitarian purposes. They were favourite sites for windmills, for example, like the Derry Mount at Nottingham Castle."

A long barrow in Dunstable is called Windmill Hill (p. 531). That the sites about Lewes are such utilised barrows seems to be highly probable; yet the author winds up his remarks upon a subject he betrays no fitness to discuss with the following peroration:—"The millers of the downs are all but gone, and the last of their mills must soon cease to struggle against the competition of steam roller-mills and the modern taste for tasteless bread; but should there come to their dusty shades any intelligence of the matters which vex the minds of men on earth, they must laugh jollily to think of their old haunts translated into temples of the 'dim red dawn of man,' of themselves apotheosised into sapient astronomers, and of the later-day Quixotes so over-read in Druidical lore that they must needs ride a-tilting against windmills! And where shall the student of earthworks find a more homely lesson in all that an antiquary should be?—cautious, and again cautions, and yet a third time cautious" (p. 539). Where, indeed, shall the student find a more homely lesson on incaution than in the author's remarks on oriented windmill sites? One whom the author may have numbered in his list of "later-day Quixotes so over-read in Druidical lore" (for the author has read the present writer's incursions into that land of mystery) may fairly return the compliment and ask, Who is the real Quixote in the case?

The author can hardly refer to anything so-called "Druidical" in a truly scientific spirit. Dealing formally nowhere with the subject of Druidism, he always refers to it in a prohibitive fashion. It is "an obsession with the multitude" (p. 586). It is something that ridicule has killed (p. 691). Nothing

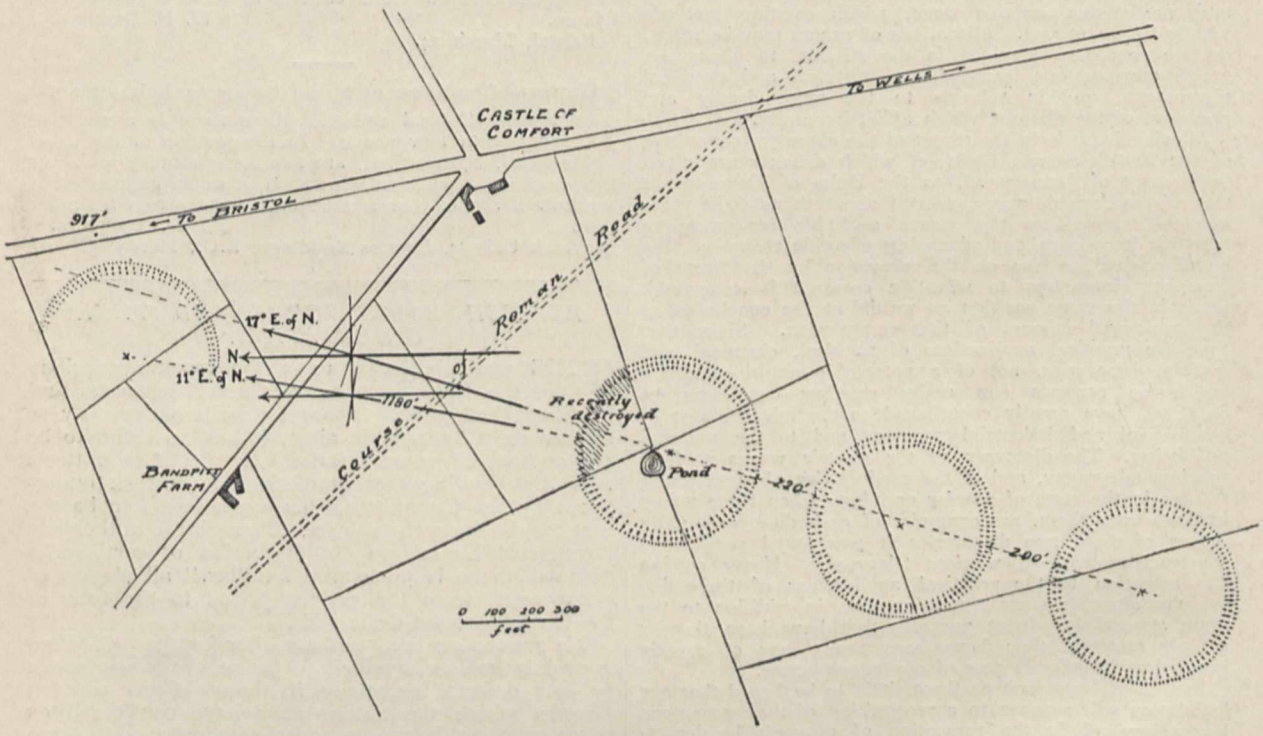


FIG. 1.—Mendip Ringworks, Priddy. From "Earthwork of England."

new, we are led to suppose, can be learnt on the subject. We should have liked to know what particularly may be the author's conception of Druidism. It must be rather peculiar to produce the remark on Warne's opinion of the Knowlton ring-works, that they were "sanctuaries of Druidic worship." "Had he written 'astronomical' instead of 'Druidic,' his opinion would have perhaps earned more attention" (p. 566).

Little as the author has done consciously for the student of astronomical archæology (and how much he could have done with little trouble!), we are gratified to find in the plans given scores of orientations agreeing with the theoretical conditions for locality. For instance, the mean azimuth of twenty-two earthworks in and about latitude 51°, which were assumed to be oriented to the summer solstice, ranging from 48° to 50°, is 48° 20′.

The author, like other recent writers who are more or less familiar with the astronomical inquiry in the field of archæology, will have it that the spade is the "solitary instrument" of comparative archæology. It is strange that the writers we have in mind have not tried any astronomical methods. There is something suspicious, as well as unscientific, in this assumption of finality, if not infallibility, for the spade.

With regard to many sites, the spade-work is confessedly disappointing. The author notes that the results of some partial explorations "of the Stripple Stones were as 'negative' as they have been at other spots of the kind" (p. 582). Astronomy, however, supplies us with "positive" information. We find there a definite Capella indication, 1250 B.C. ("Stonehenge," p. 293). On the plan given by Mr. Allcroft, we further note definite equinoctial and November alignments.

The series of four circles on the top of the Mendips (see Fig. 1) the author is inclined to think is "perhaps of astronomical character" (p. 564). The circles (Fig. 189) bear a striking resemblance in arrangement to the Hurlers in Cornwall ("Stonehenge," pp. 136–140). There are two definite star alignments, either Arcturus at different periods before 1300 B.C., or Capella at later periods, which we hesitate to say. The site is evidently that of a notable observatory. There is a Roman road running at right angles to the line of sunrise at the summer solstice (N. 41° W. –N. 49° E.). Another road, N. 61° E., points to sunrise on May-day. Meeting the last is still another road, az. S. 51° E., sunrise at the winter solstice.

One excellent result of collating so many plans of earthworks is the establishing of the fact that rectilineal and rectangular camps are by no means exclusively Roman. "The old conviction that all rectangular camps, wherever placed, must necessarily be Roman was completely upset by the excavations of Pitt-Rivers, and is now entirely discredited in England. In Scotland, according to Dr. Christison's view, of a total of more than eighty rectilineal and chiefly rectangular works commonly described as Roman, only seven have furnished any relics to bear out this attribution" (p. 143). The author shows that the "circular plan is the most economical." Why, then, have we straight walls or banks associated with circular works? An examination of the plans discloses the answer. Walls or banks were, of course, erected for defensive purposes, but they were built straight for orientation purposes. More, a straight wall gives the best earthwork orientation. Burrington Camp, Somerset, is a striking illustration in point (see Fig. 2). The only evidence of age the author cites is the finding of flint flakes in some quantity along the edge of the cliff southwards. It is described as "a very curious work, apparently a hybrid between the 'military' and the 'ritual' methods of construction" (p. 582). "Collinson was so perplexed by the oddity of the whole work that he opined it to be 'Druidical,' and to have some unexplained connection with the well-known stone circles at Stanton Drew, eight miles to the north-east" (pp. 583–4).

The plan shows the south bank to be oriented to the equinox. Another bank (B), az. 52°, may be oriented to both sunset at the summer solstice and sunrise at the winter solstice, as there is some height on the north-west. The north-east bank (D), az. N. 17° E., gives us a familiar datum. Collinson was right, and Burrington and Stanton Drew have the same star alignment, which Sir Norman Lockyer has worked out to be Arcturus, 1690 B.C. ("Stonehenge," p. 173). Surely this is another instance where the theodolite has helped the spade, and there

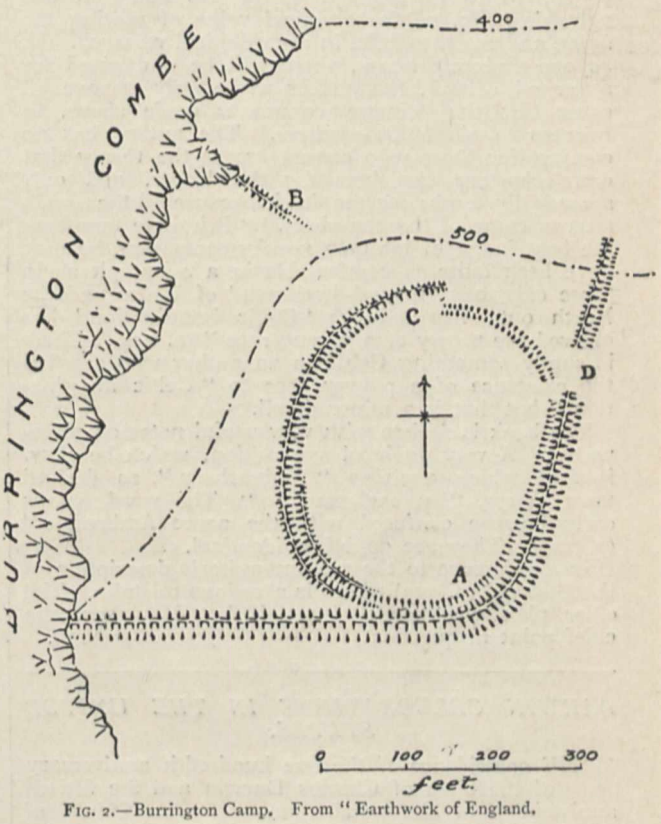


FIG. 2.—Burrington Camp. From "Earthwork of England."

is also something in "Druidism" which has not been reckoned with in Mr. Allcroft's philosophy.

At Arbor Low there seems to be an alignment to Alpha Centauri, the star concerned in our earliest monuments. Here the spade-work also indicates an early period. "The site was explored by Mr. St. George Gray in 1901–2, whose conclusions were that it was a work of the later Neolithic age, but antedating the Bronze age, that it was not intended as a place of habitation, and that, albeit interments were found within it, it did not appear to have been a place of sepulture at a period closely following its construction" (p. 577). The last sentence is most valuable. Well, an "interment" at the centre of the camp is aligned with a south-east entrance to S. 18° E., which may be regarded as Alpha Centauri about, say, 2400 B.C. This estimate is based on analogous cases where the same star is concerned.

"Not unlike this (Arbor Low) is Castle Dyke, near

Aysgarth" (Fig. 195). "At one point in the vallum, on the south-east, a single stone rises slightly above the turf" (pp. 577–8). There is also a gap in the vallum on the south-west, right opposite an entrance on the north-east. Drawing a north-south line between the two southern points mentioned, it is seen that the gap is S. 33° W., the N.E. entrance N. 33° E., and the south-west stone S. 33° E. Taking the north-east outlook into consideration, lat. 54°, dec. 29° 30′, we have an indication of Capella about 2250 B.C. But if we take the south-east stone as a direction point—a safe proceeding—we have Alpha Centauri nearly at the same time that we have it at Avebury, which is well within the fourth millennium B.C. At Maiden Castle (S. 34° E.) we seem to have practically the same datum, and at Muzbury (S. 20° E.) the same star.

Such are a few instances out of about a hundred or so, which the present writer has noted in this valuable book, of the practical value of uniting the spade and the theodolite in archæological research. If, as one sincerely hopes, there will be a demand for a second edition, the author will surely remove all cause for the adverse comments made above, in fairness to his fellow-workers. The author has no comfort for those who cannot accept the theory that cromlechs are chambers for the living, and only secondarily tombs for the dead, because of the smallness of some of the chambers. "Primitive man was the best judge of his own requirements, and he may have been quite as comfortable in a 4-foot pit as in those exiguous 'mound-dwellings' of Wales and the North out of which the 'Celtic imagination' has evolved the theory of a pygmy race" (p. 253). There is surely something Celtic in an author who ascribes the existence of a pygmy race to "Celtic imagination," but that is a minor detail.

The book is replete with very useful notes on place-names. A very doubtful supposition, which he cites, is that which explains "Ambresbury" as derived from *emrys*, "an enclosure." "The word *Emrys* early became confused with the name Ambrosius" (p. 128). They are doubtless identical.

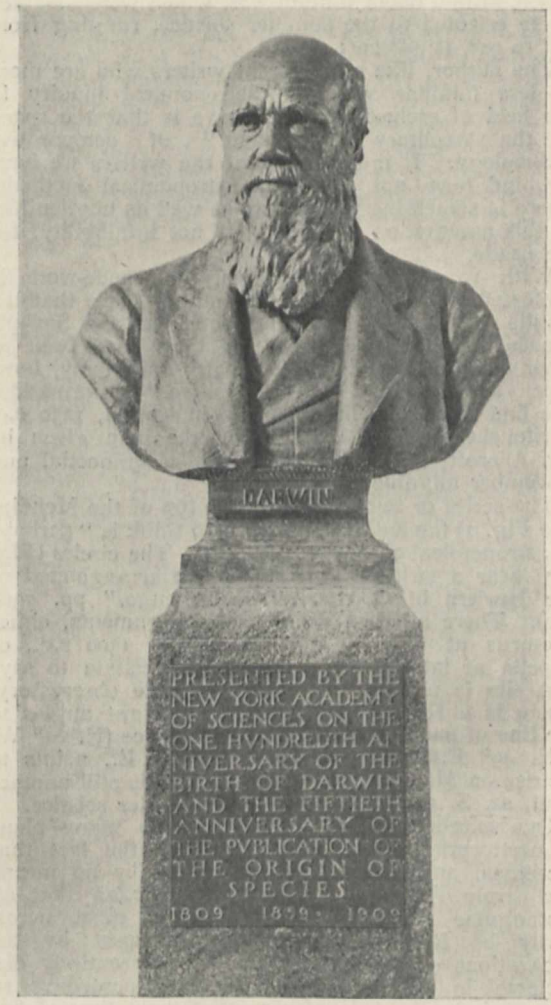
In a reference to the present writer's description of the Gorsedd (p. 593), there is a serious mistake. The older plan was not equinoctial, but May-year, the chief point in question. JOHN GRIFFITH.

DARWIN CELEBRATIONS IN THE UNITED STATES.

THE coincidence of the one hundredth anniversary of the birth of Charles Darwin and the fiftieth anniversary of the publication of "The Origin of Species" in the present year has called forth a series of noteworthy celebrations in the educational and scientific institutions of the United States.

The earliest of these, as recorded already in NATURE, was that held in Baltimore on January 1 by the American Association for the Advancement of Science, which devoted an entire day to the honour of Darwin. A year's preparation had been given to the arrangements for this day, which included a series of ten addresses by the most eminent biologists in the country, who attempted to cover the important fields of Darwin's work, except in geology, which was briefly alluded to in the introductory address by Prof. T. C. Chamberlin, of the University of Chicago, as president of the American Association. Prof. E. B. Poulton was invited from Oxford as the special representative of the English universities, and as the leading exponent of pure Darwinism. His important opening address, entitled "Fifty Years of Darwinism," will be used as an introduction to a volume, now in the press, to be published by Messrs. Henry Holt and Co., New York, which will include all the addresses of this important series. Each of these addresses was partly retrospective and partly related to the progress in the special field of the speaker since the time of Darwin.

A series of tributes to the great naturalist was arranged for his birthday, February 12, in colleges, universities, and various scientific institutions in all parts of the United States. The present writer has especially in mind addresses at Columbia University, Cornell University, University of Chicago, University of Illinois, North-Western University (Evanston, Ill.), University of Missouri, and University of Syracuse.



Other celebrations arranged were those of the Academy of Natural Sciences of Philadelphia on February 16, at which the principal address was made by Prof. E. G. Conklin (now of Princeton University). The coincidence of Darwin's birth with that of Abraham Lincoln suggested in many of the speeches and addresses several striking parallels in the personal character of these two great men: their simplicity, unconsciousness of power, abhorrence of slavery, clearness of expression, singleness of purpose. Repeatedly in Press and pulpit utterances Darwin was referred to as the emancipator of human thought, Lincoln as the emancipator of the negro race. The attitude of the pulpit and clergy everywhere has

been one of the most striking evidences of the triumph of the truth as presented by Darwin.

In New York a joint committee of the New York Academy of Sciences, the American Museum of Natural History, and Columbia University arranged a joint celebration for February 12. In the morning the students of Columbia University assembled to hear an address by Prof. H. F. Osborn on the "Life and Work of Darwin," appropriately introduced by the president of the university, Dr. Nicholas Murray Butler. This address was the first of a course of special lectures, extending over nine weeks, entitled "Charles Darwin and his Influence on Science." The topics cover terrestrial evolution, palæontology, zoology, anthropology, psychology, botany, modern philosophy, cosmic evolution, and human institutions. Besides members of the Columbia faculty the speakers included Prof. W. B. Scott, of Princeton, Dr. D. T. McDougal, of the Botanical Research Station, and Dr. G. E. Hale, of the Solar Observatory of the Carnegie Institution.

In the afternoon a large audience assembled in the Synoptic Hall of the American Museum of Natural History, under the auspices of the New York Academy of Sciences. Mr. Charles F. Cox, president of the New York Academy of Sciences, opened the meeting with a sketch of Darwin's life, and closed with the presentation to the American Museum of a bronze portrait bust of Darwin. This bust was executed by the sculptor William Cooper, and is of heroic size, mounted on a polished pedestal of the granite of which the museum is built, with an inscription tablet in bronze. It will stand permanently at the entrance of the Synoptic Hall. In accepting the bust on behalf of the trustees of the American Museum, President Osborn spoke of its three-fold significance —first as a work of art which will be welcomed everywhere as a singularly impressive likeness of Darwin, second as permanently associating the name of the great naturalist with one of the newer exhibition halls which is to be especially devoted to the exposition of the general principles of biology as seen in the structure and embryonic development, the adaptations of colour and form, the marvellous diversity, yet unity, of the animal world, to the true interpretation of which Charles Darwin devoted his life. President Osborn closed by announcing that, in order further to cement the name and spirit of Darwin with the museum, the trustees had unanimously voted to name this hall Darwin Hall, and had prepared and placed at the entrance on the centennial day two bronze tablets as a permanent record of the time and place of this dedication.

Addresses were then given by Prof. N. L. Britton, director of the New York Botanical Garden, on Darwin's contributions to botany, and by Prof. J. J. Stevenson, of the University of New York, on Darwin's contributions to geology, in which it was especially pointed out that modern biology through Lyell and Darwin largely owes its method to geology. The final address was made by Dr. H. C. Bumpus, director of the American Museum of Natural History, in which was outlined a history of the reception of Darwinism in the United States and the early contributions of Gray, of Morse, of Hyatt, of Cope, and of others to the Darwinian theory.

At the close of these addresses the guests passed from the Synoptic Hall to the adjoining hall of North American forestry, where a special exhibition had been arranged to illustrate the principles brought out in Darwin's writings. In the fifteen alcoves of the hall a special exhibit has been arranged to exhibit each of the great principles and subjects treated by Darwin. There had also been brought together temporarily an exhibit of all Darwin's publications, of the first editions of all his works, a series of portraits and autograph letters, as well as a series of photographs of Darwin's contemporaries, chiefly from the unique private collection of Mr. Charles F. Cox, president of the New York Academy of Sciences.

H. F. O.

AN IMPERIAL BUREAU OF ANTHROPOLOGY.

FOR many years past those who have appreciated the practical value of ethnology in the administration of our Empire have realised the necessity of a central organisation for the registration and co-ordination of data collected by Government officials or others, for the giving of advice to those about to reside or travel in India or the colonies, and to serve as a central office where those at home could obtain trustworthy information concerning the various races and peoples that collectively constitute the British Empire. At the Liverpool meeting of the British Association in 1896, Mr. C. H. Read, of the British Museum, proposed the foundation of a bureau of this nature. In his presidential address to the anthropological section at the Dover meeting, three years later, he announced that the trustees of the British Museum had undertaken the working of the bureau under his own supervision, if the Treasury would make a small yearly grant. Owing to lack of adequate support, very little has been accomplished to render effective Mr. Read's laudable endeavour.

The need for such an establishment has been increasingly felt. Thanks to the zeal of Prof. W. Ridgeway, of Cambridge, the president of the Royal Anthropological Institute, the matter has again been taken up. He drew up a memorial which has been signed by a large number of influential persons in all departments of activity, statesmen, eminent administrators of India and the colonies, members of Parliament, merchants, students of all branches of the humanities, anthropologists, and many others. The memorial refers to the utility of anthropology in other departments of intellectual and practical life; for example, several of our distinguished administrators, both in India and the colonies, have pointed out that most of the mistakes made by officials in dealing with natives are due to lack of training in the rudiments of ethnology, primitive sociology, and primitive religion. Nor is it only for the administrator that training in anthropology and facility for its further study are important. For purposes of commerce it is of vital necessity that the manufacturer and the trader should be familiar with the habits, customs, arts, and tastes of the natives of the country with which, or in which, they carry on their business. The Germans have long since seen the value of such a training; they have spent, and are spending, large sums annually in promoting the study of the ethnology of all parts of the world, and their remarkable success in trade in recent years, not only with primitive and barbaric races, but also in China and Japan, is largely due to this fact.

The training of young officials is a matter of national importance, and there is evidence that some of our leading administrators are fully alive to its value. Recently, Sir Reginald Wingate addressed a letter to the Universities of Oxford and Cambridge in which he asked whether those universities were prepared to give instruction in ethnology and primitive religion to probationers for the Sudan Civil Service; the Oxford Anthropological Committee and the Cambridge Board of Anthropological Studies at once replied in the affirmative, and courses of in-

struction in those subjects have already commenced. No provision has as yet been made anywhere for the training of schoolmasters and medical officers in anthropometry, to fit them to take measurements of school children and Army recruits. Yet this branch of anthropology is one of the highest importance, not simply for scientific reasons, but because of its practical bearing on the great question of physical deterioration, which has long engaged the attention of anthropologists and the medical profession, and has lately been discussed in Parliament.

The memorial urges the establishment in London of a bureau in which all the distinguished anthropologists of the kingdom could meet on common ground, as do all the leading mathematicians, physicists, chemists, and biologists in the Royal Society. All the elements of such a bureau already exist in the Royal Anthropological Institute of Great Britain and Ireland. This bureau would collect information respecting the ethnology, institutions, arts, religion, and law of all races, especially of those in the British Empire, and it would publish the notes sent in by observers in all parts of the world, issuing these in the form of bulletins. The bureau might confer a diploma on officials, scientific travellers, and others who had submitted to a proper test of their distinction in some branch of anthropology, and it would approve for certificates schoolmasters and others who had shown themselves competent to make anthropometrical observations in the examinations held under the direction of the bureau. In view of the services which such a bureau would render to the nation, "we respectfully petition His Majesty's Government to make an annual grant of 500*l.* to the Royal Anthropological Institute for carrying out the scheme set forth, and also to grant a suitable set of rooms in the Imperial Institute."

It is not proposed that the teaching of ethnology should form part of the work of the bureau. For many years past instruction has been given in the Universities of Oxford and Cambridge in various departments of anthropology. In the University of London are the only two professors of sociology in the kingdom, and instruction has also been given in ethnology for several years, and the University of Liverpool has a professor of social anthropology. Thus, although most of the teaching appointments are financially starved and work under unfavourable conditions, the foundations have been laid for anthropological instruction in several of our universities.

On March 12 the Prime Minister received an influential deputation at the House of Commons, which presented to him the memorial urging the Government to establish an Imperial Bureau of Anthropology in connection with the Royal Anthropological Institute. Prof. Ridgeway pointed out that the science of anthropology could be of the highest possible service to the State in the training of Colonial and Indian administrators, and that it was also a necessity for commercial success. Sir Edward Candy said, in reply to the Prime Minister, that he would make anthropology a compulsory subject.

The Prime Minister said that he entirely agreed that anthropology was becoming every year more and more, not only an important, but an indispensable branch of knowledge, not merely for scholars, but for persons who were going to undertake the work of administration in an Empire like ours, whether in India or in Crown Colonies. While he would hesitate to express anything like a considered and final opinion as to whether anthropology ought to be included as a compulsory subject for examination, he was quite satisfied that it was highly desirable that it should become a regular subject of study, and enter into the normal equipment of young men who went to the outlying regions of the Empire and encountered strange conditions of life. He did not, however, hold out anything like an assurance, or even an expectation, that the pecuniary grant they had asked for would be accorded. Evidently he feared that other learned societies might also urge their claims for Government support, but he did not appear to realise that a grant for a bureau is on a different footing from one merely to a society as such. The need for a bureau of ethnology is urgent, and it should be remembered that to equip a bureau as an independent body would be much more expensive than affiliating it with a society which already possesses the nucleus of the requisite organisation. It is to be hoped that the Chancellor of the Exchequer will be generous to this scheme, which is certainly one of national importance.

An additional argument for the establishment of the bureau is to be found in the Sargent prize essay by the Rev. H. A. Junod, on "The best means of preserving the traditions and customs of the various South African native races" (Report South African Association for the Advancement of Science, 1907 [1908], p. 142). The Rev. H. A. Junod is a sympathetic missionary who is well known for his studies on the ethnology of the Ba-ronga. In this essay he points out how the old lore is passing out of remembrance or becoming modified, and he adds, "What is wanted is a central agency which would receive the materials collected by people on the spot and publish them in a way which would make them available for science at large. There ought to be created without delay a South African Anthropological Commission, which would answer to the need just pointed out." It would be a credit to South Africa if the scheme outlined by M. Junod could be carried out, and all such local enterprises should be affiliated with a central bureau in London.

A. C. HADDON.

NOTES.

MR. HALDANE, Secretary of State for War, will be the guest of the evening at the anniversary dinner of the Junior Institution of Engineers, to be held at the Hotel Cecil on May 1.

THE seventeenth "James Forrest" lecture of the Institution of Civil Engineers will be delivered at the institution on Monday, April 26, by Colonel H. C. L. Holden, R.A., F.R.S., his topic being "Road Motors."

THE grand gold medal for science has been bestowed upon Dr. Sven Hedin by the German Emperor, and the Berlin Geographical Society has presented him with the Humboldt medal of the society.

THE *Times* correspondent at Ottawa states that a Daylight Saving Bill, introduced in the Canadian House of Commons on March 12, was received with laughter and ironical cheering. The Bill proposes that from April 2 to October 2 local time should be observed one hour ahead of the standard time.

WE learn from *Science* that the "sundry civil" Bill for the fiscal year 1910, as reported to the House of Representatives last month, provides for a new building in Washington to accommodate the Geological Survey, the General Land Office, the Office of Indian Affairs, and the Reclamation Service, to cost 500,000*l.*, and appropriates 20,000*l.* for preliminary work in construction.

ON Thursday next, March 25, Prof. G. H. Bryan will begin a course of two lectures at the Royal Institution on "Aërial Flight in Theory and Practice." The Friday evening discourse on March 26 will be delivered by Mr. A. S. Eddington on "Recent Results of Astronomical Research," and on April 2 by Sir J. J. Thomson on "Electrical Striations."

IN a letter to the *Times* of March 15, Prof. Osler directs attention to the useful work which is being done by the Italian Society for the Study of Malaria, founded ten years ago, for the prevention of malarial diseases. The society has promoted legislation for the gratuitous distribution of quinine, has prepared quinine in its most agreeable forms, and has introduced into practice the mechanical measures based on the defence of the habitation and the individual from the bites of mosquitoes. The result is that the mortality from malaria in Italy has declined from 16,000 in 1902 to about 4000 in 1908. Prof. Osler also points out that the growth of our knowledge of the causation and prevention of malaria illustrates the stages through which so many of the great discoveries in medicine have had to pass, and is a striking example of the value of experimental methods in medical research.

THE Belgian Legation announces that in the year 1911 the annual prize of 25,000 francs (625*l.*), instituted by King Leopold in 1874, will be awarded for the best work in French, Flemish, English, German, Italian, Spanish, or Portuguese on "The Progress of Aërial Navigation and the most Effective Means for its Encouragement." In that year foreigners will be permitted to participate in the competition, and the award will be in the hands of a jury nominated by the King, and consisting of three Belgians and four foreigners. The works submitted for competition must reach the Belgian Minister of Science and Art before March 1, 1911.

THE *Times* correspondent at Wellington, New Zealand, reports that the Ngauruhoe volcano, which has been quiescent for a year, is in active eruption. On March 8 a quivering of the earth in the neighbourhood of the volcano was felt in the evening, and loud noises were heard. These phenomena were followed by the ejection, first, of a column of steam from the crater, and afterwards of steam and volcanic ashes. The eruption was caused through the blocking of the main vent, which was cleared by the outburst of superheated steam. There was no lava flow, and the volcano remains in the solfatara stage.

THE death is announced of Prof. W. C. Kernot, professor of Engineering in the University of Melbourne. From the *Times* we learn that Prof. Kernot was born at Rochford, Essex, in 1845, and was educated at schools at Geelong, and at Melbourne University, where he graduated with honours in 1864. After being engaged on the Geelong and Coliban water-works, he became lecturer on surveying and engineering at the University, and in 1883 was appointed to the chair of engineering. In 1874 he was chief of the photoheliograph party at the Melbourne Observatory for the observation of the transit of Venus. In 1887 he presented to Melbourne University, as a jubilee gift, the sum of 2000*l.* to endow scholarships in physics and chemistry. He also founded a metallurgical department at the University at a cost of 1000*l.* He was president of the Royal Society of Victoria for several years, and was the author of various papers in technical journals.

ON the occasion of the celebration of Charles Darwin's centenary in Hamburg last month, Prof. E. Detmer delivered a eulogistic address on Darwin as a botanist, that is published in *Naturwissenschaftliche Wochenschrift* (February 21). Referring to his labours as an investigator, Prof. W. Detmer selected for consideration Darwin's researches on insectivorous plants, cross- and self-fertilisation, and the power of movement in plants; it is pointed out that the first excels in exact and comprehensive elaboration, that the second entailed an enormous amount of work in order to get details on which to base a generalisation, and the third introduces new ideas and problems in the physiology of perception. There follows an appreciation of Darwin's greatest contributions to the domain of natural science, *i.e.* selection and variation.

A CORRESPONDENT, writing from Freiburg in Baden, sends us an account of a discourse delivered by Prof. Weismann on February 12 last as the commemoration address in connection with the Darwin centenary celebration by the Natural Science Society of Freiburg University. In his oration Prof. Weismann dwelt on Darwin's early shown inclination to the truths and beauties of nature in spite of a dry and dreary education; then on the glories of the welcome voyage, which kept the young student of nature in a state of perpetual rapture; and, again, on the concentration with which Darwin worked in his English country home at the collection of endless facts to construct his theory. Prof. Weismann went on to describe how little impression the Linnæan lecture of 1858 made on the public mind, but how no scientific work has ever made so great a sensation as the "Origin of Species." He himself first read the book two years later, at the period when he had lately thrown up medicine as a profession for zoology, and so was too young in the new subject to have sunk deep into the grooves of the old school, but was freer than most older zoologists, botanists, and other natural sciences to adopt the evolution principles. Prof. Weismann then showed how greatly the evolution theory changed the whole mind of the times, and set new and varied work going in all directions. Men have made progress since 1859 by leaps and bounds in sounding the mysteries of natural sciences, such as embryology, the laws of heredity, and fertilisation. The theory has opened vistas of historical research—such as the history of art and language—in unending perspective. As man has developed from the very simplest beginnings, and has only by degrees reached his present state of high organisation, why should we suppose that we have reached the end and object of the process? The longer the human race exists, the more will it strive for what is higher, purer, and nobler, towards a life dedicated less for selfish and more for general good. Therefore, indeed, do we owe much to Darwin, not alone as a benefactor to science, but as a benefactor to the aims of humanity.

THE report of the council of the Ray Society, read and adopted at the annual general meeting on March 11, recorded some interesting facts as to the position of the society and its publications. There has been a decided increase in the membership of the society since the previous report was presented, the numerical strength being now greater than in any year since 1895. One of the volumes for the year, the "British Desmidiaceæ," vol. iii., by Mr. W. West and Dr. G. S. West, was issued in the first week of December last. The publication of the other volume, the "British Rhizopoda," vol. ii., is delayed owing to the death of Mr. James Cash, which occurred on February 20. For the present year a supplementary part of the "British Nudibranchiate Mollusca" is in preparation by Sir Charles Eliot. The forthcoming zoological works

are the "British Centipedes and Millipedes," by Mr. Wilfred Mark Webb; the "British Parasitic Copepoda," by Dr. Thomas Scott and Mr. Andrew Scott; the "British Hydrachnidæ," by Mr. C. D. Soar and Mr. W. Williamson; the "British Ixodoidea," by Mr. W. F. Cooper and Mr. L. E. Robinson; and the "Earwigs of the World," by Mr. Malcolm Burr. The only new botanical work promised is one on the "British Characeæ," by Messrs. Henry and James Groves. Lord Avebury, F.R.S., has been re-elected president of the society, Mr. DuCane Godman, F.R.S., treasurer, and Mr. John Hopkinson, secretary.

THE commemoration of the jubilee of the discovery of the source of the White Nile was celebrated by a meeting of the Royal Geographical Society, at which a paper was read by Sir W. Garstin, published in the February number of the journal of the society, entitled "Fifty Years of Nile Exploration, and some of its Results." The paper begins with a good summary of exploration prior to 1898, when the power of the Khalifa was overthrown and the Sudan re-conquered by the Anglo-Egyptian forces. An account is given of the hydrography of the river, and of the measures taken in recent years to develop its water supplies for the irrigation of the Delta. There is also a lucid account of the functions in this respect of the White and Blue branches of the river, which "automatically compensate each other, so that at the time one system is passing on a large volume of water, the other is storing up its discharge, and when the former begins to decrease in volume the stored water takes its place, and makes good the deficiency. The comprehension of these facts is, I consider, one of the most important results of our studies of the Nile since 1898." Another interesting paper in the same issue of the journal is that on the Panama Canal in 1908, by Dr. Vaughan Cornish. The probable total cost of the work is, he says, unknown, but Colonel Goethals has stated in evidence that it will be at least 250, and possibly 500 million dollars. A lively discussion followed, in which Colonel G. E. Church estimated the commerce which would possibly go through the canal, if it were now complete, at less than a million tons. On the question of its strategic value he was equally pessimistic. The monthly bibliography of geographical literature, which is a distinguishing feature of the journal, is as good and as indispensable as ever.

AN interesting work of engineering is being carried out in the construction of a railway tunnel under the river Detroit, which runs between the United States and Canada. There are no fewer than five railways that cross this river between Windsor and Detroit, the service being maintained by means of ferry-boats of such a size that there is room on deck for a complete passenger train or half a freight train. The time occupied in crossing the river, which is half a mile wide, including the loading up of the trains and the crossing, is from thirty to forty minutes for a passenger train, goods trains being often delayed three to four hours. The tedious delays in the transport of passengers and goods occasioned by the crossing of the river have for some time past been the constant subject of complaint, and various schemes have been brought forward to remedy this. A bridge is impracticable, owing to the interference it would cause to the river traffic between the Great Lakes, this being equal in tonnage to that which passes through the Suez Canal. Finally, a scheme was settled for a tunnel, the method of construction adopted being somewhat novel. This tunnel consists of two steel tubes placed 42 feet below the surface of the river, each 16½ feet in diameter, running parallel with each other, but 3 feet apart. For the reception of these a trench is first dredged in the bed of the river, which consists of clay, 48 feet wide at the bottom; as this proceeds piles are driven in the bottom of the trench by a floating pile-driver, and on these is laid a steel and concrete grillage, on which the tubes are bedded. These are made of riveted steel, each 262 feet long, 23 feet 4 inches inside diameter. These weigh 600 tons, and are made at a yard twenty-four miles distant, and conveyed to the site of the tunnel by water. Before launching the ends are plugged by a timber bulkhead. When the tubes are in position, inlet and outlet valves are opened, causing them to sink. Divers are employed to ensure that the diaphragms rest firmly on the grillage. The forward end of each tube has a sleeve 17 inches long, which fits over the end of the tube previously sunk, the flanges being bolted to the one previously laid. The trench in which the tubes are placed is then filled up with cement concrete, completely embedding them. The concrete is lowered through 12-inch tubes from a barge. When completed, the trains are to be worked through the tunnel by electricity.

To the Museum Conference held last year in Ipswich the Rev. J. S. Whitewright contributed a paper on pioneer museum-work in China, which is printed in the February number of the *Museums Journal*. The author, it appears, opened in 1887 a small museum in the city of Ching-chon-fu, in Shantung, with the view of opening the minds of the Chinese and of establishing a basis of common interests. The result was, on the whole, successful. One member of the upper classes was, indeed, inclined to be supercilious, and stated that there could be no such thing as electricity; if there were, the Chinese would have known all about it years ago. An introduction to a magneto-electrical machine convinced the sceptical visitor of his error, and he left the premises a more enlightened, if a sadder, man, with a full conviction of the powers of electricity. The exhibits in the museum consisted principally of maps and globes, diagrams illustrative of elementary physiography, geology, astronomy, and natural history, specimens of natural-history objects and manufactures, electrical apparatus, and models of engines.

A CLASSIFIED and selected catalogue of botanical publications, including a number of rare books, has been received from the publisher and second-hand bookseller, W. Junk, of Kurfürstendamm, Berlin. It contains a list of nearly seven thousand titles; the prices are apparently for new copies where these are obtainable, but in other cases for second-hand copies. The catalogue is intended to be kept for reference purposes, as it is printed on good paper, bound, and furnished with a preface, in which the publisher discourses chiefly on prices.

A CONTRIBUTION by Prof. G. Haberlandt to the *Sitzungsberichte der kaiserlichen Akademie der Wissenschaften* (vol. cxvii., part vi.), Vienna, on sense-organs in leaves, is noteworthy because it furnishes a reply to an adverse critic regarding the existence of such devices in a number of common plants. The author takes each species in detail, and finds in every case arrangements of one kind or another which he regards as functional. In *Sorbus terminalis* the arrangement is provided by a cup-shaped depression of the mucilage; the shape of the cells is peculiar in *Chelidonium majus* and *Phyteuma spicatum*, and in *Morus alba* it is maintained that the cystolith, being of a special type, might function as a light collector.

A STUDY by Messrs. W. W. Robbins and G. S. Dodds of the plant distribution on the slopes known as "mesas,"

near the city of Boulder, Colorado, is published in the University of Colorado Studies (vol. vi., part i.). The "mesa" lies between the lowest range of hills and the plains, in the present instance at an altitude of from 5500 feet to 6500 feet. *Pinus scopulorum* is the chief feature in the landscape; it extends downwards from the hills, especially on the northern slopes of the mesas, where it gives shelter to various bushes until it is checked by grass-land. *Berberis repens* and *Yucca glauca* occupy localised positions, and two species of Ceanothus grow on the dry slopes. *Symphoricarpus occidentalis* plays an important part in distribution, as it first colonises embryonic ravines, being followed by roses, currants, and *Rhus trilobata*; but eventually species of Cratægus become dominant in the ravines and gulches.

AN interesting experiment is recorded by Mr. Thornton in the January number of the *Agricultural Journal of the Cape of Good Hope*, which, although in no sense novel, is of considerable technical importance. It was found that the yield both of barley and wheat is much increased by cultivation, and the most thorough cultivation tried gave the largest profit. The use of machinery tends to diminish the cost of cultivation, and it is highly important in a country like Cape Colony, where fertilisers are dear, for farmers to be shown how to increase their crops without at the same time sacrificing any profit.

THE results of several years' feeding trials at Cockle Park are issued as Bulletin No. 12 of the Armstrong College, Newcastle-upon-Tyne. Comparisons are made between several varieties of cake, including Indian cotton cake, earth-nut cake, sesame cake, and niger cake; several other foods were also the subject of experiment. The results are expressed as gains in live weight, and an estimate of the cost is given. There is also a list of equivalent values of food-stuffs, some of which have been established by experiment, while others are only calculated; on this basis several rations for fattening and for milch stock are suggested.

THE question of breeding for milk is one which is attracting considerable attention from practical men, and is of distinct scientific interest. When a deep-milking cow is mated with a bull the dam of which was also a deep milker, it is found that the female offspring yield large quantities of milk, while the males will beget deep milkers. Records of milk yields are therefore useful guides to the breeder; illustrations of their value are not infrequently given in the agricultural Press, and one has lately appeared in the *North British Agriculturist*. On the farm referred to a group of Ayrshire cows has been bred giving the very high average yield of 1144 gallons of milk, containing 3·6 per cent. of fat, during last season, while a group of young cattle are being raised the dams of which averaged 1232 gallons of milk, containing 3·8 per cent. of fat. The sort of variation found in an ordinary Shorthorn herd is shown in Bulletin No. 15 of the Edinburgh and East of Scotland Agricultural College, where the highest and the lowest yields given by cows in the same herd were in the year ending July, 1906, 1505 gallons in forty-seven weeks, and 478 gallons in thirty-nine weeks, and in the year ending July, 1908, 1224 gallons in fifty-two weeks and 438 gallons in twenty-six weeks.

IT has long been known that the Gypsies, like other Oriental races, were acquainted with the use of poisons. According to some authorities they employed preparations of certain fungi or mushroom spores. Borrow and other writers on Gypsy lore have recorded that formerly they were in the habit of poisoning pigs and eating their flesh. One peculiar poison, known to Gypsies under the name of drab, which has never been satisfactorily identified, has recently been studied by Mr. J. Myers, who records the result of his investigations in the January number of the Journal of the Gypsy-lore Society. On apparently fairly good evidence, he identifies it with barium carbonate, known in Shropshire under the names of witherite or water-spar. Prof. Sherrington gives his opinion that the flesh of a pig poisoned with this substance might be eaten with perfect safety provided the entrails were rejected and the parts of the animal which might have come in contact with them carefully washed. It is also remarkable, as Mr. Myers shows, that when Barrow himself was poisoned, an incident in his life of which he gives an account in "Lavengro" (chapter lxxi.), the symptoms which he describes appear to be typical of barium poisoning. Sir H. D. Littlejohn, who was inclined in Borrow's case to suspect a vegetable narcotic, now agrees that a good case has been made out for the use of barium.

THE report of the chief of the U.S. Weather Bureau for the fiscal year 1906–7 has been received. In continuation of the useful plan adopted in 1903–4, the tables contain twice-daily values of the principal meteorological elements for 1906 for twenty-nine stations, selected to cover as nearly as possible all sections of the United States. These are followed by monthly and annual summaries for 189 stations, and by monthly and annual values of temperature, rainfall, &c., with dates of first and last killing frosts for a large number of stations, from the records of both voluntary and official observers, the whole of the tables extending to 402 large quarto pages. The administrative report directs attention to the valuable researches at Mount Weather Observatory, among which we may specially mention solar radiation and the daily investigation of the upper air. With regard to the latter, Prof. W. L. Moore considers that it is the one line of inquiry that at present holds out the greatest promise of immediate utility. In our issue of January 14 we referred to that part of the report that relates to wireless telegraphy; the distribution of weather forecasts and special warnings over the land areas has reached enormous proportions; at the close of the fiscal year, 1633 telephone companies were cooperating with the Bureau in the dissemination of the reports. Meteorological observations for Greenwich noon are collected from various oceans, for which forms and franked return envelopes are supplied, the observers using their own instruments. The number of vessels cooperating during the year was 1216, of which more than half were British; the great majority of the observations refer to the North Atlantic.

IN the Memoirs of the Indian Meteorological Department (vol. xx., part vii.) Mr. J. H. Field gives an account of the kite flights in India and over the neighbouring sea areas during the south-west monsoon period of 1907, in continuation of the useful experiments made in 1906, and described in vol. xx., part ii. (NATURE, July 23, 1908). The work on land, at Belgaum, lasted from July 11 to August 3, but it was only during the first week of that period that successful flights were made. The records were unfortunately few, but the conclusions indicate that at Belgaum (Bombay Presidency) the wind direction, from the surface upwards, showed increasing rotation as the wet weather approached. Temperature gradients during ascents were considerably greater in the lower stratum than the adiabatic rate for unsaturated air, and considerably smaller during descents, later in the day. At levels above 400 metres gradients during descents varied from

about −0°·4 C. to −0°·6 C. per 100 metres. An upper limit to the humid layer was reached at about 1000 metres only on one day during completely dry weather, but if it persisted afterwards, as the weather changed, it must have been at more than three times that height. In the Bay of Bengal and the Arabian Sea the experiments were made between August 24 and September 4. Over the latter the conclusions show that the following conditions obtained :—(1) The velocity of the wind increased appreciably with height, and the direction became west at 1800 metres, irrespective of the direction of the surface wind. (2) Temperature gradients were very nearly adiabatic up to about 500 metres, and afterwards decreased to about half that rate. (3) Absolute humidity remained fairly constant up to 400 metres, and afterwards decreased to quite low values. The results for the Bay of Bengal, so far as they go, indicate conditions similar to those of (2) and (3); no question of estimating wind velocity or direction arose, for the air was practically calm at the surface.

THE *Physical Review* for February contains a paper by Mr. Willard J. Fisher, of Cornell University, on the variation of the viscosity of a gas with temperature. The gas to be tested is forced to and fro through a capillary tube contained in an electric furnace, the pressures used being read on a mercury manometer, and the temperatures by means of a platinum thermometer. As the result of experiments on air and nitrous oxide, the author concludes that the viscosity of a gas is proportional to the quotient of the 3/2th power of the absolute temperature by a linear function of the absolute temperature. The constants which enter into the expression of this relation appear to vary from gas to gas, and Mr. Fisher hopes, by determining them for a large number of gases, to establish a connection between them and the chemical constitution of the gas.

THE new vessel by means of which the Carnegie Institution of Washington intends to continue the magnetic survey of the world is described in the *Scientific American* of February 20. In order to render this vessel non-magnetic, she is constructed of timber, white oak, yellow pine, and Oregon pine being extensively used. The fastenings consist of locust tree-nails, copper and Tobin bronze bolts, and composition spikes. The only magnetic materials used are the thin cast-iron liners of the cylinders and the steel cams for the valves of the six-cylinder internal-combustion engine with which the vessel is fitted for manœuvring purposes, the remainder of the engine, shaft, and propeller being constructed of bronze. The vessel is 128 feet 4 inches long on the load water-line, and has a displacement of 568 tons with all stores, &c., on board. The auxiliary engine is to be operated by gas from a producer plant using anthracite peas. The vessel is to have full sail-power with a brigantine rig, and is being constructed at Tebo's Yacht Basin, Brooklyn.

WITH the advent of tall buildings, many new problems have had to be considered by the engineer and builder. The solution of some of these problems regarding the foundations of lofty buildings in American practice is dealt with in an exceptionally interesting manner by Mr. Frank W. Skinner in the *Century Magazine* for March. In lower New York the rock extends usually 50 feet below the surface, and is covered to a depth of 30 feet or more with water and quicksand. In addition to the responsibility of founding a new building weighing, perhaps, 50,000,000 lb., and of a height of about 400 feet above the pavement, the engineer is held by law in New York to be responsible for any damage to surrounding property if its foundations are more than 10 feet deep. Very frequently existing buildings rest on such poor foundations that they must be underpinned. The recent practice has been to adopt the Breuchaud method of forcing long steel hollow columns by hydraulic pressure right down to bed-rock. These are then filled with concrete, and finally built over and wedged so as to carry the weight of the existing building. New foundations are often laid on the surface of the sand, which at 30 feet below surface will carry safely 6000 lb. to 8000 lb. per square foot. In modern practice such foundations consist of a layer of concrete a foot or two thick having rows of steel beams bedded on it, and set closely together. The columns of the structure rest on these beams. Settlement is found to be small. Chicago raft foundations, pile foundations, and caisson construction are also clearly explained and illustrated with many drawings and photographs.

BULLETIN No. 75, part iv., Bureau of Entomology, U.S. Department of Agriculture, by Dr. G. F. White, deals in a popular manner with diseases of bees, their prevention and treatment.

WE have received a "Selected Bibliography on Sanitary Science and Allied Subjects," by Prof. Arthur Smith, University of Colorado, which has been prepared with reference to the needs of students pursuing the course in sanitary science at the University. The selection seems to have been carefully made, and includes many British authors (*The Daily Camera*, Boulder, Colorado, pp. 37, price 80 cents).

THE *Annals of Tropical Medicine and Parasitology* for February (ii., No. 4), issued by the Liverpool School of Tropical Medicine, contains several important papers. One, by Prof. Moore and Drs. Nierenstein and Todd, deals with the experimental treatment of trypanosomiasis with anilin colours and various combinations of atoxyl with mercury. As a rule, though life may be prolonged in experimental infections with *Tr. brucei* and *Tr. gambiense*, no method was able to cure a well-established infection.

A SIXTH edition of the second part of the "Elementary Practical Chemistry" by Dr. Frank Clowes and Mr. J. B. Coleman has been published by Messrs. J. and A. Churchill. This section of the work deals with qualitative and quantitative analytical chemistry, and in the present edition additions have been made to the volumetric portion and to the preparation of inorganic compounds.

MESSRS. A. GALLENKAMP AND CO., LTD., have issued a comprehensive catalogue (No. 52) of charts, maps, hygienic and anatomical models, and lantern-slides they are in a position to supply. Both diagrams and slides are available to illustrate most subjects of science, and the detailed summary which the catalogue provides should save teachers much time in looking through the lists of individual publishers.

THE Natural Science Society of Wellington College continues its excellent work in the direction of maintaining the interest of the boys at Wellington in scientific subjects. A copy of the thirty-ninth annual report, which summarises the work accomplished during 1908, has reached us. The majority of the subjects of the Saturday lectures were scientific and refreshingly varied in character. The meteorological data recorded are, as usual, very complete, and indicate the useful part public-school boys can take in scientific observation.

ANOTHER example of the thoroughness with which the work in connection with the Carnegie Institution of Washington is done is afforded by the recently published "Guide to the Manuscript Materials for the History of the United

States to 1783, in the British Museum, in Minor London Archives, and in the Libraries of Oxford and Cambridge." This large volume runs to 500 pages, and has been prepared by Prof. C. M. Andrews, of the Johns Hopkins University, and Miss Frances G. Davenport, of the Carnegie Institution. The volume is but one of a series, of which two volumes have appeared previously, in which the Carnegie Institution proposes to present inventories guiding the student of American history to such manuscript materials as are to be found in the archives and libraries of foreign countries.

OUR ASTRONOMICAL COLUMN.

STELLAR EVOLUTION.—In discussions appertaining to the evolution of individual masses in the cosmos, two hypotheses have received a great deal of attention, the first being that of Laplace, in which masses are thrown off by a condensing nebula, the second, due to Darwin, in which the subdivision is due to fission caused by tidal strains.

In No. 1, vol. xxix., of the *Astrophysical Journal*, Prof. Moulton discards the former, on the lack of evidence, and discusses the probability of the latter theory.

His results are not favourable to the fission theory, and applying them to the members of the solar system it appears unlikely that the planets originated by fission from a parent mass; similarly, he concludes that the moon and earth have not originated by fission from a common parent mass.

Again, in reference to multiple stellar systems, the type of fission discussed by Prof. Moulton appears to be ruled out of court as the factor producing such systems unless the parent nebulæ had originally well-defined nuclei.

Prof. Moulton states that up to the present it has been assumed that evolution took place from the nebulous state to the stars; he suggests that both aggregation and dispersion of matter should now be considered as possible factors in cosmological evolution.

HALE'S SOLAR VORTICES.—In an English reprint of the Proceedings of the Koninklijke Akademie van Wetenschappen te Amsterdam, at the meeting held on January 30, we find a criticism of Hale's theory of solar vortices by Mr. A. Brester, Jz., whose work on periodicity in the sun and variable red stars was reviewed in NATURE for February 11 (p. 431, No. 2050).

Mr. Brester gives reasons for doubting the existence of *material* vortices, and ascribes the varying configurations of the flocculi and the spectral-line displacements to the action of submerged radio-active substances from which issue forth, through spot cavities, β and γ rays, which, in turn, cause the stationary matter of the solar atmosphere to become variably luminescent.

COMET TEMPEL$_3$-SWIFT, 1908*d*.—Observations of comet 1908*d* were made at the Algiers Observatory by MM. Rambaud and Sy on nine dates between October 29 and December 3, 1908. In the 12½-inch *coudé* equatorial the comet was a very feeble, nebulous object with a scarcely perceptible condensation; the coma was round, and of about 2′ diameter (*Astronomische Nachrichten*, No. 4307).

THE CAPE OBSERVATORY.—Mr. Hough's first report of the work done at the Cape Observatory covers the two years 1906 and 1907; owing to the change of directors, consequent upon the retirement of Sir David Gill in February, 1907, no report for 1906 was issued.

The discussion of the azimuth determinations made in 1906 showed that, although the underground azimuth marks themselves were quite stable, there was a persistent systematic difference in the results, apparently depending upon the position, east or west, of the instrument; subsequent investigation showed that this error was due to a loose jewel in the end bearing of the micrometer screw.

An improved system of circulating the air in the prism box has greatly improved the working of the line-of-sight spectroscope. The transit-circle, the heliometer, and the equatorials were in constant use, and brief summaries of the observations made are contained in the report.

The astrographic chart work is well advanced, the total number of plates now measured being 1285, containing some 700,000 star images, corresponding to nearly 300,000 different stars.

During the two years under report, 496 stellar spectra, mostly selected for a spectroscopic determination of the solar parallax, were taken with the four-prism spectrograph attached to the Victoria (24″) telescope. The radial velocities of α Tauri, α Orionis, α Canis Majoris, β Geminorum, α Boötis, α Centauri, and α Scorpii are completely reduced, and await final discussion.

HOURS OF SLEEP FOR CHILDREN.

THAT a child needs proper sleep and longer hours of sleep than an adult is such a well-recognised fact among common-sense people that it seems strange it should still be necessary to preach it to the public. Sir James Paget so long ago as 1857 pointed out the physiological reasons for this necessity, in that organic processes are performed with rhythm, and the habitual alternation of activity and rest is an all-important factor in the realisation of the highest potentialities of the growing child. It is during the hours of sleep that growth due to the building up or anabolic side of metabolism is most in evidence, and anabolism is specially necessary in children, not only to repair the wear and tear of the day's activities, but also because the child is growing. Eminent alienists such as Sir James Crichton Browne and Dr. Clouston have supported these views, and have shown the bad effects want of rest has on the mental as well as the physical well-being of the child. Dr. Rayner, formerly medical superintendent of Hanwell Asylum, in his evidence given last year before the Royal Commission on the Care of the Feeble-minded, said, "I have had normal children brought to me as defective simply as a result of insomnia."

A few years ago Dr. Theodore Acland brought the question before the public, in a letter to the *Times*, in relation to the hours of sleep in boys' public schools. Schoolmasters, as a rule, are extremely conservative, and regard early rising as a useful method of discipline. Dr. Acland was supported by Dr. Clement Dukes, and it is to be hoped that their efforts have been successful in modifying the customs at such schools, and that the means of "hardening" adopted there may be changed in favour of methods which may be less harmful to the physique of the boys.

It is, however, not only in the schools and homes of the better classes that the evil prevails, and the aspect of the question in relation to the poor has been specifically dealt with in an article by Miss Alice Ravenhill (*Child Study*, vol. i., No. 4, January), which deserves wide publicity. Her investigations, illustrated by examples, abundantly prove that this most important time law of regular sleep is heedlessly violated, and the penalties exacted are both far-reaching and heavy. The hours of sleep are curtailed at both ends; late hours of retiring are the custom owing to a failure to appreciate that the child is not an adult; early rising is regarded as a necessity among the poor because the miserable pittances the children earn before school time are held of greater value than their normal development into efficient citizens; the quality of the sleep itself is poor, for few of the mites have a bed to themselves, and sleep often three, four, or even five in the same bed. Miss Ravenhill gives cases where a retirement at 10 p.m. or 11 p.m. at night is followed by rising for milk rounds at 5.30 a.m. or 6 a.m. This frequently occurs in children six years of age, and the proportion of early risers increases as the children reach the errand-boy age of ten or eleven. There are further exceptional cases where rising for market at 3 a.m. or 4 a.m. is mentioned.

The returns for girls are not so complete as for boys, but the evidence is abundant that the suffering is widespread in both sexes, and the range of occupations pursued is almost incredibly various.

This is a matter which a great nation should speedily rectify. The facts are collected and are indisputable, action ought to be immediate; parents must be instructed on this and other points of elementary hygiene, and legislation on the subject appears imperative.

MAGNETIC RAYS.

THE complex phenomena that occur at the kathode of a vacuum tube in the presence of a magnetic field have given rise to numerous researches since the time of

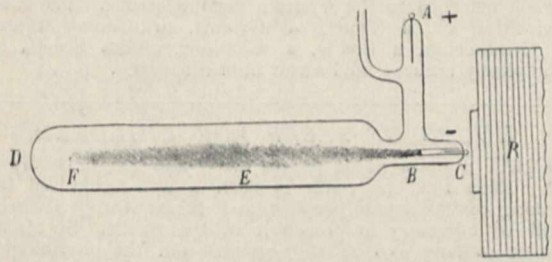


FIG. 1.

Plucker, and a great number of the effects observed still await an explanation.

Birkeland has shown that if a cylindrical discharge tube is placed in a longitudinal magnetic field of gradually increasing strength, there is at a certain value of the field an abrupt fall in the potential at the terminals. Almy has connected this with a sudden change in the appearance of the discharge. Willows has found that a transverse field causes the discharge to pass more readily below a certain value of the gas pressure; according to Peck, this effect is not found if the kathode fall of potential is greatly reduced by the use of a hot lime kathode. Broca has discovered that, in addition to the kathode rays which go in helices round the lines of force, there is produced a second species which follow the lines. Villard calls these magneto-kathode rays, and has shown that they are deflected by an electrostatic field, but in a direction *perpendicular* to the latter. By directing them into the interior of a Faraday cylinder, he has been unable to prove that they carry a charge; the experiment is, however, not conclusive, because the conducting power of the surrounding gas may be sufficient to disperse any charge so collected.

In a recent paper by Righi (*Accad. d. Sci., Bologna*, May, 1908) the hypothesis is made that these rays are electrically neutral doublets, more or less unstable, consisting of an electron and a positive ion rotating round each other. On account of its larger mass, the latter may be looked upon as stationary while the electron moves in an orbit around it. If the plane of rotation is perpendicular to the field, the force acting on the electron, arising from this field, will be radial, and the doublet may have stability conferred upon it. If the plane of rotation is inclined to the field, the electron, and hence also the doublet, will tend to move up or down the lines of force. Such doublets he calls magnetic rays, because the magnetic field is necessary to their stability. Fig. 1 shows one form of tube used by Righi in his efforts to demonstrate the existence of such rays. A is the anode, C the kathode, R an electromagnet; the source of current is a Holtz machine. Figs. 2 and 3 show the appearance of the tube when the discharge is passing, while the magnet is off and on respectively. The part BE (Fig. 1), according to the author, consists of the rays in question; to the left of E the field is too weak to confer stability on the doublets. The luminosity, EF, behaves, to a magnet, like the positive column of the ordinary discharge, but with E as anode and F as kathode. Fig. 4 shows the effect of a transverse magnetic field on this column. In order to obtain the magnetic rays the field has to exceed a certain value, depending on the gas pressure, and when this value is reached the discharge becomes intermittent, as may be shown by a rotating mirror or telephone. The period increases with the field. The paper contains numerous photographs and measurements of the discharge under different conditions, and there is no doubt of its interest and suggestiveness, although it cannot be said to have demonstrated the actual existence of the hypothetical rays.

R. S. W.

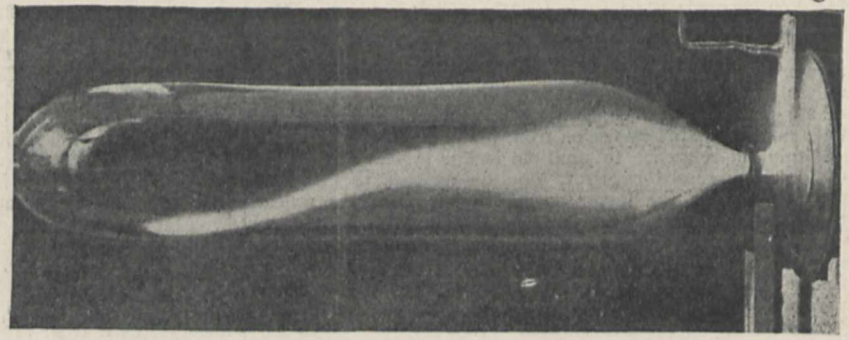
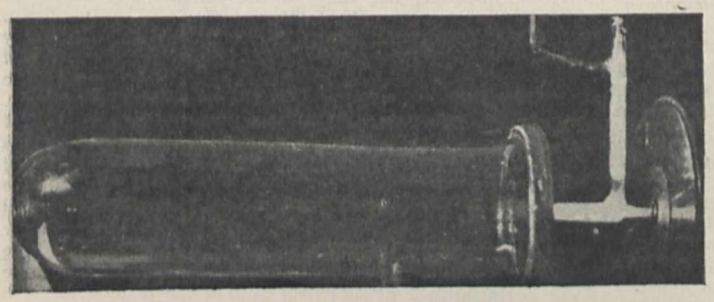


FIG. 4.

FIG. 2.



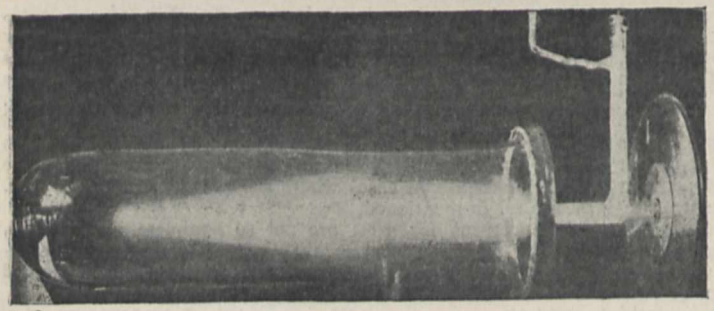


FIG. 3.

PRIZE SUBJECTS FOR SCIENTIFIC RESEARCH.

AT the annual meeting of the Société Batave de Philosophie expérimentale de Rotterdam, a series of forty-eight questions, or proposed researches, were put forward for the coming year. Amongst these are the following: an exact critical review of the present state of knowledge of the volcanoes and volcanic phenomena in the archipelago of the East Indies, and an explanation of the origin of these volcanoes based upon these data or upon the author's own researches; an experimental research on the cause of phosphorescence, especially in animals of a lower order; an experimental research on the electrical properties of some metallic alloys; an exact determination of the

indices of refraction at different parts of the spectrum of substances possessing anomalous dispersion, and a discussion of the bearing of these observations on the theory of dispersion of light; experimental determinations, carried out with the greatest care, of the atomic weight of at least one element, the value of which is at present uncertain; a critical discussion of the theories of flight and of the experimental researches which form the base of such a discussion; a theoretical and experimental examination of the causes of the deviations from Ostwald's dilution law; exact direct measurements of the osmotic pressure of solutions, not showing electrolytic dissociation, especially in view of the determination of the limit of concentration at which the deviations from the laws of Boyle and Gay-Lussac begin to be felt; a research on the origin and physiological signification of the green colouring matter in the bodies of articulated green animals; an experimental research on the electrolytic dissociation of substances dissolved in different mixtures of water and alcohol; a determination of the diminution of the vapour pressure of solutions in water of the chlorides of sodium, potassium, calcium, and magnesium between the temperatures 0° C. and 100° C. for at least six different concentrations, the molecular conductivity, the lowering of the freezing point, and the rise in the boiling point are to be determined for the same solutions, the whole to be discussed from the point of view of the theory of Arrhenius and the criticisms of Kahlenberg; a quantitative research on the radiation of two simple gases in a magnetic field; new quantitative determinations on the distribution of radium in the earth's crust; a study, as complete as possible, of the structure and development of one species of the genus Trypanosoma, *Tr. lewisi* for preference.

The gold medal of the society (or its value) is offered for the best paper received in answer to one of these questions. Replies should be written in Dutch, French, English, German, or Latin, not signed by the author, but bearing a motto, accompanied by a sealed letter containing the same motto and the author's name, and addressed to Dr. G. J. W. Bremer, the secretary of the society, at Rotterdam, before February 1, 1910.

PAPERS AND REPORTS ON INSECTS.

BULLETIN No. 3 of the Sleeping Sickness Bureau is devoted to the life-history of the tsetse-fly, *Glossina palpalis*, a species which appears to have been originally obtained in Sierra Leone, but is now known to have a very wide distribution, including Angola, Nigeria, the Congo State, the lake region, the Egyptian Sudan, Uganda, and north-eastern Rhodesia. After referring to the peculiar mode of propagation of tsetses, the author discusses the influence of external conditions on the distribution and numbers of the species under consideration, referring particularly to shade, altitude, season, temperature and humidity, forest, water, and food-supply.

A number of new species and one new genus of American mosquitoes are described by Messrs. H. C. Dyar and F. Knab in vol. lii. of the Smithsonian Miscellaneous Collections, as a preliminary to a monograph now in course of preparation by Dr. L. O. Howard and the authors of this paper. The new genus, Dinanamesus, is allied to Dinocerites, from which it differs by a reduction in the length of the second joint of the antennæ.

In the report of the entomologist of the U.S. Department of Agriculture for 1908, Dr. L. O. Howard refers to the work done during the year in connection with the Mexican cotton-boll weevil, a species which continues to inflict much damage on growing cotton. It has been found that parasites are year by year becoming much more effective in controlling the ravages of this weevil, a fact promising favourable results in the efforts of the Bureau to encourage and spread the former. During the season under review the average parasitism is shown to have been doubled in Texas and trebled in Louisiana. Special attention was also directed during the year to insects injurious to forests, and it is satisfactory to learn that the efforts of private owners and the forest officials to check and control the alarming outbreaks of the Black Hills beetle in the neighbourhood of Palmer Lakes and Colorado Springs, as well as in the adjoining Pikes Peak National Forest, have proved a complete success.

The whole of vol. xxxi., No. 1, of Notes from the Leyden Museum is devoted to a monograph, by Dr. H. W. van der Weele, on the Mecoptera (scorpion-flies) and Planipennia of "Insulinde." The latter name is taken to denote the Dutch colonies in the Malay and Papuan archipelagoes, but the paper, which is illustrated by five plates, includes descriptions of species from those parts of Borneo and New Guinea which do not belong to Holland. A number of new species and subspecies, and three new genera, are named and described in the course of the paper, while some interesting particulars are given with regard to the life-history of one of the species of "ant-lion" (Myrmeleon).

EXPLOSIVE COMBUSTION, WITH SPECIAL REFERENCE TO THAT OF HYDROCARBONS.[1]

IT is hardly necessary to remind you that the subject of my discourse will be ever associated with the illustrious name of Davy. Davy turned his attention to the phenomena of flame in the year 1815, in response to an urgent appeal on the part of a committee formed in the north of England, to investigate the causes of accidents arising from the explosion of fire-damp in coal mines, and to devise means for their prevention. The perennial interest of his researches, however, lies not so much in their immediate practical success, great as this undoubtedly was, as in the broader theoretical issues which were disclosed, and brought within the region of experimental inquiry, by so splendid an exercise of genius.

Davy insisted on the necessity of considering flames in all cases "as the combustion of an *explosive mixture* of inflammable gas, or vapour, and air," and he defined flame as "aëriform, or gaseous matter, heated to such a degree as to be luminous." For the starting and propagation of a flame in an explosive mixture, he showed that each successive layer of gas must be raised to a certain definite temperature, called the "ignition point," and he investigated both the ignition temperatures and the explosion limits of a large number of the commoner combustible gases. He then proceeded to his famous discovery that, notwithstanding the extremely high temperatures of flames, which, in the case of cyanogen, he estimated to be "above 5000° of Fahrenheit," they can be readily extinguished by contact with a cooling surface of sufficient area and heat-conducting power, and that for this purpose metal surfaces are by far the most efficient. How he developed and applied this discovery to the construction of his "safe-lamp" for miners is a matter of history.

In experimenting upon the ignition temperatures of explosive mixtures, Davy made the important observation that combustible gases combine with oxygen at lower temperatures without any appearance of flame whatever. He emphasised the importance of a complete investigation of the chemical aspects of this flameless combustion, and he himself was led to ask whether, seeing that the temperatures of flames far exceed those at which solids become incandescent, a metallic wire can be raised to incandescence by the slow combustion of two gases "without actual flame, but producing heat enough to keep the wire ignited." In this way he discovered the remarkable property of platinum and other metallic wires of inducing surface combustion, and in the course of his further experiments on this subject he made two notable observations respecting the burning of compounds containing carbon and hydrogen. He found "much carbonic oxide" produced when a platinum wire was kept incandescent by the slow combustion of a mixture of ethylene and oxygen, rendered non-explosive by an excess of the hydrocarbon, and in a similar experiment with ether vapour he recorded the appearance of "a pale phosphorescent light" accompanied by "the formation of a peculiar acrid volatile substance possessed of acid properties."

Finally, in speculating upon the difficult and thorny subject of the luminosity of hydrocarbon flames, he was

[1] Abridged from a discourse delivered at the Royal Institution on Friday, Febrary 28, 1908, by Prof. W. A. Bone, F.R.S..

"led to imagine" that it "might be owing to the *decomposition* of part of the gas towards the interior of the flame where the air was in smallest quantity, and the deposition of solid charcoal, which, first by its *ignition* and afterwards by its *combustion*, increased in a high degree the intensity of the light." It is important to observe that not only did Davy rightly attribute the luminosity of a hydrocarbon flame to the presence therein of incandescent carbon, but also that he avoided the error of attributing the separation of carbon to a supposed preferential burning of hydrogen.

In considering the propagation of a flame through an explosive mixture of gases, it is necessary to distinguish between two well-defined conditions. When such a mixture is ignited, the flame travels for a certain limited distance (a few feet only) at a fairly uniform slow velocity, which in the case of a mixture of hydrogen and oxygen in their combining ratios is approximately 34 metres (38 yards) per second. This initial stage of the combustion is called "*inflammation*."

After traversing a few feet, however, the flame begins to vibrate, and alters in character. The vibrations become more and more intense, the flame swinging backwards and forwards with oscillations of increasing amplitude. Then one or other of two things happens; either the flame is extinguished, or it goes forward with an exceedingly great and constant velocity, producing the most violent effects. The new condition thus set up is termed "*detonation*," and the forward movement of the flame is called the "*explosion wave*."

The discovery of "*detonation*" in gaseous mixtures was made simultaneously by M. Berthelot and MM. Malard and Le Chatelier in the year 1881; Berthelot proved that the velocity of the explosion wave is independent of the length of the column of gas traversed, and that for the same gaseous mixture under given physical conditions it always has a constant value. In this connection I must mention Prof. H. B. Dixon's exhaustive researches on the "*rates of explosion*" of gaseous mixtures, which have extended in so many ways our knowledge of explosive combustion.

Experiment I.—Perhaps the best illustration of the outward difference between ordinary "*inflammation*" and "*detonation*" is afforded by the case of a mixture of carbonic oxide and oxygen in their combining ratios. When ignited in an open tube 4 or 5 inches long, the mixture burns quietly with the familiar blue flame. Far otherwise is it, however, when a long column of the mixture is fired in a leaden coil, where the brief initial period of *inflammation* is succeeded by the *explosion wave*, which dashes onwards through the gases at a rate of 1700 metres (about a mile) per second with shattering effect.

Another notable feature of "*detonation*" is the extremely short duration of the flame. In the course of some experiments carried out under Prof. Dixon's direction, it was found that the duration of luminosity in each successive layer of gas in the detonation of electrolytic gas does not exceed 1/5000th part of a second; but, short as this time is, it is something like a million times longer than the interval between successive molecular collisions in a gaseous mixture.

The question of how a hydrocarbon burns, that is to say, precisely how it is attacked by the oxygen, has been the subject of much discussion during the past fifteen years. The main points in dispute may be conveniently summarised under three heads.

(1) During the greater part of last century the belief prevailed that the hydrogen is much the more combustible of the two elements of a hydrocarbon, and that consequently when combustion occurs in a limited supply of oxygen, the hydrogen is preferentially burnt, as follows:—

$$C_2H_4 + O_2 = 2C + 2H_2O.$$

Who was the author of this view, or what was originally its experimental basis, is not quite clear, but it received the active support of two such eminent authorities as Thomas Graham and Michael Faraday, and for fifty years it was regarded as one of the most certain articles of chemical faith. It was finally overthrown by Dixon and Smithells in the year 1892.

(2) The second theory originated with Kersten in 1861, who, as the outcome of experiments on the explosion of a mixture of ethylene and electrolytic gas, asserted that "before any portion of the hydrogen is burnt, all the carbon is burnt to carbonic oxide, and that the excess of oxygen then divides itself between the carbonic oxide and the hydrogen." In other words, Kersten attempted to substitute the idea of the preferential burning of carbon for that of the preferential burning of hydrogen. His views, however, received no serious attention until they were revived by Dixon and Smithells.

The chief experimental basis for this theory is the behaviour of ethylene and acetylene when exploded with their own volume of oxygen. More than a century ago Dalton found that a mixture of equal volumes of ethylene and oxygen yields mainly carbonic oxide and hydrogen on explosion, without any separation of carbon, in conformity with the equation

$$\underset{1\text{ vol.}}{C_2H_4} + \underset{1\text{ vol.}}{O_2} = \underset{2\text{ vols.}}{2CO} + \underset{2\text{ vols.}}{2H_2}$$

This fact, after being overlooked for nearly eighty years, was re-discovered by Dixon in 1891; moreover, a few years later, when it was proved that acetylene behaves in a precisely similar manner,

$$\underset{1\text{ vol.}}{C_2H_2} + \underset{1\text{ vol.}}{O_2} = \underset{2\text{ vols.}}{2CO} + \underset{1\text{ vol.}}{H_2},$$

the advocates of the theory were able to claim a considerable body of evidence in support of their case.

(3) But the idea of a "*preferential*" combustion, whether of carbon or of hydrogen, seemed repugnant to well-established principles concerning the nature and conditions of chemical interactions in gaseous systems. Moreover, whilst the assumption of a *direct* passage from an initial system of ethylene and oxygen, $C_2H_4 + O_2$, to the system carbonic oxide and hydrogen, $2CO + 2H_2$, implied a simple transaction from the kinetic standpoint, an extension of the idea to the case of such a hydrocarbon as propylene,

$$2C_3H_6 + 3O_2 = 6CO + 6H_2,$$

would at once raise serious difficulties.

It therefore remained to consider whether the solution of the problem might not lie in the assumption of an initial *association* of the hydrocarbon and oxygen forming an unstable "oxygenated" molecule, which subsequently rapidly decomposes. Thus, for example, the changes involved in the explosive combustion of an equimolecular mixture of ethylene and oxygen might conceivably be represented somewhat as follows:—

$$C_2H_4 + O_2 = \underset{\text{unstable}}{[C_2H_4O_2]} = 2CO + 2H_2$$

Many years ago, indeed, Prof. H. E. Armstrong suggested that the combustion of a hydrocarbon takes place under the conjoint influence of water and oxygen, and involves the successive formation of intermediate "*hydroxylated*" molecules, which at high temperatures rapidly decompose into simpler products. Little notice was taken of his suggestion at the time, but recent researches have shown that "*hydroxylated*" molecules are probably formed, even in flames, although I think it doubtful whether water vapour is an essential factor in the process.

The researches recently carried out at the Manchester University have covered the entire range of conditions under which hydrocarbons can be burned, from the slow, flameless combustion discovered by Davy right up to the extreme conditions of detonation. An exhaustive study of the slow combustion of methane, ethane, ethylene, and acetylene, at temperatures between 250° C. and 400° C., afforded decisive evidence against the preferential burning, whether of carbon or of hydrogen. Large quantities of aldehydic intermediate products were isolated, and the balance of evidence was decidedly in favour of the "*hydroxylation*" theory, with the proviso, however, that the oxygen is directly active.

With the extension of the research to the conditions existing in hydrocarbon flames and explosions, it became increasingly evident that the mechanism of combustion is essentially the same above as below the ignition point. I do not mean, of course, that the phenomena observed at low temperatures, in slow combustion, are exactly reproduced in flames, but rather that the result of the initial molecular encounter between the hydrocarbon and oxygen is probably much the same in the two cases, namely, the formation of an "oxygenated" molecule. At the higher temperatures of flames, secondary thermal decompositions undoubtedly come into operation at an earlier stage, and play a more important *rôle* than in slow combustion, but they do not precede the onslaught of the oxygen upon the hydrocarbon, but arise in consequence of it.

Having thus explained the main issues, I propose to perform a series of experiments on the explosive combustion of acetylene, ethylene, and ethane, some of which are crucial as regards the rival theories under discussion.

Experiment II.—I have here three cylindrical bulbs of stout borosilicate glass (capacity = about 60 c.c.), fitted with firing wires, hermetically sealed, and containing respectively equimolecular mixtures of each of the three hydrocarbons with oxygen, that is to say, mixtures corresponding to $C_2H_2+O_2$, $C_2H_4+O_2$, and $C_2H_6+O_2$, respectively.

Now, according to the theory of the preferential combustion of carbon, these mixtures should on explosion yield nothing but carbonic oxide and hydrogen, without any separation of carbon or formation of steam, as follows:—

	p_2/p_1*
(*a*) $C_2H_2+O_2=2CO+H_2$	1·5
(*b*) $C_2H_4+O_2=2CO+2H_2$	2·0
(*c*) $C_2H_6+O_2=2CO+3H_2$	2·5

* The symbols p_1 and p_2, used in this and subsequent tables, denote the initial and final pressures of the *cold* original mixture and gaseous products (dry) at constant volume and at the same temperature.

On firing the mixtures, it is at once evident that something very like this does happen in the cases of (*a*) and (*b*). There is absolutely no deposition of carbon, and no appreciable condensation of steam in the cold products. Far otherwise is it, however, in the case of the bulb containing the mixture $C_2H_6+O_2$. A lurid flame fills the vessel, accompanied by a black cloud of carbon particles, and a close inspection of the cold bulb will reveal a considerable condensation of water. The pressure ratio p_2/p_1 is approximately 1·5, and an analysis of the gaseous products would prove the presence of about 10 per cent. of methane. The bulb will now be opened, rinsed out with water, and the formation of aldehydic products demonstrated by means of Schiff's reagent. It is clear that these results are wholly inconsistent with the theory of the preferential burning of carbon.

Did time permit, I could easily demonstrate to you by other similar experiments that the *outward* difference here revealed between the burning of ethylene and that of ethane extends to all the other gaseous olefines and paraffins; that is to say, whereas mixtures of olefines and oxygen corresponding to $C_nH_{2n}+\frac{n}{2}O_2$ on explosion yield mainly carbonic oxide and hydrogen, without separation of carbon, mixtures of paraffin and oxygen corresponding to $C_nH_{2n+2}+\frac{n}{2}O_2$ yield carbon, oxides of carbon, methane, hydrogen, and steam, all in considerable quantities. Are we then to conclude that there is some peculiarity about the constitution of an olefine which induces a preferential burning of its carbon, whilst the corresponding paraffin is burnt in an entirely different way? The following experiment will show that such a view cannot for a moment be entertained.

Experiment III.—I will now fire a bulb containing a mixture of 60 per cent. of ethylene and 40 per cent. of oxygen (*i.e.* $3C_2H_4+2O_2$). As might be expected, the flame is accompanied by a large deposition of carbon, but what is of greater importance still is the fact that a considerable amount of water is also formed. The full significance of this experiment may be gathered from the following data:—

Original mixture { $C_2H_4=59·65$ per cent. $p_1=562$mm. $p_2/p_1=1·45$; $O_2=40·35$,, $p_2=816$,,

Gaseous products { $CO_2=2·5$, $CO=37·2$, $C_2H_2+C_2H_4=6·4$, $CH_4=6·5$, $H_2=47·4$ per cent.

	C	H	O
Units in original mixture ...	670	670	227
Units in gaseous products ...	482	572	172
Difference	188	98	55

I think it will be now admitted that such an experiment as this completely destroys the foundations of the theory of the preferential burning of carbon. As I have already stated, the original experimental basis of the theory was the behaviour of an equimolecular mixture of ethylene and oxygen, yet here is proof that on closer examination the behaviour of ethylene is inconsistent with the theory, which must, therefore, be abandoned.

Experiment IV.—The next experiment is designed to illustrate the infinitely greater affinity of acetylene and ethylene as compared with that of hydrogen for oxygen at the high temperatures of flames. I have here two bulbs containing mixtures of each of these hydrocarbons with hydrogen and oxygen corresponding to $C_2H_2+2H_2+O_2$ and $C_2H_4+H_2+O_2$ respectively, and I will ask you to contrast the behaviour of these with that of the equimolecular mixture of ethane and oxygen, $C_2H_6+O_2$, which was exploded a few minutes ago. It should be noted that whilst all three mixtures contain the same relative proportions of carbon, hydrogen, and oxygen, they differ in respect of the proportions between the combined carbon and hydrogen. Asking you to bear in mind how the equimolecular mixture of ethane and oxygen on explosion gave rise to a black cloud of carbon and a considerable formation of water, I will now fire the other two mixtures. You will observe that in neither case has there been any deposition of carbon, and an inspection of the cold bulbs will show that little or no steam formation has occurred. In fact, the hydrocarbon has been burnt to carbonic oxide and hydrogen, leaving the hydrogen absolutely untouched by the oxygen.

These experiments have an important bearing on the chemistry of flames. Hydrogen is usually considered as one of the most combustible of gases, but here we see it pushed to one side by the all-powerful hydrocarbon as though it were so much inert nitrogen. This at once raises another question which has lately been occupying my attention. Ever since Davy's experiments on flame, the combustibility of hydrogen has been considered to be superior to that of methane; this, however, cannot be true in regard to slow combustion, for it can be easily proved that between 300° C. and 400° C. methane is oxidised at a far faster rate than hydrogen[1] in the absence of surfaces, such as platinum or palladium, which readily occlude hydrogen.

It does not, I think, impose too great a strain on the imagination to picture the probable mechanism of combustion in hydrocarbon flames, and for this purpose ethylene and ethane may be taken as typical examples. It may be assumed that the affinity of a hydrocarbon for oxygen is so great at high temperatures that the initial stage of its combustion takes precedence of all other chemical phenomena in flames. This is probably true of the propagation of flame through explosive mixtures of hydrocarbons and oxygen. In the special case of a stream of a hydrocarbon burning in air, partial decomposition may occur in the innermost regions of the flame, where the supply of oxygen is very limited, before combustion begins; but, in general, whenever the hydrocarbon and oxygen are brought together at high temperatures, their mutual affinities will prove superior to any disruptive forces which would otherwise break down the hydrocarbon. It is probably not so much the original hydrocarbon as its hydroxylated molecule which decomposes in flames; the sudden increase in the internal energy of the hydrocarbon molecule, consequent upon its initial association with oxygen, would render the resulting hydroxylated molecule extremely unstable, and, in default of its immediate further oxidation, it would

[1] Since the above was written, it has been proved experimentally that even in explosive combustion at high initial pressures the affinity of methane greatly exceeds that of hydrogen for oxygen

speedily decompose. The explosive combustion of ethylene may, therefore, be represented by the following scheme :—

$$H_2\overset{0}{C}{:}\overset{0}{C}H_2 \longrightarrow HO.\overset{1}{C}H{:}CH_2 \longrightarrow HO.CH{:}\overset{2}{C}H.OH$$

$$\left\{\begin{matrix} C_2H_2+H_2O \\ 2C+H_2+H_2O \end{matrix}\right\} \qquad 2CH_2O=2CO+2H_2$$

In a sufficient supply of oxygen, the transition from the original hydrocarbon to the *dihydroxy* state is probably so rapid that no breaking down of the ethylenic structure occurs in passing through the initial *monohydroxy* stage. Indeed, it is conceivable that under the extreme conditions of detonation the passage from 0 to 2 may be effected in a single molecular impact. The *dihydroxy* derivative would at once break down into carbon monoxide and hydrogen, *via* formaldehyde.

But when the oxygen supply is reduced below the equimolecular proportion, it is evident that the initial *monohydroxy* derivative cannot all be oxidised to the *dihydroxy* stage; some of it would, therefore, decompose partly into acetylene and steam and partly also into carbon, hydrogen, and steam, together with some methane.

In a similar manner the combustion of ethane would involve the rapid passage through *ethyl alcohol* to *acetaldehyde*, and *steam*, with subsequent decomposition of the aldehyde into carbon, hydrogen, methane, and carbonic oxide, with the proviso that a reduction of the oxygen supply below the equimolecular proportion would bring about in some measure the decomposition of the alcohol into ethylene and steam, &c., at stage 1.

$$H_3C.\overset{0}{C}H_3 \longrightarrow CH_3.\overset{1}{C}H_2OH \longrightarrow CH_3.\overset{2}{C}H(OH)_2$$

$$\left\{\begin{matrix} C_2H_4+H_2O \\ 2C+2H_2+H_2O \end{matrix}\right\} \qquad CH_3.CHO+H_2O$$

$$\left\{\begin{matrix} CH_4+CO \\ C+2H_2+CO \end{matrix}\right\}$$

But the cases of ethane and ethylene are typical of all other hydrocarbons, so that it may be said that, in general, the mechanism of explosive combustion involves (1) the initial formation and subsequent decomposition of hydroxylated (or "oxygenated") molecules; (2) in a sufficient supply of oxygen, the independent oxidation of the decomposition products; (3) in an insufficient oxygen supply, the subsequent breaking down of unsaturated hydrocarbons, interactions between carbon and steam, or between oxides of carbon, hydrogen, and steam, the final system depending on the amount of available oxygen, the temperature of the flame, and the rate of cooling.

Experiment V.—The influence of different rates of cooling of the flame on the final system may be illustrated by firing an equimolecular mixture of ethane and oxygen in two glass vessels having approximately the same volume but widely different surface areas. For this purpose I have selected (1) a tube about 1 metre long and 2 cm. internal diameter, and (2) a globe of 8·5 cm. internal diameter. Both these vessels have the same volume (about 300 c.c.), but the surface area of the tube is very nearly three times that of the globe. It is therefore to be expected that, in consequence of the more rapid cooling of the flame, there will be a greater accumulation of the primary combustion products in the case of the tube experiment. On comparing the results of the two explosions, it is at once evident that more water and less carbon have been produced in the case of the tube; moreover, the pressure ratio p_2/p_1 is 1·45, as compared with about 1·75 in the globe experiment, and an examination of the products would show that the lower ratio is accounted for by the much greater survival of acetylene, ethylene, and aldehydic products in the tube experiment. These facts, which are set forth in the following table, are in complete harmony with the hydroxylation theory.

Experiment VI.—The experiments I have so far shown you refer more particularly to the initial period of "*inflammation*" in explosive combustion, that is to say, to the conditions ordinarily prevailing in hydrocarbon flames. The question may be asked whether or not the views I have advanced are applicable to the extreme conditions of "*detonation*" or of explosions under high initial pressures. This question can best be answered by a consideration of the behaviour of an equimolecular mixture of ethane and oxygen under these extreme conditions.

Inflammation of an Equimolecular Mixture of Ethane and Oxygen.

—		A In Long Tube	B In Large Globe
	p_1	701 mm.	685 mm.
	p_2	1018 ,,	1187 ,,
	p_2/p_1	1·45	1·73
% Composition of Gaseous Products	CO_2	4·20	3·40
	CO	34·80	36·10
	C_2H_2	5·00	0·15
	C_2H_4	2·65 (7·65)	0·15
	CH_4	8·85	7·25
	H_2	44·50	53·05

	C	H	O	C	H	O
Original mixture .	694	1041	354	678	1017	346
Gaseous products	643	738	220	558	805	255
Difference . .	51	303	134	120	212	91
% Difference .	7·6	29	37·8	18	20	27·5

It is difficult to set up detonation in this mixture; the gases must be fired at an initial pressure of about 1½ atmospheres in a stout leaden coil of about 1-inch internal diameter. Even then it is necessary to start the explosion wave in a special firing piece containing electrolytic gas under pressure. I therefore regret that, owing to the special arrangements requisite for success, it is not possible to make the experiment to-night. I will, however, carry out an experiment on the explosion of the gases at an initial pressure of 15 atmospheres.

The cylindrical steel bomb on the table is part of an apparatus recently installed in the fuel and metallurgical laboratories of the University of Leeds for investigations on gaseous explosions under high pressures. The bomb is about a foot long with an external diameter of 4 inches, and the central cylindrical explosion chamber is 8 inches long by 1 inch in diameter. It has been tested by hydraulic pressure up to 1000 atmospheres, and has been repeatedly used for experiments with mixtures of hydrocarbons and oxygen at initial pressures of as much as 40 atmospheres. The bomb is now connected, through a valve at the top, with a standard Bourdon gauge, and contains an equimolecular mixture of ethane and oxygen at a pressure of 15·8 atmospheres. The valve will now be closed, and the mixture fired by means of an electrical arrangement in the special firing piece.

All that is audible of the explosion is a sharp click, and on opening the valve connecting with the gauge again the final pressure of the cold products of explosion is recorded. After applying the necessary correction for the "dead space" in the gauge connections, the final "corrected" pressure is as nearly as possible 30·8 atmospheres, corresponding to a ratio $p_2/p_1=1·93$. I would now direct your attention to the tabulated results of a similar bomb experiment carried out a few weeks ago at Leeds at an initial pressure of 25 atmospheres, and also at the same time to those of another experiment in which the gases were detonated in a lead coil at an initial pressure of 1½ atmospheres.

In both these experiments carbon was deposited, and it is evident also that steam was formed. The ratio p_2/p_1 was as nearly as possible 2·0 instead of the 2·5 required by the theory of the preferential combustion of carbon. Moreover, a notable feature of the results is the presence of as much as 7 per cent. of methane among the products of the experiment at 25 atmospheres; the fact that so much methane survived when all other hydrocarbons were battered to pieces during the explosion (no traces of either acetylene or ethylene being found in the products) is a remarkable testimony to its relatively great stability at the

highest temperatures of explosion flames. There is no evidence in these experiments of any real discontinuity between the chemical phenomena of ordinary "*inflammation*" and those of "*detonation.*" The higher temperatures and more violent conditions in "*detonation*" are responsible for the more complete breaking down of unsaturated hydrocarbons and a greater "unburning" of steam by carbon, but there is probably no difference as regards the mode in which the hydrocarbon is attacked by the oxygen in the two cases.

Results of Explosion of an Equimolecular Mixture of Ethane and Oxygen under High Pressures.

—		A Detonation in Lead Coil			B Explosion in Steel Bomb		
p_1		1180 mm.			25·2 atms.		
p_2		2240 ,,			51·7 ,,		
p_2/p_1		1·90			2·05		
% Composition of Gaseous Products	CO_2	1·80			2·6		
	CO	39·10			37·2		
	C_2H_2	0·90		1·40	*nil*		
	C_2H_4	0·50					
	CH_4	7·70			7·0		
	H_2	50·00			52·2		
		C	H	O	C	H	O
Original mixture.		1186	1779	587 mm.	25·35	38·0	12·55 atms.
Gaseous products		1151	1507	488 ,,	24·50	34·6	11·05 ,,
Difference . .		35	272	99 ,,	0·85	3·4	1·5
% Difference .		3	15	17	3·4	9	12·0

I therefore believe that, so far as our present knowledge goes, the views I have put forward afford a simple and consistent interpretation of hydrocarbon combustion, whether it be the slow flameless kind discovered by Davy or the more complex phenomena of ordinary flames so wonderfully expounded by him, or, finally, the extreme conditions of temperature and pressure characteristic of the explosion wave.

SUPPLEMENTARY LIST OF FORTHCOMING BOOKS OF SCIENCE.

IN addition to the books referred to in NATURE of last week, the following works are announced:—

ANTHROPOLOGY.

G. Fischer (*Jena*).—Die paläolithischen Funde von Taubach in den Museen zu Jena und Weimar, Dr. G. Eichhorn, illustrated. *Hodder and Stoughton.*—New Impressions of Primitive Man, E. Clodd; The British Race, J. Munro. *Elliot Stock.*—Folk Lore and Folk Stories of Wales, M. Trevelyan, with introduction by E. S. Hartland; Indian Folk Tales, E. M. Gordon (cheap edition).

BIOLOGY.

W. Engelmann (*Leipzig*).—Geschichte der biologischen Theorien, Prof. E. Radl, 2 Teil; Der Vegetation der Erde, xi. Band, Die Vegetationsverhältnisse der Balkanländer, Prof. L. Adamović, illustrated; xii. Band, Botanical Survey of the United States of North America, Prof. J. W. Harshberger, illustrated; Prantls Lehrbuch der Botanik, new edition, illustrated; Vorträge und Aufsätze über Entwicklungsmechanik der Organismen, edited by Prof. W. Roux, vi. Heft, Über chemische Beeinflussung der Organismen durch einander, Prof. E. Küster; vii. Heft, Der Restitutionsreiz, Dr. H. Driesch. *G. Fischer* (*Jena*).—Recueil des Travaux botaniques Néerlandais, publié par la Société botanique Néerlandaise, vol. iv., illustrated; Histologische Beiträge, Prof. E. Strasburger, Heft vii., illustrated; Zoologisches Wörterbuch, edited by Prof. H. E. Ziegler, Lief. iii. *Hodder and Stoughton.*—Germ Life: Bacteria, H. W. Conn. *T. Werner Laurie.*—The Garden Booklets:—The Rose Garden; The Rock Garden; The Bulb Garden; The Formal Garden; The Water Garden; The Fern Garden. *G. Philip and Son, Ltd.*—School Gardening, W. E. Watkins and A. Sowman.

GEOGRAPHY AND TRAVEL.

Hodder and Stoughton.—Camps and Cruises of an Ornithologist, F. M. Chapman, illustrated; The Story of Geographical Discovery, J. Jacob. *Hutchinson and Co.*—The American Egypt: a Record of a Sojourn in Yucatan and other Parts of Mexico, C. Arnold and F. J. Frost, illustrated. *G. Philip and Son, Ltd.*—A Guide to Geographical Books and Appliances, J. F. Unstead and N. E. MacMunn, edited by A. J. Herbertson; A Rational Geography, E. Young, part ii.; Our Own Islands, H. J. Mackinder; and a new edition of L'Estrange's Junior Course of Comparative Geography, revised and entirely rearranged, with maps in black and white.

GEOLOGY.

W. Engelmann (*Leipzig*).—Das Salz, dessen Vorkommen und Verwertung in sämtlichen Staaten der Erde, Dr. J. Buschman, 2 vols.

MATHEMATICAL AND PHYSICAL SCIENCE.

W. Engelmann (*Leipzig*).—Tafeln für Maschinenrechnen, Prof. O. Lohse. *Harper Brothers.*—The Ether of Space, Sir Oliver J. Lodge, F.R.S. *T. Werner Laurie.*—Everyday Electricity, F. Broadbent, illustrated; Everyday Astronomy, H. P. Hollis, illustrated. *T. Murby and Co.*—Hobbs's Electrical Measurements (new edition). *G. Philip and Son, Ltd.*—Practical Elementary Science, T. Samuel and H. Foxcroft, three parts; A Handy Book of the Stars, Captain W. B. Whall (new edition). *S. Rentell and Co., Ltd.*—New editions of the Telegraphist's Guide; The Telegraphist's and Telephonist's Notebook; and Questions and Solutions in Telegraphy and Telephony: being Solutions to the Questions set by the City and Guilds of London Institute in the Ordinary Grades of Telegraphy and Telephony for the Years 1904–8, H. P. Few.

MEDICAL SCIENCE.

W. Engelmann (*Leipzig*).—Die aphasischen Symptome und ihre corticale Lokalisation, Dr. N. von Mayendorf, illustrated; Die basedowsche Krankheit, Prof. H. Sattler, 1 Teil, Symptomatologie, illustrated; Anleitung zur Präparation und zum Studium der Anatomie des Gehirns, Dr. E. Villiger. *G. Fischer* (*Jena*).—Handbuch der Anatomie des Menschen, Erster Band, Skeletlehre, illustrated; Ländliche Hygiene, Dr. E. Roth, Zwanzigster Band.

TECHNOLOGY.

W. Engelmann (*Leipzig*).—Die Gasmaschinen, A. von Jhering, in 2 Teilen, 2 Teil, Geschichtliche Entwicklung und Beschreibung der Gasmaschinen, illustrated; Vorlesungen über Ingenieurwissenschaften, Prof. G. Mehrtens, 1 Teil, Statik der Baukonstruktionen und Festigkeitslehre, Erster Band, illustrated (new edition).

MISCELLANEOUS.

W. Engelmann (*Leipzig*).—Die mnemischen Empfindungen in ihren Beziehungen zu den Originalempfindungen, Prof. R. Semon (Mneme, ii. Band). *Hodder and Stoughton.*—Thought and Feeling, F. Ryland.—*The St. Bride's Press, Ltd.*—Lectures on Sanitation, W. D. Scott-Moncrieff; The Polar Planimeter: How it is Used and How it Operates, F. J. Gray.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—An exhibition of 50*l.* a year, tenable for two years, is offered by the governing body of Emmanuel College to an advanced student commencing residence at Cambridge as a member of Emmanuel College in October. The exhibition will be awarded at the beginning of October.

LONDON.—The governors of the Imperial College of Science have decided to purchase a section of freehold property in Cornwall giving free access to a mine for the

practical study of surveying in connection with the course in mining. Prof. E. W. McBride, F.R.S., of McGill University, Montreal, has been appointed chief assistant in the zoological department of the college. The title of "Professor Emeritus" has been conferred upon Prof. Tilden, F.R.S., in recognition of his long services as dean of the Royal College of Science and professor of chemistry.

M. PAUL LANGEVIN has been appointed professor of general and experimental physics at the Collège de France in succession to the late Prof. Mascart.

THE Scottish Meteorological Society offers for competition among matriculated students or graduates of the four Scottish universities, including University College, Dundee, a prize of 20*l*. for the best essay on a meteorological subject. As an indication of the kind of essay the council is prepared to consider, the following subject is mentioned:—"A discussion of the extent to which the heat set free when water vapour is converted into the liquid state influences the temperature of the atmosphere, with special reference to the climatology of different parts of Scotland." An essay on any other subject will, however, be equally eligible. The essays must be lodged with the secretary to the Scottish Meteorological Society, 122 George Street, Edinburgh, on or before March 31, 1910.

SEVERAL further gifts to colleges and universities in the United States have been announced. *Science* states that at the recent commemoration of the founding of Johns Hopkins University, which opened thirty-three years ago, it was reported that the gift of Mr. Henry Phipps, of New York, for the psychiatric clinic was considerably in excess of 200,000*l*. A gift of 40,000*l*. to the University of Pennsylvania from an anonymous donor has been announced. The sons and daughters of the late Mr. and Mrs. F. C. A. Denkmann, of Rock Island, Ill., have promised to give a library building to Augustana College, Rock Island, the building to cost not less than 20,000*l*. By the will of Dr. Gordon W. Russell, of Hartford, Trinity College receives 1000*l*. for the natural history department and a collection of books on that subject.

THE Estimates for Civil Services for the year ending March 31, 1910, show an increase compared with the grants in the 1908 session. The provision made for universities and colleges shows an increase of 15,000*l*. for university education in Wales, and among increases under the heading "scientific institutions, &c.," are 2000*l*. for the National Museum of Wales and 4500*l*. for the National Library of Wales. A building grant of 20,000*l*. is made in aid of the building fund of the University College, Bangor. The estimates for the Board of Education show an increase of 60,986*l*. The total estimates for the British Museum are 127,935*l*., and for the Natural History Museum, South Kensington, 60,543*l*. It is interesting to notice under the estimates for the Board of Education an increase of 23,550*l*. available for grants for secondary schools and the instruction of pupil teachers, and of 20,000*l*. for grants for technical institutions and evening schools.

ON Friday evening, March 12, at the South-Western Polytechnic Institute, Chelsea, the certificates and prizes were distributed by Dr. H. A. Miers, F.R.S., principal of London University. The principal of the polytechnic read a report which showed that the institute had been very successful in the university and other examinations. After the distribution Dr. Miers delivered an address. He said that twenty years ago he had taken a class in electricity at an evening recreative centre under the old School Board in Chelsea, and he felt on this account that his visit to Chelsea was particularly appropriate. His great-grandfather, Francis Place, also had taken a leading part in founding some of the original polytechnics. He said that the great object of education should be to stimulate intellectual effort, and he knew no better way than by studies in science and art. In both it was always possible to discover or to produce something new, provided the student had the seeing eye. He himself had been led to researches and discoveries by chance observations. At a lecture at the Royal Institution one of his experiments on crystallisation had acted differently from his expectation, and this had led him to a year's successful research. It was the seeing eye, educated by scientific study, which enabled discoveries to be made, and the more alert a student was the more likely he would be able to seize the opportunity when it came. Many discoveries had been made in this way, of which he gave examples. The interest of scientific and artistic studies was to him akin to the sporting instinct, which is merely a sense of expectation and curiosity of what was about to happen. All teachers should try to stimulate the spirit of research.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 14.—"On the Velocity of the Kathode Rays ejected by Substances exposed to the γ Rays of Radium." By R. D. **Kleeman.** Communicated by Sir J. J. Thomson, F.R.S.

Part of the kathode radiation from a plate exposed to the γ rays of radium consists of very soft rays which are absorbed in 1 cm. or 2 cm. of air.

The softness of the radiation is practically independent of the thickness of the radiator, and previous sifting of the γ rays through a thick screen.

The radiation appears to be considerably softer on the side of the radiating plate where the γ rays emerge than on the side where they enter.

Measurements of the softness of the radiation for radiators of different materials on the side where the γ rays entered showed that it is practically independent of the nature of the material of the radiator.

The soft radiation produced by the β and γ rays of radium together is of a more penetrating character than that produced by the γ rays alone.

The penetrating kathode rays produced directly by the γ rays have been shown to possess different velocities. It was found that the penetrating power of the kathode radiation from a plate decreases with the increase of absorbability of the γ radiation which produces it.

The velocity of these secondary rays as a whole is, as a first approximation, equal to that of the β rays of radium.

March 11.—Sir Archibald Geikie, K.C.B., president, in the chair.—Note on the stability of Jacobi's ellipsoid: Sir G. H. **Darwin.**—The wave-lengths of lines in the secondary spectrum of hydrogen: H. E. **Watson.** A great deal of work has been done by numerous investigators with the object of discovering the causes which produce two hydrogen spectra, the view for which there appears to be most evidence being that the primary spectrum arises from atomic hydrogen, and the secondary spectrum from molecular hydrogen. On the other hand, information as to the wave-lengths of the lines is very scanty, the only measurements of the red and yellow lines being those of Hasselberg about the year 1883. The results are based on Ångström's scale, and were made with a prism spectroscope, so that they are not very trustworthy. As it seemed highly important to have accurate information on the subject owing to the frequent necessity of eliminating hydrogen lines from a spectrum, the present work was undertaken. About 800 of the lines in the spectrum were measured by means of a Rowland concave grating, the error in the case of the stronger lines being probably not greater than 0·03 Ångström unit. Many of the lines are very weak, and can barely be photographed even with prolonged exposures. No lines have been detected which are less refrangible than the C line, and very few appear to exist beyond the theoretical limit of the primary series according to Balmer's formula. In fact, of those which were seen in this position, the majority appear to be due to water-vapour, and it does not seem unlikely that the remaining ones are not due to hydrogen. A remarkable feature is an apparently continuous spectrum, which extends from the extreme ultra-violet almost to the visible region. A list is also given of the wave-lengths of thirty-three mercury lines which were seen in the spectrum, and measured with particular care in two orders.—The measurement of dielectric constants by the oscillations of ellipsoids and cylinders in a field of force: W. M. **Thornton.** The method used was to suspend by a quartz

fibre in an alternating field of force very accurately formed ellipsoids or cylinders of the substance to be tested. The field had an intensity of about 300 volts per cm., and made sinuous alternations at a frequency of 80 a second. The polarisation couple upon the specimen was found by measuring the periods of small swings with and without the field. From these, and the dimensions of the body, the dielectric constant was calculated. The values so found for quartz and flint-glass ellipsoids, carefully made by Messrs. Hilger, agree to one part in a thousand with those calculated by the Sellmeier-Ketteler formula from optical data, and with Hopkinson's values for glass. Substances which could be moulded were formed in a split lead mould, using a steel ellipsoid, also by Hilger, as a matrix. In order that cylindrical specimens could be used, the longitudinal reaction coefficient N was found for a series of cylinders of known dielectric constants. Liquids were measured by enclosing them in thin paper cylinders suspended in a saddle of silk thread. The air in the testing vessel was thoroughly dried over phosphoric anhydride, and the drying was continued in each case until the period reached a steady value. Quite invisible traces of moisture on the surface of the specimens caused them to behave as conductors, and in the case of water the conductivity of the surface masked the polarisation effect completely. The following values were obtained:—Quartz, parallel to optic axis, 4·606; perpendicular to axis, 4·548. Flint-glass, $\Delta=4·65$, 10·64; $\Delta=4·12$, 8·52; $\Delta=3·30$, 6·98. Paraffin wax, 2·32. Beeswax, 4·75. Shellac, 2·49. Sealing wax, 4·56. Gutta-percha, 4·43. Chatterton's compound, 3·98. Ebonite, 2·79. Amber, 2·80. Ivory, 6·90. Canada balsam, 2·72. Resin, 3·09. India-rubber, 3·08. Sulphur, 4·03. Olive oil, 3·16. Heavy paraffin oil, $\Delta=0·885$, 2·55.

Linnean Society, February 18.—Dr. D. H. Scott, F.R.S., president, in the chair; afterwards Lieut.-Colonel Prain, C.I.E., F.R.S., vice-president.—Alternation of generations in plants: discussion opened by Dr. W. H. **Lang.** After some introductory remarks and reference to some examples of well-marked alternation of generations, and the nuclear difference between the two generations, the author adduced the ontogeny of organisms without alternation of generations, the concept of a specific cell corresponding to each specific form. The concept of the specific cell must be applied to organisms with alternation; the bodies of the two alternating individuals in the life-history may be similar or dissimilar. Two alternative explanations of the differences between the two generations in the complete life-history were stated:—(*a*) that the differences are due to the different state of the specific cell in the spore and zygote respectively; (*b*) that they are due to different environmental conditions acting on equivalent germ-cells. The mode of reproduction—sexuality or spore-production—appears to be necessarily associated with the state—haploid or diploid—of the specific cell. While the possibility of the different states of the specific cell in the spore and zygote having some causal influence on the difference of the resulting individuals must be borne in mind, it is suggested that this ontogenetic theory of the nature of the alternation seen in Bryophyta and Pteridophyta may prove a useful working hypothesis, that it will lead to work on new lines, and that it is to some extent open to experimental test.

March 4.—Dr. D. H. Scott, F.R.S., president, in the chair.—A contribution to the montane flora of Fiji, including cryptogams, with ecological notes: Miss L. S. **Gibbs.** The Fiji group consists of 200 islands, only eighty of which are inhabited; Viti Levu is about 4100 square miles in area, with forest-clad mountain ranges, the highest point being Mt. Victoria, 4000 feet in height. The botanical history of the group begins with the visit of H.M.S. *Sulphur* in 1840, and in the same year the Wilkes expedition touched at the islands. The *Herald* called in 1856, and Dr. Seemann visited the group in 1860–1, and embodied his results in his "Flora Vitiensis." Mr. Horne, director of the Botanic Gardens at Mauritius, spent a year collecting in the late 'seventies of last century. Thanks to these investigators, the flora of the lower parts of the chief islands are fairly well known. The author therefore decided to confine her investigations to the region lying at 2900 feet and above, and the three spring months of August, September, and October were spent at Nadarivatu, the highest inhabited point. From the collections the flora may be described as Indo-Malayan. They contain about forty new species and many new records. Thus, of the eight species of Piper, Mr. C. de Candolle found five to be new, and of Peperomia all seven proved novelties. The introduction concludes with some observations as to the origin of the flora, and is followed by a systematic enumeration of the whole collection.

Physical Society, February 26.—Dr. C. Chree, F.R.S., president, in the chair.—A laboratory machine for applying bending and twisting moments simultaneously: Prof. E. G. **Coker.** The paper describes a machine built by students of the City and Guilds Technical College, Finsbury, in which uniform bending and twisting moments can be applied simultaneously over the whole length of the specimen, and in any desired proportion to each other. The principle of the design is to suspend a rod at two intermediate points by wires depending from a fixed support. The equal overhanging ends of the rod are loaded by weights W, so that the applied couple between the points of support is uniform and of amount Wa, where a is the length of the lever-arm. The rod is also twisted by weights W_1 attached to equal arms of length b, so that there is a uniform twisting moment of amount W_1b between the points of suspension. The two systems of loading are independent, and their ratio can be adjusted to any value desired.—The self-demagnetising factor of bar magnets: Prof. S. P. **Thompson** and E. W. **Moss.** This paper consists of three parts:—(1) a discussion of the significance and definition of the self-demagnetising factor of magnets in general, and of bar magnets in particular; (2) a re-determination of the values of the self-demagnetising factor for bar magnets of circular section; (3) determination of the values of the self-demagnetising factor for bar magnets of rectangular cross-section of various proportions. It is shown that, in general, for every bar magnet there is a self-demagnetising action, the value of which at the middle of the bar depends, for a given intensity of magnetisation, on the length of the bar relatively to its cross-section, on the permeability of its parts, and on the distribution of its surface-magnetism. Owing to the circumstance that with every kind of steel the permeability is neither constant nor stands in any simple relation to the flux-density, any calculation of the actual polar distribution for rods and bars is impracticable. The only form of magnet that is practicable for calculation is that of the ellipsoid, the properties of which are that for any and every value of the permeability, and in any uniform field, the surface magnetism is so distributed that the magnetic force which this distribution exerts in the interior is uniform at every point within, and therefore the internal demagnetising force everywhere within is constant.

Zoological Society, March 2.—Mr. G. A. Boulenger, F.R.S., vice-president, in the chair.—The development of the subdivisions of the pleuro-peritoneal cavity in birds: Miss Margaret **Poole.**—The growth of the shell of *Patella vulgata*, L., E. S. **Russell.** The breeding season of this limpet extends from July to January. Sexual maturity is reached at a length of 20–25 mm. An average size for a limpet of the last season's brood in January or February is 10 mm.; at the end of the first year it may be 29 mm. Probable sizes at the end of the second and subsequent years are 38 mm., 44 mm., 48 mm., 53 mm. Shells more than 50 mm. may be considerably more than five years old. Sexual maturity is reached in the first year, and when the limpet is only half-grown. The rate of growth decreases with age and maturity, and is slower during the colder months of the year. Considerable changes take place in the ratios of the shells' dimensions during growth, being probably in large part the expression of "laws of growth," and not due to natural selection.—The life-history of the agrionid dragon-fly: Frank **Balfour-Browne.**—Growth stages in the British species of the coral genus Parasmilia: W. D. **Lang.**

Mathematical Society, March 11.—Prof. W. Burnside, vice-president, in the chair.—The transformation of the electrodynamical equations and the laws of motion: H. **Bateman.** The paper is occupied with the development of some ideas introduced into the subject by Minkowski.

The transformations, which leave the electrodynamical equations unaltered in form, are obtained by considering the invariance of two integral forms of which the coefficients are the components of the electric and magnetic vectors. In obtaining these transformations use is made of a pair of integral formulæ which have been used as equivalents of the electrodynamic equations by R. Hargreaves. —The transformation of the electrodynamic equations of moving bodies: E. **Cunningham.** The equations for moving media have been deduced from the general electrodynamic equations by Lorentz by the use of a method of averaging. The question discussed in the paper is that of the changes produced in the equations for moving media by those transformations for which the electrodynamic equations are invariant.—The kinetic image of a convected electric system formed in a conducting plane sheet: Prof. J. **Larmor.** The question arises in connection with recent observations of the magnetic fields in the neighbourhood of sun-spots. It appears that such fields are confined to thin layers, and this effect is traced to the action of conducting layers in screening the magnetic fields due to moving charges. The details of the screening action are worked out by adapting the method used by Maxwell in the discussion of the effects produced by a magnetic pole moving in the neighbourhood of a conducting disc.—An integral equation: G. H. **Hardy.** The paper is occupied with functions defined by an integral formula which is a generalisation of Fourier's integral theorem.—Term-by-term integration of oscillating series: Dr. W. H. **Young.** —Further researches in the theory of elimination: A. L. **Dixon.**

CAMBRIDGE.

Philosophical Society, February 22.—Prof. Sedgwick, president, in the chair.—The alleged influence of lecithin on the determination of sex in rabbits: R. C. **Punnett.** —Observations on the changes in the common shore crab caused by Sacculina: F. A. **Potts.** Giard first showed that the association of the parasitic cirripedes, the Rhizocephala, with crustacean hosts is the cause of sexual modification in the latter. In the spider crabs, the male, at the moult after infection, takes on all the external characters which are associated with the female. These changes are associated with the suppression of the gonads. In the common shore crabs the modification is of a much lower grade. In a single character the parasitised male becomes intermediate between normal male and female. The female, as in the case of the spider crabs, seems incapable of change toward the male type. The male gonads may still remain in reproductive activity under the influence of the parasite, though the female is restrained from producing mature eggs.—A so-called "sexual" method of forming spores in bacteria: C. C. **Dobell.** The paper was an attempt to show that the process which has been described as a "conjugation" in certain disporic bacteria (*Bacillus bütschlii* and *B. flexilis*) should really be interpreted quite differently. From a study of the spore-formation of *Bacillus spirogyra* and *Bacterium lunula*, n.sp., the author was led to conclude that the "conjugation" represented really an abortive cell-division, and hence that no "sexual" phenomena exist. The bearing of these observations upon the problems of the sexuality of the Protista and the affinities of the bacteria were briefly indicated.—The migration of the thread-cells of Moerisia: C. L. **Boulenger.** The thread-cells of the oral battery of the Egyptian medusa *M. lyonsi* do not develop *in situ*, but are formed in the more proximal parts of the manubrium, whence they make their way through endoderm and structureless lamella to the ectoderm of the mouth region. Similarly, the thread-cells on the tentacles develop in the eye-bearing tentacle-bulbs and migrate to the batteries when completely formed.—A note on a specimen of Pelagothuria from the Seychelles: J. C. **Simpson.** This pelagic holothurian was first discovered off the Pacific coast of America by Agassiz in 1880. Since then it has been taken in the Indian Ocean by the *Valdivia* expedition, and in the North Atlantic by the Prince of Monaco. The present specimen was taken by Mr. Stanley Gardiner in 750 fathoms of water in the Indian Ocean north of the Seychelles. The general features of its anatomy conform fairly closely to the published descriptions of previous specimens, with the exception of the characteristic swimming membrane, which in this case is composed almost entirely of a sponge, which is evidently living commensally with the holothurian.—The study of discontinuous phenomena: N. R. **Campbell.** A further study of von Schweidler's theory of radio-active "fluctuations," which has been applied experimentally by Kohlrausch, Meyer and Regener, and Geiger. The theory is put in a somewhat more general and complete form, and its application to the interpretation of observations with actual instruments considered at some length. Finally, the validity of the experiments mentioned is discussed.

DUBLIN.

Royal Irish Academy, February 8.—Dr. F. A. Tarleton, president, in the chair.—Theorems on the twisted cubic: M. J. **Conran.** It is shown that the three diameters of a cubical hyperbola are situated *in* the "plane of centres," and are the medians of the triangle formed by the "points" of the curve in that plane. The intersection of the diameters is the centre of the "locus of centres," and is also the centre of the hyperboidal locus of poles of planes parallel to the plane of centres with respect to the conic sections of the developable. It is, moreover, proved that the osculating planes touch this hyperboloid, and that the points of contact lie on a second twisted cubic with the same plane of centres and the same three diameters. A theory of correspondence is developed from which a number of metrical theorems are deduced. Finally, the geometrical interpretations of some of the invariant and covariant forms of the general equation are given.—Proofs of generalised Fourier sum theorems in trigonometrical and in Bessel functions: Prof. W. McF. **Orr.** Proofs are given of expansions in some respects more general than any which the writer has seen rigorously treated. Any function, $\phi(x)$, subject to Dirichlet's conditions, is expressed between the limits a, b, in the form

$$\sum_{\mu}(Ae^{\mu x}+Be^{-\mu x}),$$

where the admissible values of A, B, and μ are determined by the equations

$$AF_1(\mu)e^{\mu a}+BF_2(\mu)e^{-\mu a}=0, \quad AF_3(\mu)e^{\mu b}+BF_4(\mu)e^{-\mu b}=0,$$

the F's denoting polynomials. A similar expansion in Bessel functions is established which includes that employed in the treatment of problems in vibratory motion in the space between concentric cylinders and spheres. The method is that of contour integration previously used by Carslaw and others. The nature of the convergence and the possibility of term by term differentiation is discussed to some extent. The statement in a previous paper (see NATURE, December 24, 1908, p. 240) of an integral theorem analogous to Hankel's, involving the derivatives of Bessel functions, is a blunder.—The limestone caves of Marble Arch, Co. Fermanagh: H. **Brodrick.** Several streams descending from the sandstone uplands sink when they reach the limestone, reappearing at intervals at the bottom of pot-holes or cliff-walled depressions, and returning to the open after a distance of about a mile. The course of the stream was determined, so far as practicable, with the aid of rope-ladder work in the pot-holes and a good deal of wading and swimming in the caves. Complete plans were submitted of the water-courses surveyed.

Royal Dublin Society, February 23.—Prof. W. F. Barrett, F.R.S., in the chair.—Mechanical stress and magnetisation of iron: W. **Brown.** In this paper are given some quantitative results obtained from experiments with iron wires by varying the following four qualities:—longitudinal magnetisation, longitudinal stress, circular magnetisation, and the cross-sectional area of the wire. The results so found are given in tables and curves.—The quantity of the alkaloid taxine in yew: Richard J. **Moss.** The leaves of common yew grown in south county Dublin were found to contain 0·082 per cent. of taxine, calculated from the weight of the leaves immediately after gathering. The leaves of the variety known as Irish yew or Florence-

Court yew (*Taxus baccata*, var. *fastigiata*), growing at the same place, contained 0·323 per cent. of taxine in one tree and 0·623 per cent. in another. In the fruit taxine was found in the seed only, 0·079 per cent. and 0·082 per cent. in two specimens of Irish yew. The wide variation in the quantity of taxine in the leaves of yew accounts for the very contradictory statements made from time to time about their toxic properties.—A proposed analytical machine: Percy E. **Ludgate.** The paper gives an account of a portable machine designed by the author to evaluate automatically any algebraic function for given values of the variables. Mathematically it is closely allied to the projected analytical engine of Charles Babbage, but it rests on different mechanical principles. The machine is guided in the development of any given function by a perforated "formula-paper," which is specifically prepared for that function. A single "formula-paper" can be used for an infinite number of algebraically identical calculations, the numerical values of the variables for any particular case of the general formula being communicated by a key-board to the machine, which inscribes them in type-carrying shuttles. The shuttles are compactly stored in two coaxial cylindrical shuttle-boxes. The fundamental operations of the machine, which take place under the guidance of the "formula-paper," are the multiplication of the numbers inscribed in any two shuttles, and the inscription of the product in one or two shuttles. Important features of the machine are the use of a slide-rule method for multiplication, and the adaptation of the binomial theorem to provide a converging series for division. It is claimed that a new rapid method of mechanically performing the carrying of tens is embodied in the machine.

PARIS.

Academy of Sciences, March 8.—M. Bouchard in the chair.—The *rôle* of the septic tank in the biological purification of sewage: A. **Müntz** and E. **Lainé.** Whilst the utility of the septic tank in the biological treatment of sewage is generally admitted, there is no general agreement as to whether its chief function is that of a depositing tank or whether the fermentative processes which take place are really an essential step in the purification. According to the authors' experiments, the deposition of the material in suspension is practically all that happens in the septic tank.—The evacuation of tubercle bacilli by the bile in the intestine in animals affected with latent lesions: A. **Calmette** and C. **Guérin.** A portion of any tubercle bacilli introduced into the circulatory system may be eliminated by the hepatic gland and evacuated with the bile in the intestine. Owing to the bile acting on the envelope of the bacilli, the latter are more easily absorbed by the healthy intestinal membrane, and hence re-infection may easily take place.—The determination of conjugate systems: S. **Carrus.**—The generalisation of a theorem of Poisson: Th. **De Donder.**—Certain systems of differential equations: E. **Goursat.**—The multiform integrals of algebraical differential equations: Pierre **Boutroux.**—The thermal effects of the musical arc: M. **La Rosa.** From the sugar carbon heated in the musical arc, an experiment described in an earlier communication, small crystals possessing some of the properties of diamonds have been isolated.—Electrocapillary actions and discharge in rarefied gases: G. **Reboul.**—The unsymmetrical effect produced by a continuous current in chains of aqueous solutions of electrolytes possessing a common ion: M. **Chanoz.**—The part played by impurities in the photoelectric effect with liquids: Eugène **Bloch.** The effects have been traced to a superficial layer of grease. Water carefully purified, and placed in a vessel freed from all traces of grease, does not show the Hertz effect, but simply stirring with the finger is sufficient to make this water strongly photoelectric.—The hypothesis of the existence of positive electrons in vacuum tubes. Reply to the note of M. J. Becquerel: A. **Dufour.** The author strongly denies the necessity of the hypothesis of the existence of positive ions to explain the phenomena described by M. J. Becquerel.—Spectrophotometry with a monochromatic field: J. **Thovert.**—The influence of impurities on the thermoelectric power and resistance of aluminium: H. **Pécheux.** The amounts of iron and silicon were determined in three specimens of aluminium, and measurements made of the resistance and also of the electromotive forces of Al/Cu thermocouples.—Researches on the coefficient of diffusion of the actinium emanation: G. **Bruhat.** The actinium emanation was shown to behave like a gas, since the coefficient of diffusion was found to vary inversely as the pressure. Measurements of the rate of diffusion into carbon dioxide and into hydrogen were then made, leading to 70 as the approximate molecular weight of the actinium emanation.—Observations on spontaneous crystallisation: René **Marcellin.** The hypothesis of the preexistence of crystalline nuclei in the solution does not accord with the experimental facts given in this paper; on the other hand, the supposition that particles of dust in suspension form the starting points of the crystals appears to be very probable.—The nature of the metatungstates and the existence of rotatory power in crystals of potassium metatungstate: H. **Copaux.**—The phosphides of tin: Pierre **Jolibois.** By heating together phosphorus and tin under atmospheric pressure, the phosphide, Sn_4P_3, is the only definite compound capable of isolation in the pure state. Heating in a closed tube under pressure the compound SnP_3 was obtained. Chemical and microscopical examination confirmed the existence of these compounds; ingots containing tin and phosphorus in other proportions were shown to be heterogeneous, and hence such phosphides as Sn_3P_2, Sn_2P, Sn_3P_2, SnP, and SnP_2, described by earlier workers, have probably no real existence.—Experiments on an old vitrified glass which had become violet coloured under the influence of the sun's rays: M. **Delachanal.**—A new method for determining the constitution of the sugars: M. **Hanriot.** This method is based on the formation of a chloralose, by the addition of chloral, and subsequent oxidation to a chloralic acid. It applies to any C_5 or C_6 aldehydic sugar, but fails with the two ketones (levulose and sorbose) examined.—The preponderance of temperature in direct decompositions: the case of the benzoic and salicylic esters: Albert **Colson.**—The transformation of pinonic acid into 1:3-dimethyl-4-phenylacetic acid: Ph. **Barbier** and V. **Grignard.** This unexpected intramolecular change, in which the tetramethylene ring is opened up and a hexamethylene ring formed, takes place under the action of bromine and water at 100° C. The yields are good, and a crude pinonic acid may be used in the preparation.—The preparation of the anhydrides of cyclic and acyclic acids: A. **Béhal.** A study of the action of benzenyl chloride upon the fatty acids.—The normal heteromerism of *Phlox subulata*: Paul **Vuillemin.**—The experimental determination of the effective doses of the X-rays retained by the tissues of the organism: H. **Guilleminot.**—The action of the quartz mercury vapour lamp on the toxin of tetanus: Jules **Courmont** and Th. **Nogier.** After a long exposure to the mercury lamp the activity of the toxin is slightly diminished.—The action of d'Arsonvalisation on the peripheral circulation: E. **Doumer.**—The constitution of the macronucleus of the ciliated infusoria: E. **Fauré-Frémiet.**—The interstitial granulations of striated muscular fibres: Cl. **Regaud** and M. **Favre.**—The structure acquired by the seminiferous canal of the common mole (*Talpa europaea*) after the period of reproduction: A. **Lécaillon.**—The discovery of a Danian horizon with echinids in the basin of Seybouse, Algeria: J. Dareste **de la Chavanne.**—The physico-chemical variations of sea-water on the coast at Concarneau: R. **Legendre.**

CALCUTTA.

Asiatic Society of Bengal, February 3.—On the correlations of areas of matured crop and the rainfall and certain allied problems in agriculture and meteorology: S. M. **Jacob.** Apart from the fact that the data of this paper differ from those considered by Blanford, the special object has been to find equations which will predict within certain limits of error the amount of a crop from the rainfall on which it depends. These equations are the well-known regression equations, and in forming them the author

believes that at any rate a first approximation to scientific prediction is attained. In each case diagrams are given from which the probable extent of a crop can be found from the antecedent rainfall for the localities considered. In this part of the paper there is also a theoretical discussion of the way in which the regression equations are modified by errors of measurement such as certainly occur for agricultural statistics, and to a less extent in rainfall data. In part ii. the distribution of rainfall, a fundamental problem both for agriculture and meteorology, is considered by the method of curve fitting developed by Prof. Karl Pearson.—Mosquito-larvæ-eating propensity of the genus Haplochilus: B. L. **Chaudhuri.** A note suggesting that fish of this genus are useful in keeping down mosquitoes, and saying that further observations will be made.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), No. 4, for 1908, contains the following memoirs communicated to the society:—

July 11.—The uniformisation of given analytical curves, iii.: Paul **Koebe.**

October 31.—The valency between metals and oxygen, and its dependence on temperature: W. **Blitz.**

December 19.—The kinetics of dissociation-equilibrium and reaction-speed: F. **Krüger.**—The conformal representation on a circular lamina of a solid angle determined by the intersection of a finite number of regular analytical surfaces: Paul **Koebe.**

DIARY OF SOCIETIES.

THURSDAY, MARCH 18.

ROYAL SOCIETY, at 4.30.—An Attempt to Detect some Electro-optical Effects: Prof. H. A. Wilson, F.R.S.—On the Influence of their State in Solution on the Absorption Spectra of Dissolved Dyes: Dr S. E. Sheppard.—The Ferments and Latent Life of Resting Seeds: Miss Jean White.

ROYAL INSTITUTION, at 3.—Recent Advances in Agricultural Science: A. D. Hall.

LINNEAN SOCIETY, at 8.—The Dry-rot of Potatoes: Miss Sibyl Longman.—The Structure and Affinities of *Davidia involucrata*, Baill.: A. Horne.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Experiments upon the Forces acting on Twist-drills when operating on Cast-iron and Steel: D. Smith and R. Poliakoff.

FRIDAY, MARCH 19.

ROYAL INSTITUTION, at 9.—Experiments at High Temperatures and Pressures: Richard Threlfall, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Some Aspects of Chemical Engineering: C. J. Guttmann.

SATURDAY, March 20.

ROYAL INSTITUTION, at 3.—Properties of Matter: Sir J. J. Thomson, F.R.S.

MONDAY, MARCH 22.

ROYAL SOCIETY OF ARTS, at 8.—Steam Turbines: Gerald G. Stoney.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Colorado Canyon: Some of its Lessons: Prof. W. M. Davis.

TUESDAY, MARCH 23.

ROYAL INSTITUTION, at 3.—The Evolution of the Brain as an Organ of Mind: Prof. F. W. Mott, F.R.S.

MINERALOGICAL SOCIETY, at 8.—On a Stage-goniometer for Use with the Dick-pattern of Microscope: Prof. H. L. Bowman.—On the Electrostatic Separation of Minerals: T. Crook.—On the Identity of Guarinite and Hiortdahlite: Dr. F. Zambonini (with Chemical Analyses by Dr. G. T. Prior).—Note to a Paper "On the Comparison of Refractive Indices of Minerals in Thin Sections": Dr. J. W. Evans.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Exhibition of Flint Implements of the "Older Series" from Ireland: Miss N. F. Layard.—Melanesians and Polynesians: Rev. Dr. Brown.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Construction and Wear of Roads: A. Mallock, F.R.S.

WEDNESDAY, MARCH 24

GEOLOGICAL SOCIETY, at 8.—Glacial Erosion in North Wales: Prof W. M. Davis.

ROYAL SOCIETY OF ARTS, at 8.—Afforestation and Timber Planting in Great Britain and Ireland: Dr. J. Nisbet.

THURSDAY, MARCH 25.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Liberation of Helium from Radio-active Minerals by Grinding: J. A. Gray.—On *Sphaerostoma ovale* (*Conostoma ovale* et *intermedium*, Williamson) and *Crossotheca Grievii*, the Ovule and Pollen-synangium of *Heterangium Grievii*: Miss M. Benson.

ROYAL INSTITUTION, at 3.—On Aërial Flight in Theory and Practice: Prof. G. H. Bryan, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Electrical System of the London County Council Tramways: J. H. Rider.

ROYAL SOCIETY OF ARTS, at 4.30.—Native Man in Southern India: Edgar Thurston.

FRIDAY, MARCH 26.

ROYAL INSTITUTION, at 9.—Recent Results of Astronomical Research: A. S. Eddington.

PHYSICAL SOCIETY, at 5.—Note on the Production of Steady Electric Oscillations in Closed Circuits and a Method of Testing Radio telegraphic Receivers: Prof. J. A. Fleming, F.R.S., and G. B. Dyke.—The Effect of an Air Blast upon the Spark Discharge of a Condenser Charged by an Induction Coil or Transformer: Prof. J. A. Fleming and H. W. Richardson.—On the Action between Metals and Acids and the Conditions under which Mercury causes Evolution of Hydrogen: Dr. S. W. J. Smith.

SATURDAY, MARCH 27.

ROYAL INSTITUTION, at 3.—Properties of Matter: Sir J. J. Thomson, F.R.S.

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