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"*To the solid ground
Of Nature trusts the mind which builds for aye.*"—WORDSWORTH

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"*To the solid ground*
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THURSDAY, JULY 6, 1911.

CANCER AND ITS SUPPOSED CAUSES.

Induced Cell-Reproduction and Cancer. The Isolation of the Chemical Causes of Normal and of Augmented Asymmetrical Human Cell-Division. By H. C. Ross. Being the results of researches carried out by the author, with the assistance of J. W. Cropper. Pp. xxviii+291. (London: John Murray, 1910.) Price 12*s.* net.

MR. ROSS may be congratulated on having written a book singularly unlike most sober scientific treatises. He has been continually on the track of new things, and even the frontispiece, purporting to portray photographically a mitotic figure induced in a large lymphocyte, seems to have been inserted in order to embody a fresh discovery made after the rest of the book had gone to press, though whether others will attach the same significance to the photograph that Mr. Ross himself appears to do, the future will doubtless decide.

The book is written in an interesting and somewhat journalistic style, and the preface contains excellent autobiographical material designed, *inter alia,* to show how "a new method of experimentation with individual living human cells" was accidentally lighted on by the author.

Briefly, the method in question consists in concocting a jelly with agar, to which certain substances, including a dye, are added. Upon this jelly, films of blood containing living leucocytes are spread, which can thus be examined microscopically under various conditions. Ingenious devices for rapid photography are described, and considerable use is made of the photographs so taken in recording the results of observation.

A cytologist will find he has fallen into a rather strange environment when he gets immersed in Mr. Ross's book. He will have much to unlearn, and many new facts to assimilate, before he can hope to emulate the confident progress of his new leader. He will have to recognise that "the word 'nucleus' has a very vague meaning"; that chromosomes are not really of nuclear origin, but that they originate from the Altmann granules, and are formed in the cytoplasm; that the nucleus forms the spindle and the nucleolus constitutes the centrosomic apparatus. He will probably also be astonished to hear that living cells have not hitherto been studied, and consequently that his own reminiscences of observations on Ascaris and many other animals' eggs, to say nothing of plants, in all of which he will seem to remember that nuclear divisions have been followed in the living cell, must be founded on delusion. The zoological investigator will further discover that he owes a larger debt than he was aware of to his botanical colleagues, for Mr. Ross tells us that "most cytological research has been carried out with plant-cells."

Mr. Ross thinks that "from the persistent examination of dead structures, cytology has been rather led away into a maze, from which it will be difficult to extricate it." The main task which he sets himself in his book is to perform this service of extrication and to show what can be accomplished by the study of the living cell in ascertaining the causes which underlie cell division, and especially of cell proliferation. The latter process is obviously of special importance, inasmuch as it lies at the root, not only of the ordinary processes of healing, but also, when it assumes an aberrant character, of malignant disease as well.

The new engine of research, the jelly method, is fully described, and one of the main objects in its use by the author was to control the rate of diffusion of different substances into the cell. There is an excursus on the problem of diffusion, and the net outcome is embodied in formulæ for making what Mr. Ross terms "coefficient" jelly, meaning thereby a jelly in which the rate of diffusion of stain, &c., can be related to a standard in which a particular rate is accepted as unity.

This jelly is made up of a 2 per cent. solution of agar, to which certain proportions ("units") of alkalis, salts, stains (commonly Unna's polychrome methylene blue), and other substances are respectively added. The "units" of each ingredient are so fixed that a doubling of any one of them (*i.e.* two units) will double (or halve) the rate at which any particular substance, the action of which on the cell it is desired to study, will be absorbed. The method is a neat one, but it possesses obvious drawbacks, unless the separate action upon the cell of its constituents in the different strengths employed is fully known. The formulæ employed present an unfamiliar appearance, as the factors are all added together, and the inclusion amongst them of time- and heat-factors, on the basis of units composed of ten minutes and 5° C. respectively seems to assume unusual simplicity in the reactions involved.

By means of this method, however, depending largely on the entrance of the stain to the nucleus, many surprising results were obtained. The addition, for example, of various alkaloids, putrefactive products, &c., led the author to formulate far-reaching conclusions as to the causes underlying cell division, with the result that he believes himself to be justified in announcing the discovery of the main causes that bring about cell division, and induce cell proliferation. The causal agents in question are, of course, chemical, and probably most people who have paid any attention to the matter would agree with Mr. Ross that the fundamental causes of mitosis (nuclear division) are assuredly of a chemical nature. He thinks he has identified certain of these bodies, and this would constitute a most important addition to science if his views as to their action on the living cell should turn out to be as well founded as he imagines them to be.

It is, however, difficult to avoid scepticism on this very point, namely, as to whether the evidence on which the conclusions are drawn is really cogent, and whether the latter are themselves fully warranted.

The author might himself have contributed towards the solution of these crucial difficulties had he seen fit, in addition to the picturesque presentation of his results, to have subjected the foundations on which they rest to a full and wary criticism. For it is clear enough from the account actually given that the cells, even as they were being examined in the jelly, were moriturient. It is stated, over and over again, that under the conditions of the experiments it was not easy to keep them alive for more than ten minutes. It is not, after all, very surprising to learn that all sorts of movements and distortions followed on the application of drugs like atropin, but it is at least uncommon to find that a mitosis can be completely carried through in three minutes. Numerous examples of alleged "mitosis" are described, and photographs are adduced in support of the descriptions. But the photographs themselves are singularly unconvincing, and suggest fragmentation or breaking up of the cell as a whole rather than anything one would expect to see in an actual cell- or nuclear-division. We fail to find any critical guard against misinterpretation of phenomena that might be due to osmotic differences or to the poisonous action of reagents employed.

Nor is one reassured by the account of mitosis (*i.e.* nuclear-division) as referred to in the book. The treatment of the whole subject is suggestive of the enthusiastic amateur who is simply unable, owing to temperament or lack of training, critically to check and examine his own work. Of course, we do not mean positively to assert that such is really Mr. Ross's position, but anyone who puts forward statements on mitosis such as appear on pp. 148 and 149, or again on p. 166, without producing the strongest and most convincing proofs, must not complain if in other directions his views fail to command unreserved acceptance. We are not at all surprised to learn that when Mr Ross attempted to convince his friend of the soundness of his conclusions by demonstrating to them his preparations they all with one consent, as he himself avers, "began to make excuse."

It may be readily admitted that the book contains much that is interesting and valuable by way of suggestion, but we do not regard the conclusions of its author on cell-division and cell-proliferation as sufficiently well founded. J. B. F.

THE EVOLUTION OF LUNAR DETAIL.

Vergleichende Mond- und Erdkunde. By Prof. S. Günther. Pp. xi + 193. (Braunschweig: F. Vieweg und Sohn, 1911.) Price 5 marks.

THE resemblance which exists between the surface of the globe and that of the moon, as shown in the irregularities of level and the general character of the superficial formations, has long attracted attention, and much ingenious speculation has been exhibited in tracing a connection and seeking the cause. Fanciful theories exist without number, but men of the highest eminence have occupied themselves with the same theme, being led to it by the fascinating problem of the "Plurality of Worlds." This is the attraction that has induced Prof. Günther to study the subject, or, perhaps it would be more correct to say, to sift and examine what others have written about it. His book is a marvel of research and a triumph of industry. He seems to have examined all that has been written, whether in fact or fiction, bearing on the relations of earth and moon. Mr. H. G. Wells and Jules Verne represent one school of thought; Procter and Flammarion another; the highest authorities, as Darwin, Loewy, and Puiseux, form a third. Every page bristles with notes, and is encumbered by the author's commentaries on those notes. This arrangement perhaps shows greater power of collection than of assimilation. Much of the matter, if worth preserving, could have been incorporated in the text and made the book easier to read.

But however wide the outlook, whether in time or in nationality, problems connected with the physical constitution of inaccessible bodies are likely to remain unsettled, and the discussion prove barren of result. The history of this speculative inquiry is profoundly interesting, but from a philosophical and not an astronomical point of view. We are indebted to the author for the skill with which he has marshalled his facts and the enormous amount of information he has collected, but the moon seems little likely to contribute any fresh facts of importance to the main issue, since the probability in favour of similarity of structure and of evolutionary history is so great. By whatever process we suppose the genesis of the moon to have been accomplished, it would be difficult to imagine a body so near the earth not possessing the same external characteristics and passing through similar geological changes. There is some evidence to show that the actual materials that once formed part of the globe were transferred to our satellite, and this probability is strengthened by the agreement between the density of the moon and that of the superficial rocks on the earth. Indeed, as the author reminds us, there are not wanting those who can point to the exact spot where the catastrophe occurred that in times past tore from the earth the eightieth part of its mass.

The main result of the author's examination is to show the general uniformity of the conviction possessed by all students of the lunar surface that the earth and moon have passed through approximately identical processes of evolution. Prof. Günther reproduces the speculations of ancient Greek philosophers and continues the theme to modern times. Kepler's "Traum von Monde" and the observations of Galileo form connecting links, with the results derived from lunar cartography. In this newer research we start from Hevel and Cassini onwards to the exact methods of Meyer, Lohrmann, Schmidt, and Neville Neison. We are reminded of the artistic work of Nasmyth and Carpenter, of Klein, and of Weinek, and justice is done to their penetrating insight and the ingenuity with which they have pursued their researches. One does not realise how engrossing this subject has proved, how keen has been the attention and the hold it has had upon so many ardent workers, until the whole history is methodically exposed.

Another chapter is devoted to the results of photographic research, in which the pioneer work of De la Rue, Rutherford, and Draper is reviewed, and the history traced down to the admirable series of pictures issued from the Paris Observatory by MM. Loewy and Puiseux. The last four or five chapters are really the kernel of the whole. Herein are considered the formation of lunar craters, the origin of the bright streaks, the debated question of changes of the surface, sufficient in amount to be observed telescopically. The tectonic and orogenic structures here come under review, also, but without much approval, the views of Mr. G. K. Gilbert as to the possibility of the fall of meteors influencing or explaining the external features of our satellite.

SUBSTITUTION IN BENZENE.

Die direkte Einführung von Substituenten in den Benzolkern. Ein Beitrag zur Lösung des Substitutionsproblems in aromatischen Verbindungen. By Prof. A. F. Holleman. Pp. vi+516. (Leipzig: Veit and Co., 1910.) Price 20 marks.

IT is well known that the empiric rules of substitution, which have been evolved from the study of the aromatic compounds, may enable a chemist to predict roughly the result of such a process; it is equally well known that not one of these rules is free from exceptions. The absence of any rational theory underlying the process or the lack of novelty in the methods employed may have deterred chemists in recent years from following up what was formerly regarded as one of the most attractive lines of inquiry; but it is quite certain that very little in the way of systematic study, especially of a quantitative character, has been done in this field of research. Yet the process of substitution possesses not merely a theoretical significance; it has a very considerable technical value. The formation of halogen, nitro and sulphonic derivatives of aromatic compounds are among the most familiar technical operations of the colour-maker.

Though the subject has undoubtedly suffered from neglect, nevertheless a few serious students of the process are to be found. Prof. Holleman and his pupils have for many years devoted themselves to the task of systematising the scattered facts and adding new knowledge by a careful qualitative and quantitative study of these reactions. The volume before us contains not only an account of these inquiries and a critical review of methods and results, but forms at the same time a complete book of reference to all the published observations referring to benzene derivatives containing up to three substituents. It is obviously a work of immense labour, but should be invaluable to those engaged in this fundamental branch of organic chemistry. It may possibly also serve to direct more attention to a topic of so much interest. It is impossible in a limited space to give more than an outline indicating the scope of the book.

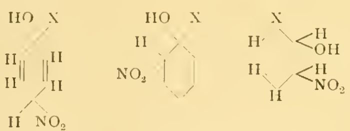
The first three chapters contain an account of substitution methods, the quantitative estimation of the products by chemical and physical means (many of which have been devised in the author's laboratory), and the nature of the di-derivatives formed.

Chapter iv. contains a compendium of results and a critical review of the rules and theories of orientation. Some of the apparent inconsistencies and contradictions in the ordinary rules may be realised from such facts as the following:—The nitration of a halogen derivative of benzene containing an atom of fluorine, chlorine, bromine, or iodine follows the ortho-para rule, yet the amount of ortho compound under similar conditions varies from 12 to 37 per cent. in the four cases. In the nitration of benzonitrile, nitrobenzene, benzoic acid and its esters, all of which are supposed to follow the meta rule, the first gives exclusively a meta compound, whereas the three latter yield an amount of ortho compound varying from 6, in the case of nitrobenzene, to 28 per cent. in that of ethyl benzoate. Whilst aniline and dimethylaniline under certain conditions give meta or meta and para compounds as chief products, dimethylaniline oxide and nitrous acid give mainly ortho and para derivatives. But perhaps the most striking case is that of acetanilide, which, when nitrated in presence of sulphuric acid, gives 80 per cent. of para, but when acted on by nitrogen pentoxide in a solution of acetic anhydride, forms almost exclusively the ortho derivative.

The empirical rules which have been drawn up at different times by Hübner, Nölting, Armstrong, Crum-Brown, and Gibson, and Vorländer, are carefully considered and rejected in turn as inconsistent with the facts, whilst the theories of Armstrong, Flürscheim, and Obermüller are shown to be fundamentally untenable or self-contradictory. The author concludes :—

"Das Endergebniss unserer theoretischen Betrachtungen ist kein erfreuliches; alle Versuche, welche bis jetzt gemacht sind, um die Gesetzmässigkeiten, welche den Ort bestimmen, wo ein zweiter Substituent im Kern eintritt, zu ergründen, sind vollkommen fehlgeschlagen; ja selbst ist es nicht möglich gewesen, die Tatsachen in einer empirischen Regel zusammenzufassen."

After discussing the position taken up by the third entrant group in chapter v., the author develops his own views on the mechanism of substitution. These views, which are published here for the first time, are so eminently simple and rational that chemists may be interested in the following brief outline. Following Kekule's idea that substitution is a succeeding phase of an additive process, Prof. Holleman considers that such a process as nitration, for example, of a compound containing a substituent X produces in the first place one or more of the following three substances :—



para ortho meta

from which the elements of water are subsequently detached. The nature of the predominating compound or compounds will be determined by the accelerating or retarding influence of the substituent X, just as addition of bromine to an olefine will be determined by the substituents already present. If X accelerates the reaction of ortho and para, substitution will be the main result, if it retards, meta substitution (where the double link is unconnected with the X complex) will be the primary effect. If X has no marked effect meta and ortho, meta and para, or all three may be formed.

A work of this kind, which, the author tells us, necessitated the careful perusal of upwards of a thousand original papers, ungrateful and laborious as the task of compilation may have been, will always remain a standard book of reference, for which chemists will feel fully grateful to the author.

J. B. C.

FERMENTS AND FERMENTATION.

Micro-Organisms and Fermentation. By A. Jörgensen. Translated by S. H. Davies. Fourth edition, completely revised. Pp. xi+489. (London: C. Griffin and Co., Ltd., 1911.) Price 15s. net.

IN this translation of the fifth German edition (dated January, 1909) of his well-known textbook, the author has incorporated the main results of investigations made since the appearance of the previous English edition about ten years ago. Although the book has been, to a considerable extent, rewritten, its original characteristics are retained.

Five of the six sections of the work have been enlarged, whilst the sixth, dealing with the pure culture of yeast on a large scale, has undergone marked reduction in volume, possibly because it forms the subject of a separate publication by the author. The illustrations have been increased in number from 83 to 101, nearly all of those found in the previous edition being again given; most of the figures are good, but those numbered 12, 13, and 51 would undoubtedly bear improvement, while Fig. 80 fails to bring out the peculiar bean- or kidney-shape of the spores of *Saccharomyces fragilis*. The bibliography has been revised and supplemented; it is, however, questionable whether a bibliography placed at the end of the book is more convenient than references given as footnotes to the text. One new feature, which will be welcomed by all readers, is the provision of an alphabetical index of subjects.

As the author is a member of the Danish school of micro-biologists, the book would naturally be expected to give, as in reality it does, a prominent place to the investigations of Hansen and his followers on the micro-organisms met with in the brewing industry. At the same time, the more important researches carried out during recent years in Germany and elsewhere are not, as a rule, lost sight of, although no reference is made to the valuable work of Slator on alcoholic fermentation, while the meagre notices given to the results obtained by Ehrlich and by Harden and Young might have been replaced profitably by more extended discussions.

The first chapter, headed "Microscopical and Physiological Examination," deals with such subjects as staining, sterilisation, antiseptics, nutritive substrata, and pure culture methods. In this section the space devoted to technique is very small, and a more detailed description of the methods employed in the author's laboratory would have been of value. In the part dealing with nutritive media, no mention is made of "eau de touraillons," which furnishes an excellent basis for such media, and is largely employed by some of the French investigators. Attention is directed to the stimulating action of small proportions of various poisons on the growth of micro-organisms, but no reference is made to the very thorough researches of Javillier on the influence of zinc on the growth of vegetable organisms, including moulds.

Chapter ii. treats of the biological examination of air and water, chiefly from the point of view of brewery requirements.

In chapter iii., the functions and conditions of growth of zymogenic bacteria are described. A paragraph is given to the nitrifying bacteria, but nothing is said of the very important class of nitrogen-fixing bacteria.

The moulds form the subject of chapter iv., which also deals incidentally with enzymes and with the influences of various external conditions on micro-organisms in general. The occurrence and life-history of most of the commoner moulds are studied, and reproductions are given of some of the excellent drawings made by Brefeld and de Bary.

The fifth chapter, occupying nearly two hundred pages, is concerned with the yeasts, and deals, in addition, with non-sporulating or Torula forms, as well as *Mycoderma vini* and *cerevisiae*. A short account is given of the history of fermentation and of the controversy respecting spontaneous generation. Then follow discussions of the biological relationships of yeasts, variations in the Saccharomycetes, morphology and anatomy of yeast-cells, spore-formation and its application to the analysis of yeasts, and a number of allied subjects. Lastly come descriptions of the more important culture and wild yeasts met with in the brewing, distilling, and wine-making industries.

The last chapter gives a brief account of the methods and apparatus employed in the preparation and transport of cultures of pure yeast for industrial purposes.

The translation has been on the whole well done, although in some cases the English is stiff and the grammar faulty. Rather ugly split infinitives occur in moderately large number, and subject and verb do not always agree in number. Use of the expression "equal molecules of dextrose and lævulose" is difficult to defend, and "sorbite," "mannite," and "albuminoid" are nowadays better termed "sorbitol," "mannitol," and "protein." Very few misprints are noticeable; *d*-methylglucoside (p. 359) obviously refers to α-methylglucoside. T. H. P.

THE FISHES OF AFRICA.

Catalogue of the Fresh-Water Fishes of Africa in the British Museum (Natural History). By G. A. Boulenger, F.R.S. Vol. ii. Pp. xii+529. (London: British Museum (Natural History), 1911.) Price *2l.* *5s.*

THE author is to be heartily congratulated on the appearance of the second volume of this great work, which succeeds its predecessor after an interval of two years, a period by no means excessive when the amount of labour involved in a task of this nature is taken into consideration. The present volume completes the account of the carp tribe (Cyprinidæ), containing the great bulk of that group, and likewise includes the whole of the cat-fishes (Siluridæ), several new genera and species being named.

Although no one regards systematic works of this class as the final aim and end of zoological science, their importance and value cannot be overestimated, since it is upon such sure foundations that all superstructures of a more far-reaching and philosophical nature must be based. That it was high time the task of bringing our knowledge of the African Cyprinidæ and Siluridæ up to date was undertaken will be evident by a comparison of the number of species of certain groups recorded in the present volume with that given in Dr. Günther's "Study of Fishes," published in 1880, and based on articles in the ninth edition of the "Encyclopædia Britannica." It is stated, for instances, in p. 573 of the "Study of Fishes" that the total number of species of cat-fishes of the exclusively African genus Synodontis is fifteen, whereas Mr. Boulenger has swelled the list to fifty-seven. Again, Dr. Günther estimated the total number of representatives of the Old World cyprinoid genus Barbus at about 200, while Mr. Boulenger gives a list (inclusive of nine additional uncatalogued species) of no fewer than 194 African members of the genus. Unfortunately comparisons cannot be extended to the total numbers of African Cyprinidæ and Siluridæ recorded by the two naturalists, as Dr. Günther enumerates only those inhabiting Africa south of the Sahara; but, even so, his lists of fifty-two Cyprinidæ and sixty-one Siluridæ (*op. cit.* p. 230) inhabiting Ethiopian Africa are altogether outclassed by Mr. Boulenger.

This great increase in the number of African representatives of the two families has, of course, a most important bearing on previous conclusions as to the place of origin of the two groups. Dr. Günther (*op. cit.* p. 225) suggested that since the majority of the groups of fresh-water fishes common to India and Africa, with the exception of the siluroid Clarias and its relatives, had more representatives in the former than in the latter area, the presumption is that they are of Asiatic origin. Although these conditions are now in many cases reversed, the conclusion will, we think, still hold good in the case of Barbus, the members of which, like many groups of antelopes with ancestral forms in India, would appear to have undergone an unparalleled development when they reached Africa. On the other hand, the abundance of siluroids in the Eocene of the Fayum, where no remains of cyprinoids have hitherto been discovered, points to the conclusion that this group is endemically African. And here it is noteworthy that the connection between the African and South American cat-fishes is now regarded as even less intimate than was the case when Dr. Günther's work was written, the two African species there referred (p. 233) to the South American Pimelodus now being assigned to a genus apart. But to pursue this interesting subject would demand more space than can be given to it in these columns.

If such space were available, we might presume to criticise some details in Mr. Boulenger's "keys"; and we cannot conclude without mentioning that the value of the work would have been increased if the dates of presentation of the specimens were added. The work appears singularly free from misprints. R. L.

THE INTERNAL-COMBUSTION ENGINE.

Gas Engines. By W. J. Marshall and Captain H. R. Sankey. Pp. xvi+278. (London: Constable and Co., Ltd., 1911.) Price 6*s.* net.

THIS book is the latest addition to Messrs. Constable and Co.'s Westminster series, and is intended to be useful to

"those who, being either purchasers or users of gas engines, wish to know the principles underlying the design or construction and the methods of diagnosing defects when they occur, and the steps to be taken to remedy such defects."

It may fairly be said to have achieved its purpose, and, for the most part, any criticism to which it lays itself open is little more than that to which almost any first edition is liable.

The book (an unusually heavy one to handle for its size) is divided into ten chapters, of which the first three deal with the theory of gas engines and with the Otto and two-stroke cycles of operation. The fourth, fifth, and sixth chapters are concerned with the water cooling of the engine parts, the various methods of ignition, and the principles of operation. Then follows a section on the arrangement of a gas-engine installation and the testing of the plant, whilst the two concluding chapters contain a good description of the various methods used for the governing of the engine and of the use of gas producers.

The book is stated on the title-page to be by the two authors mentioned in the heading to this review, and it is therefore puzzling on pp. 1, 110, and 152 to find "the author" only referred to. Possibly the book was written in sections, and this explanation appears plausible by reason of the curious contradictions that occur in it. Thus, on p. 1 it is stated that "the modern gas engine is a prime mover, perfectly reliable, cheaper in first cost, including the gas producer, than a steam engine and its boiler"; whereas on p. 21, we learn "the capital cost of the gas-engine plant is much greater than that of the steam-turbine plant," and on p. 152 that "the modern gas engine is very nearly as reliable a machine as a steam engine."

These statements should not all of them appear in one publication, as, even if explicable by some verbal modification, they tend to confuse the non-expert readers for whom this book is intended. It is this very use by the non-expert that renders slips in explaining the theory of the engine very unfortunate. On p. 5 an unlucky oversight has led to the statement appearing that if "pressure be kept constant the volume will vary as to absolute pressure." Again, the author or authors in stating (on p. 7) that "only a certain proportion of a given quantity of heat can be converted into work," neglect such a well-known fact that the heat conveyed to a gas to keep its expansion isothermal is all of it converted then and there into work.

These are matters which should be put right in a second edition, and, in view of the very thorough knowledge shown of the practical working of the engine and of the misfortunes to which it is sometimes liable, it is likely that there will be a large number of persons to whom the book will be of such value as to render a second edition a necessity. The description of the mode of working of the Clerk engine is specially good, and the letterpress is well illustrated. The authors commit themselves on p. 94 to an interesting prophecy concerning the probable future development of the gas engine.

"It seems likely," they say, "that in the future large gas-engine plants will be designed with engines working on two-stroke cycles, but, instead of each engine having its own charging pumps, a central set of independently driven pumps for gas and air will be provided"; "these pumps," they suggest, "will probably be of the turbine type, and of greater efficiency than is obtainable with pumps forming an integral part of the engine."

Finally, we welcome the book as an interesting addition to the less ambitious side of gas-engine literature, and foresee a useful place for it in the library of many persons who wish to learn something of this growingly important prime-mover.

RESINS, RUBBER, AND ESSENTIAL OILS.

Allen's Commercial Organic Analysis. A Treatise on the Properties, Modes of Assaying, and Proximate Analytical Examination of the Various Organic Chemicals and Products Employed in the Arts, Manufactures, Medicine, &c. With Concise Methods for the Detection and Estimation of their Impurities, Adulterations, and Products of Decomposition. Edited by W. A. Davis and S. S. Sadtler. Vol. iv., Resins, India-Rubber, Rubber Substitutes, and Gutta-Percha, &c. Fourth edition, entirely rewritten. By the editor and the following contributors, M. B. Blackler, E. W. Lewis, T. M. Lowry, E. C. Parry, H. Leffmann, and C. H. Lowall. Pp. viii+466. (London: J. and A. Churchill, 1911.) Price 21s. net.

THE general characters of the new issue of Allen's work have been described in the notices of earlier volumes reviewed in this journal (NATURE, vol. lxxxv., pp. 37, 365). In this connection therefore it is only necessary to remark that the present volume is notable among its fellows for the rather large proportion of theoretical and descriptive chemistry which it contains.

Many users of the book, however, will probably find this a convenience. Considerable advances have been made in the chemistry of the resins and essential oils since the publication of the earlier editions, and many of the results have not hitherto been brought together. Taken with the numerous references supplied, the articles upon the three groups of products dealt with in the book—namely, resins, india-rubber, and essential oils—form an excellent summary of the general and analytical chemistry of these products. The following are a few out of many interesting matters to be found in the volume.

Thanks largely to the work of Tschirch and his coadjutors, it is now possible to make at least a provisional attempt at a satisfactory classification of the resins. The proximate constituents of these bodies, so far as they are yet known, may be divided into (1) *Resin-esters* and their decomposition products; (2) *Resinolic* or *Resin acids;* and (3) *Resenes;* the last being oxygenated compounds with no very characteristic chemical properties beyond the attribute—a very valuable one—of resistance to the action of alkalies. In many of the resins one or other of these three classes is the preponderating constituent, whence three groups can be distinguished, namely, *ester-resins*, *acid-resins*, and *resene-resins*. The first group, for instance, includes (among others), gum benzoin, storax, "dragon's blood," ammoniacum, and asafœtida; in the second group are the coniferous resins and copaiba balsam; and in the groups of resene-resins are included myrrh, olibanum, dammar, and Manila copal. From a number of the ester-resins the alcohol of the ester has been isolated, and Tschirch distinguishes two kinds of these alcohols—*resinols* and *resinotannols*. The former are colourless, and give no reaction for tannin when tested with iron salts; the latter are coloured and give a tannin-reaction. For the general analytical examination of resins, the acid, saponification, iodine, methoxyl, and acetyl values are the determinations most frequently useful in forming a conclusion.

The chemistry of the essential oils is no doubt better and more widely known than that of the resins. Nevertheless, in the interests of readers who are not specialists in this branch of chemical work, a summary of the chief facts respecting the composition of the essentials oils may not be unprofitable. These oils, to which the characteristic odours of flowers and plants are nearly always due, are composed of some half-dozen groups of compounds, one or two of the groups predominating in any particular oil. *Terpenes* constitute the bulk of many essential oils, but are seldom the most useful portion. In fact, various so-called "terpeneless" oils are now prepared, the removal of terpenes serving in effect to concentrate the odoriferous properties of the oil in the residual constituents. *Alcohols* of various types—open-chain, aromatic, and sesquiterpene alcohols—with their corresponding *aldehydes* and *ketones,* are the important compounds in many oils. Examples are the alcohol *geraniol* in otto of rose; the aldehyde *citral* in lemon-grass oil, and the ketone *pulegone* in oil of penny-royal. Bergamot, clove, and mustard oils respectively owe their special properties to *esters, phenols,* and *sulphur compounds.* Methods by which the proportions of the various constituents may be determined, usually with a fair approach to accuracy, are described at length in the volume, which can be recommended as well worthy of its place in the series.

C. Simmonds.

MECHANICS, THEORETICAL AND TECHNICAL.

(1) *Lehrbuch der technischen Physik.* By Prof. Hans Lorenz. Dritter Band, Technische Hydromechanik. Pp. xxi+500. (Munich and Berlin: R. Oldenbourg, 1910.) Price 14 marks.

(2) *Die Theorie der Kräftepläne.* By Prof. H. E. Timerding. Pp. iv+100. (Leipzig and Berlin: B. G. Teubner, 1910.) Price 2.50 marks.

(3) *Vibrations of Systems having One Degree of Freedom.* By Prof. B. Hopkinson. (Cambridge Engineering Tracts, No. 1.) Pp. 54. (Cambridge: University Press, 1910.) Price 2s. 6*d*. net.

(4) *Leerboek der Werktuigkunde.* By F. J. Vaes. Vol. i., pp. xii+152. Vol. ii., pp. xiv+224. (Schiedam: H. A. M. Roelants, 1910.) Price 1.40 gulden.

THERE is probably no branch of science in which such wide gaps occur between theory and practice as in the study of the motion of fluids. We have, on one hand, the mathematical theory of hydrodynamics, which is limited by the difficulty of obtaining soluble problems and building up integrals of the differential equations of motion subject to given boundary conditions. This difficulty alone restricts the scope of the investigation mainly to the study of perfect fluids, thus immediately introducing a discrepancy between theory and observation. On the other hand, we have the hydraulics of the engineering student, the object of which is mainly to enable numerical calculations to be made regarding such problems as town water supply, efficiency of turbines, pumps, propellers, and ships.

In endeavouring to produce a text-book on technical hydromechanics (1) which should be satisfactory both from a theoretical and from a technical point of view, Prof. Lorenz thus undertook a duty of enormous difficulty. It is not surprising that when he had half finished the manuscript in 1906 he was so dissatisfied with the result that he decided to start afresh, a task which he did not commence until 1908, after re-studying the subject and making a number of original investigations. That such difficulties would exist was shown not only by what he describes as the "step-motherly" treatment of this subject in technical colleges, but also by the absence of any comprehensive treatise covering the required ground. Books on hydraulics generally treated the subject entirely from Bernouilli's principle, combined with the hypothesis of parallel sections, nothing being said about Euler's equations of motion in three dimensions, much less of their modifications for viscous fluids. In one case the treatment of hydraulics was preceded by an introduction on hydrodynamics, an order of treatment likely to confuse rather than enlighten the "applied science" student. On the other hand, we have purely theoretical treatises on hydrodynamics, where practical applications are represented only by half a chapter on the hypothesis of parallel sections, and this Cambridge lecturers, at any rate formerly, told their students to omit.

The order of treatment adopted by Prof. Lorenz is probably the best that could be devised for the object in view. Starting with analytical hydrostatics (including the oscillations of floating bodies, and surface tension) the author next deals with steady, and subsequently with variable, one dimensional motion treated by the hypothesis of parallel sections. These chapters constitute hydraulics proper, and contain applications to flow over weirs and through sluices, pumps, efficiency of turbines, and propellers, long waves in canals, and tides. The extension of the investigation to three dimensional motion leads up quite naturally to Euler's equations of motion of a perfect fluid, problems in irrotational motion, both continuous and discontinuous, vortex motion, and viscosity. In addition to such problems as are commonly treated in hydrodynamics, we have discussions of the oscillations of ships, including a digression on the Schlick gyroscope, approximate theories of the turbine, and of the resistance of ships, and the equations of motion of underground waters. The latter subject might with advantage be brought more prominently than it has been before mathematical students in this country. It affords excellent examples of motion derived from a potential, and the divergence between theory and observation is probably less than in Eulerian irrotational motion. Not the least important feature is a concluding chapter on the history of hydrodynamics. A few points in the book might be improved. The proof of the permanence of irrotational motion on p. 342 scarcely appears conclusive. The equation shows that if the components of spin are ever zero their rates of change will also be zero. This does not prove *without further investigation* (*e.g.* by Stokes's method) that if the components are zero initially they always will remain zero, for a similar argument applied to uniformly accelerated motion from rest would lead to a *reductio ad absurdum.* Does not the author, however, assume this inference? Again, in dealing with flow of a viscous liquid between two parallel plates, would it not be more correct to say that Hele-Shaw first made the experiments, and Stokes subsequently showed that the results were largely due to viscosity, although it was previously thought, and perhaps even incorrectly stated, that these motions represented an actual realisation of two-dimensional flow of perfect liquids?

(2) Prof. Timerding's introduction to "Graphical Statics" contains a praiseworthy attempt to bridge over the gap which so often exists between treatises of a purely theoretical character, and text-books dealing too exclusively with technical applications. In particular the author shows clearly the equivalence which exists between the equations of equilibrium of uniplanar analytical statics and the geometrical constructions of force diagrams, funicular polygons, and stress diagrams of loaded frameworks, such as roof trusses. It is not surprising to find the author compelled to limit the scope of his book to the simplest portions of the subject. By this means he rightly claims to have produced a handbook which is accessible to students possessing a limited knowledge of mathematics (including very elementary analytical geometry but excluding calculus), but which constitutes a self-contained and connected exposition of the subject-matter of which it treats. As the author points out, the book should show to the technical worker that he can derive help and elucidation even from apparently abstract theories, while, on the other side, the mathematician will see with pleasure how densely the path of practice is strewn with the finest flowers of theory.

(3) "Vibrations of Systems having One Degree of Freedom" is a tract of a rather more elementary character than the series of "Cambridge Mathematical Tracts" which have proved so useful already. It might afford a useful supplement to existing text-books for such students of physics as have attended a suitable course of preparation in the elements of the calculus and differential equations. The equations of free and forced oscillation with one coordinate are discussed, and are applied to such problems as the rolling of ships and its measurement by the pendulum. The main difficulty is for students to find time to read such tracts when they have so much other subject-matter to study; this difficulty can probably be overcome by placing the book in the hands of the lecturer rather than of the pupil. There is certainly much to be said for requiring students to get a clear understanding of vibrations with one degree of freedom before introducing them to the more general problem where there are several coordinates. So much for the use of the book by students of pure science. As for its use for the class of students for which it appears to be primarily intended, we can only express the opinion that the book tends in exactly the same direction as the two German works above reviewed, and we hope it will be as successful as they are in making such students appreciate the value of theoretical knowledge.

(4) "Leerboek der Werktuigkunde" (=Lehrbuch der Werkzeugkunde) is a text-book on elementary statics and dynamics treated without the calculus for use in the Dutch higher schools, and by private students. Both in the methods of treatment and exposition, and in the worked-out exercises, examples and questions for examination, this book closely resembles our numerous English school books on elementary mechanics. Its contents include uniformly accelerated motion, component and resultant velocities, relations between force, mass and acceleration, composition of coplanar forces and couples, centres of gravity, ordinary examples on equilibrium of bodies resting against one another, the principle of work, circular and harmonic motion, elementary moments of inertia, impact, and the so-called mechanical powers. This course of study is so familiar to English readers that further description is unnecessary. It may be noticed that while the familiar "first and second systems of pulleys" appear in the last-named section, allowance is made for passive resistances, such as friction, which is not always done in English books. On the other hand, the author still follows old customs in trying to deal with composition of velocities without the necessary explicit references to relative velocity, which last receives somewhat meagre attention, a plan which experience shows to lead to frequent mistakes on the part of students.

G. H. B.

OUR BOOK SHELF.

History of Biology. By Dr. L. C. Miall, F.R.S. (The History of Science Series.) Pp. vii+151. (London: Watts and Co., 1911.) Price 1s. net.

This is a wise and instructive book, such as we have learned to expect from Prof. Miall. It is scholarly but restrained, so that the reader is not overwhelmed with too much learning. It is a model of terseness, yet it has that picturesqueness of illustration which is necessary if a history is to grip the ordinary mind. A book like this, which commands our warmest admiration, could not have been written except by one who had studied the history of biology for a long time, and at first hand.

After a brief reference to the biology of the ancients, the long cessation of scientific inquiry that followed, and the revival of knowledge, Dr. Miall sketches the history in five periods. The first (1530–1660) saw the fresh start of botany and zoology, the beginning of experimental physiology, the exploration of new lands. The second (1661–1740) was the period of the early microscopists, of discussions as to the meaning of fossils, of early comparative anatomy and taxonomy, and of inquiry into the sexes of flowers. The third (1741–1789) was the time of Linnæus and the Jussieus, of Réaumur, of the rise of the genetic or historical method as illustrated by the works of Montesquieu and Buffon, of inquiries into animal intelligence and instinct, the metamorphoses of plants, the function of the green leaf, and so on. The fourth period (1790–1858) is illustrated by Sprengel and the fertilisation of flowers, by Cuvier and palæontology, by Chamisso and alternation of generations, by von Baer and embryology, by the cell-theory, and by the investigation of the higher cryptogams. The fifth period is illustrated by Darwin and Pasteur.

At the end of the book there is an interesting chronological table—a good lesson in itself. There is reason for regret that students often take relatively little interest in the historical development of the science which they pursue. The excuse sometimes offered, that they have no time for "historical studies," is made impossible by a book like this, short and illuminating. It shows us, with singular success, how "Biology, which in the sixteenth century sent out only a few feeble shoots, has now become a mighty tree with innumerable fruit-laden branches. The vigour of its latest outgrowths encourages confident hopes of future expansion." J. A. T.

Catalogue of the Lepidoptera Phalænæ in the British Museum. Vol. x. Plates cxlviii–clxxiii. (London: Printed by order of the Trustees, 1911.) Price 20*s.*

VOL. x. of Sir George F. Hampson's great work on the moths of the world was issued in November, 1910, and was reviewed in NATURE for February 23, 1911 (p. 539). It was published in advance of the plates, which were not quite completed, but which appeared in May of the present year. They number twenty-six, and on each plate thirty-two species are figured, making a grand total of 842 species figured out of 1222 described (except a few described in vols. viii. and ix.) in vol. x., and if we add to this number the 214 species figured in the text, we find that only a few species are described and not figured, and even of these most are recognisably figured elsewhere. The enormous number of species of insects makes this of great importance, and the close resemblance and frequent dull colouring of many species often makes it difficult to point out their characters by description alone. With these excellent illustrations it should be easy to identify most, if not all, the species represented, and it is to be regretted that we have not yet a sufficient series of illustrated works on other orders of insects besides Lepidoptera.

The Mechanism of Weaving. By Thomas W. Fox. Pp. xxii+604. Fourth edition. (London: Macmillan and Co., Ltd., 1911.) Price 7*s.* 6*d.* net.

SINCE the first edition of this book was reviewed in NATURE on December 13, 1894 (vol. li., p. 149), 130 pages and twenty-six new illustrations have been added. Some parts of the work have been rearranged and others enlarged. The sections dealing with dobbies, Jacquards, figuring harnesses, card-cutting, picking, multiple shuttle boxes, letting off, taking up, beating up, loom adjustments, and reeds have all been extended; and those on gauze, lappets, and swivels have been rewritten. Descriptions of terry weaving, the automatic supply of weft to looms, and warp stop motions have been included in this edition, and also an ind.x.

Die Grundlehren der höheren Mathematik. By Prof. G. Helm. Pp. xvi+420. (Leipzig: Akademische Verlagsgesellschaft, 1910.) Price 13.40 marks.

THIS is much more like an English school class-book than usually reaches us from Germany. Practically it is a revision course of pure mathematics for what we should call a degree standard. There are chapters on differential and integral calculus, analytical plane and solid geometry, differential equations, interpolation, and the elementary theory of vectors. The author has had in mind the requirements of technical students, and his illustrations of theory are mainly of a practical kind. Finally, there are nearly 400 diagrams, so that the "appeal to the eye" has not been neglected. M.

LETTERS TO THE EDITOR.

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

The Duration of Geological Time.

THERE is at the present time a great discrepancy in the numerical values given for geological time by the various methods employed. Considering the period which has elapsed since the commencement of the Cambrian, the evidence afforded by the study of radio-active minerals suggests that its length is of the order of 500 million years. Arguments derived from the study of sedimentation give, according to recent writers, a space of time for the same period not exceeding 50 million years, and the method based on the salinity of the ocean gives a similar figure. It is with regard to sedimentation that I wish here to make a few remarks.

It is evident that at the present time the volume of post-Eozoic sediments in existence is greater than ever it has been, and also that it is slowly increasing at the expense of the igneous and pre-Cambrian rocks now exposed to denudation. Knowing the rate of this denudation and the total volume of these sediments, all of which must necessarily have had their origin in igneous and pre-Cambrian rocks, the period represented by the fossiliferous strata is given by a simple process of division.

Situated as I am in Africa, without any geological literature, I can only give the most approximate estimates of the necessary factors with which to illustrate the method and arrive at the required length of time.

Sollas gives the thickness of the post-Eozoic sediments as 250,000 feet, or approximately 50 miles.

If we suppose all the sediments to be deposited at the maximum rate, they will form a regular bed along the continental shores for a distance of 35 miles seawards. Taking 100,000 miles as the average shore line of the Cambrian and subsequent periods, we arrive at the total volume of sediments—175×10^6 cubic miles. This spread over the whole globe represents a thickness of seven-eighths of a mile.

The average rate of continental denudation is probably 1 foot in 5000 years, or 1 mile in 26 million years. The continental area is 56 million square miles, one quarter of which is occupied by igneous and pre-Cambrian rocks, *i.e.* 14 million square miles. The rate of denudation of the latter is therefore 14 million cubic miles in 26 million years. The time for all the sediments to collect at that rate would be 325 million years. This figure is only an indication of the order of the time elapsed. It requires to be corrected for the following factors:—

A. Factors tending to decrease the estimate.

(1) Exposed surface of igneous and pre-Cambrian rocks may have been greater in former ages.

(2) Marine denudation of igneous and pre-Cambrian coasts.

(3) Greater density of igneous rocks than of sediments.

B. Factors tending to increase the estimate.

(1) Average land area has probably been about 0·8 that of to-day.

(2) Average continental mean height has probably been below that of to-day.

(3) Recent glaciation has laid bare many pre-Cambrian areas.

(4) Present is a volcanic period, increasing the weathering capacity of rain.

(5) Present climates are of maximum variability.

(6) Parts of land area are subject to deposition, *i.e.* negative denudation.

(7) Unconformities not represented by sediments elsewhere.

(8) Some sediments at great depths may have become igneous rocks.

It is hoped that, with the increase of accurate quantitative knowledge of former conditions, and of the processes at work in denudation and deposition, the above factors may be verified and allowed for in making an estimate of the antiquity of sediments.

The estimate here given is probably too low in the light of these corrective factors, and it is interesting to notice how much more closely it agrees with the results of the totally independent method based on radio-activity than do those deduced from the facts of sedimentation in the usual way.

Arthur Holmes.

Mosuril, Portuguese East Africa, May 6.

Breath Figures.

The two interesting letters on breath figures by Lord Rayleigh and Dr. Aitken (Nature, May 25 and June 15) seem to me to contain a statement of the cause of this phenomenon as well as the data necessary to support it.

Thus it is shown that a blow-pipe flame, burning sulphur, sulphuric acid, hydrofluoric acid, and caustic soda give these breath figures, while heat and alcohol flame give no such result. The conclusion apparent from these chemical data is that when the glass is coated with a film having an affinity for water, breath figures are formed.

Coal gas contains sulphur, and a blow-pipe flame gives sufficient sulphuric acid to form a film on glass; burning sulphur gives similar acid products, and both yield breath figures.

Sulphuric acid, hydrofluoric acid, and caustic soda are each capable of dissolving glass, which implies wetting and a certain amount of penetration; washing does not immediately remove this, and a film of acid or alkali is left capable likewise of forming breath figures.

In ammonia solution we have a strong alkali which cannot dissolve glass in the caustic soda sense; when it is allowed even to stand on a glass plate no breath figure is formed, but when it is well rubbed in a faint figure is produced.

If breath figures, from blow-pipe flames, say, be soaked in ammonia solution and washed, they may be gradually destroyed—by neutralisation of the acid in the superficial pores of the glass—until breath outlines only exist. These lines correspond to the lines of greatest acid penetration, and would be represented by charred lines on a piece of wood.

This gradual destruction of the figures on gradual neutralisation of the acid conclusively shows that these figures are neither due to cleanliness nor dust, as has been suggested.

This explanation enables one to predict that Dr. Aitken's suggested experiment of burning pure hydrogen in dustless air would give breath figures, while pure (dusty) hydrogen burning in pure (dusty) oxygen would give no figures, the reasons being that pure hydrogen burning *in air* gives sufficient nitric acid to produce figures, while pure hydrogen burning *in pure oxygen* produces no acid, and would produce no figures.

Caeteris paribus, it may be inferred that pure quartz glass would not give figures with sulphuric acid, but with hydrofluoric acid and caustic soda.

If the rays from radium can produce breath figures on glass, it constitutes another cause.

Glasgow. George Craig.

A Zenith Halo.

Will you permit me to quarrel with your correspondent for the heading "A Zenith Rainbow," attached to his letter from Bruges, published in Nature of May 11, p. 340? The phenomenon described was not a rainbow, as Mr. Gold has taken pains to point out. The heading is unfortunate, for two reasons: first, because it tends to confirm the prevalent misuse of the word "rainbow," and, secondly, because it will probably lead to the improper classification of Mr. Kreyer's letter in bibliographies.

The terminology of atmospheric optics is in a state of dire confusion, even among scientific men, but all the latter are agreed in calling the phenomenon in question a halo. Mr. Gold follows Pernter and most other writers in terming this particular halo an "arc of contact." However, this name, as well as the common alternative, "tangent arc," is objectionable, for the reason that the halo thus designated is by no means always in contact with, or tangent to, the halo of 46° (or the position which the latter would occupy if present). On this subject see M. Besson's article "Le halo du 21 décembre 1910; un arc tangent qui n'est pas tangent," in *La Nature* of March 11, 1911, p. 248. In the picture that accompanies M. Besson's article, the "tangent" arc is shown separated from the halo of 46° by an interval of about 3°.

Another common name, "circumzenithal arc," is open to the objection that this halo is but one of many that are central at the zenith.

The only accurate and distinctive name for the phenomenon is "upper quasi-tangent arc of the halo of 46°."

Statistics of the frequency of the various halo phenomena are misleading. Mr. Gold states, on the authority of Pernter, that the arc in question had been observed only about seventy times up to 1883. Besson, "Sur la théorie des halos," records 111 observations of it in ten years (1898–1907) *at Montsouris alone.* If systematic observations of halos were made all over the world, the frequency of such phenomena would doubtless be found to be far greater than is now generally supposed.

C. Fitzhugh Talman.

U.S. Weather Bureau, Washington, May 22.

Probably no one will be inclined to dispute Mr. Talman's proposition that systematic observations would largely increase the apparent frequency of the phenomenon mentioned.

With reference to the terminology, it is, as he points out, unfortunate that the terms "arc of contact," "tangent arc," should have come into general use for a bow which is not always in contact with the halo. I cannot, however, agree that Mascart's term, "quasi-tangent arc," is a satisfactory substitute. It was, I believe, intended to meet those cases when the arc is present at approximately 46° from the sun, but without the 46° halo. It does not fit cases for low or high solar altitudes when the arc is more than 46° from the sun. I think it would be better, instead of trying to indicate all the peculiarities of the phenomenon by its name, to use a term such as "auxiliary arc," if the present names are to be abandoned.

The phenomenon is described by Bravais as "un véritable arc-en-ciel," and this may account for the less appropriate use of the term "rainbow."

E. Gold.

Meteorological Office, South Kensington, London, S.W., June 2.

Jelly Rain.

On the morning of Saturday, June 24, the ground here was found to be covered with small masses of jelly about as large as a pea. There had been heavy rain on Friday night, and it was raining at 7 a.m., when, so far as I can ascertain, the phenomenon was first seen. On being examined microscopically the lumps of jelly turned out to contain numerous ova of some insect, with an advanced embryo in each. The egg itself is very minute—an elongated oval 0·04 mm. in length. Yesterday and the day before many larvæ emerged, and were obviously those of some species of Chironomus, though colourless, having no hæmoglobin, as is the case with the larvæ of *C. plumosus*. Not being an entomologist, I am at a loss to understand how these egg-masses could have appeared where they did unless they were conveyed by the rain, as it does not seem likely that the midges would have laid their eggs on pavements, gravel paths, tombstones, &c., even had they been wet; nor has any large number of adult insects been seen in the locality. It would be interesting to hear whether the same thing was observed elsewhere, and whether the phenomenon often occurs. Showers of algæ, small snails, and even frogs have been recorded from time to time, but I cannot recall a like instance to the above.

Eton, Bucks, June 30. M. D. Hill.

NOTES ON THE HISTORY OF THE SCIENCE MUSEUM.

THE recent discussions relating to the Science Museum have brought to the front several important questions connected with the utilisation of land for public purposes connected with science and the arts. They have occurred, too, at a time when the Royal Commissioners for the Exhibition of 1851, who in times past have behaved so generously in selling their land at a nominal price, have now parted with the last square yard of it which can be used for the high purposes determined upon by the late Prince Consort when it was placed at his disposal by them.

It seems desirable, therefore, to bring together as briefly as possible the facts touching the various allocations of the land which have been made from time to time. In this way we shall be able to touch upon some of the circumstances which have arisen regarding museum sites during the last half-century. Further, we shall be led to recognise the vast benefits which have been conferred upon the nation by the Commissioners' action.

The present site of the new Victoria and Albert Museum to the east of Exhibition Road was the first thus devoted in 1858, after the partnership between the Commissioners and the Government had been dissolved, chiefly to the purposes of Art, although a small Patent Museum ("the Boilers") had before that year been erected by the Government at a cost of 15,000*l*.

Next came the plot on the south face of the main square of the Commissioners' estate, facing Cromwell Road. This was the largest plot conveyed to the Government for national purposes, and its transfer was made memorable by a remarkable speech by Lord Palmerston concerning the Cabinet's decision to purchase it, and the uses to which it was proposed to apply it. In this speech (*Hansard*, June 15, 1863), Lord Palmerston, the Prime Minister, took pains to show the generous action of the Commissioners. Some extracts from this speech may be given.

"Sir, I rise to propose the Vote of which notice has been given, for the purchase of land and buildings on the site of the Exhibitions of 1851 and 1862. This City of London may, without exaggeration, be called the commercial capital of the world. It ranks high among the great political centres of civilised nations, and in point of wealth and population it may very fairly be stated to exceed any other European city. But the very circumstances which I have mentioned—the great wealth and great population of the City—have tended progressively to impair the architectural and ornamental character of the town. Our streets are narrow, our open spaces few and small, our public buildings are not many, and, respecting those which do exist, differences of opinion prevail as to their propriety of ornamentation and architectural design. We have not, in this town, what are to be found in many smaller towns upon the Continent, a great number of splendid palaces belonging to individuals. When we have mentioned Northumberland House, and, perhaps, Lansdowne House, if we are called on to enumerate other great ornamental constructions, we shall be driven to the, no doubt, very beautiful collection of apparent palaces—the clubs in Pall Mall, many of which are imitations of beautiful palaces on the Continent. In all the Italian towns, at Prague, and in most German towns, there are large piles of ornamental buildings which represent the wealth and taste of the nobility of those countries. What is the reason of that? What is the reason of the inferiority of this city as compared with other first-rate towns, in regard to the conditions of the space occupied by and the character of the buildings? The great run of the private houses of London may really be termed mean. I am not speaking of those more lately constructed, which are on a better plan; but the old red-brick houses of London are low, they are destitute of architectural ornament, and may be said to be mean in their character. What is the cause? It arises from the great value of the ground—from the immense competition which the wealth of the metropolis causes for the small spaces of ground. People are unable to buy a large quantity of ground on which to construct a house, and, having paid dearly for such a portion of the land as they require, they have smaller disposable means for the erection of ornamental and handsome structures. The price of land in London is very great. I will just mention a few instances to show the value that attaches to the surface in this great town. . . . Therefore I say that the natural progress of wealth and civilisation tends to add greatly to the value of land to be covered by buildings in the interior of towns; and admitting that there are certain requisites which are necessary for the development of the public establishments and buildings, the question arises where the land for such purposes can be acquired, and whether we should look for it in the centre of the town, where everything is covered with valuable property, or whether we should embrace the opportunity of acquiring it at certain greater distances, but still within reach for all the purposes to which it is to be applied. Well, we hold that the land held at Kensington by the Commissioners of 1851 does afford the means of providing for our immediate and prospective wants, and we are able to get land there for our immediate purposes on terms infinitely cheaper than those on which land can be acquired nearer the centre of the metropolis."

Having shown how the question was dominated by the price of land in various parts of the metropolis, Lord Palmerston passed to the then requirements of the Government. The chief of these was an expansion of the Patent Museum before referred to, and also of the British Museum.

In 1859, two years after the establishment of the Patent Office Museum, the Commissioners of Patents laid a Report before Parliament, in which the following passage occurs:—

"It is intended to make the Patent Office Museum an historical and educational institution for the benefit and instruction of the skilled workmen employed in the various factories of the kingdom, a class which largely contributes to the surplus fund of the Patent Office in fees paid upon patents granted for their valuable inventions. Exact models of machinery in subjects and series of subjects, showing the progressive steps of improvement in the machines for each branch of manufacture, are to be exhibited; for example, it is intended to show in series of exact models each important invention and improvement in steam propellers (steamboat propulsion) from the first engine that drove a boat of two tons burden to the gigantic machinery of the present day, propelling the first-rate ship of war or of commerce. The original small experimental engine that drove the boat of two tons burden, above referred to, is now in the museum."

Add to these illustrations of applied science similar illustrations of the instruments used in the advance of pure science, and we have a picture of what is required in the Science Museum of to-day.

Lord Palmerstone thus referred to the needs of this museum:—

"Now, the question is, what do we want? What are the requirements that press on the Government? In the first place, we want a Patent Museum. Anyone who considers the value of a great collection of models and inventions to those employed in the mechanical and productive arts of the country must know that it is of great importance that they should have access to a repository in which they can find everything connected with that particular department of industry to which they have devoted themselves. In America, a country not supposed to be addicted to unnecessary ornament, but where a great disposition is shown to practical improvement, there is a Patent Museum which covers eleven acres. Well, we do not propose a museum of such dimensions. I think that about three acres will be sufficient for all present needs in regard to a Museum of Patents."

He then passed on to the British Museum requirements:—

"Then we want an addition to the British Museum. The question then arises where that addition is to be found—whether the land is to be had by purchasing land in immediate contiguity to the British Museum, or by the purchase of land at Kensington, as we propose. Calculations have been made that eight acres are required, but that is, I think, more than is necessary. I think that five acres would be a nearer approximation, and three acres have been named as the smallest amount of space that is required."

Next we have a reference to the National Portrait Gallery, room for which was eventually found elsewhere:—

"We have got together, at some expense and trouble, a most interesting collection of portraits of distinguished men connected with the history of the country. They are now placed in a house where they cannot be seen, and it is urgently desirable to have a better building in which to place that Portrait Gallery, Then we have a Museum at Kensington, full of most valuable and instructive productions, and a Committee of the House of Commons that sat two or three years ago strongly recommended additions to that institution."

"Now, we calculate the cost of these various augmentations—supposing that the land were bought in the metropolis and at the rate which it now bears—as follows:—If eight acres are taken for the British Museum, the cost of land will be 390,000*l*., and the buildings 824,000*l*., making a total of 1,214,000*l*. If five acres only are required, the land will cost 240,000*l*. and the building 567,000*l*., making a total of 807,000*l*. Supposing the lowest estimate of three acres to be sufficient, the land will cost 150,000*l*. and the building 300,000*l*., making a total of 450,000*l*. I then take the Patent Museum, which will require three acres. The land is set down at 100,000*l*. and the building at 100,000*l*., making together 200,000*l*. . . . The Portrait Gallery will require half an acre, and we calculate will cost 25,000*l*. for land, and 25,000*l*. for the building, or together 50,000*l*. These sums would come to the following total:—If you take eight acres for the British Museum, the total for all these buildings will be 1,514,000*l*.; if you take five acres, 1,107,000*l*.; if three acres, 750,000*l*. Assuming that these are wants which Parliament may think it proper to meet, these would be the sums you would require if you took land now occupied by houses in any central part of town. Now, the proposal that we make is one which the Committee will see is a very economical one. By the plan which we recommend we should have much more space and at far smaller expense. The arrangement that we propose is, that the public should purchase seventeen and a half acres. (Several hon. Members: Sixteen.) No—seventeen acres of the land belonging to the Commissioners, which is now covered with the building in which the Exhibition took place. For that land the Commissioners are willing to take 120,000*l*. My hon. friend will admit that to get seventeen acres of land at about 7000*l*. per acre, for which we should pay 50,000*l*., 60,000*l*., or 70,000*l*. an acre elsewhere, is a considerable advantage."

It will be gathered from this speech what an enormous saving had been effected by paying such a low price for the land. The plot in question was sold for half its then value, thus presenting the public with 120,000*l*. In the conveyance a covenant was inserted restricting the use of the land to purposes connected with Science and the Arts.

In 1863 the only land to be obtained on these low terms was the large plot purchased from the Royal Commission of 1851, capable of containing the Patent Museum, the Natural History Museum, and other institutions; but by 1869 there was another plot available for the building of a Natural History Museum. This plot consisted of land reclaimed from the Thames near Hungerford Bridge by the construction of the Embankment. As no action had yet been taken on the Cabinet decision of 1863, referred to in Lord Palmerston's speech, concerning the Natural History Museum, it was suggested that it should be built here, and a Select Committee was appointed to inquire into the matter. Their first report was published on May 10, 1869 (Report of Select Committee on Hungerford Bridge), and this was soon followed by a second.

These reports and their accompanying plans are a mine of information, especially in relation to the then stated requirements of biologists with regard to the natural history collection.

It has already been shown that the demands for space for these collections before the Government in 1863 were three acres and eight acres, and that Lord Palmerston compromised with five acres, which were to be provided for out of the sixteen and a half acres purchased from the Royal Commission of 1851.

In the interval between 1863 and 1869 further inquiries had been made, as will be gathered from the following extracts of the evidence (second Report):—

"Examination of Prof. Owen, p. 107.

"2343. [Mr. Cowper.] Will you state, according to your present views, what area you think necessary for properly providing for the natural history collection?—Mr. Hunt, in 1863, went carefully into all those details and questions with me and ultimately embodied them in a plan, which is printed in a Parliamentary paper. He arranged the building for present actual wants on a space of three acres, and I asked for two additional acres for later additions, looking forward to the next thirty years."

"2344. Is that your present view of the subject?—It is so."

"Examination of Prof. Huxley, p. 112.

"2422. [Mr. Tite.] Probably three acres might include it all?—Yes. I reckon that five times the space now occupied by the bird-room in the British Museum (taking that space at 15,000 square feet) would suffice for the erection of a building in which the largest zoological collection that can ever be formed may be displayed and preserved in a manner most advantageous to the public and to men of science. Thus, for zoology, I ask, say, an acre and three-quarters; I should provide another 15,000 square feet for the fossils, and half as much for the mineralogical collections; and half as much for the botanical collection, if any such collection is to be taken to the new site. This makes a sum total of about two acres and a half, and half an acre for margin, offices, and residences, and the like, and I believe that ample provision will be made not only for all present, but for all future, needs of a great national natural history museum. In saying that, I think the building ought to be of only one storey, and top-lighted; I mean so far as it is devoted to museum purposes. But I think that the museum galleries might be conveniently supported on a side-lighted ground floor, which would afford ample room for the library and offices.

"2423. [Mr. Layard.] Of course, when I asked you the question about the space, I meant to include all the natural history collections, together with the collections of mineralogy, zoology, geology, osteology; in fact, everything that appertained to the department of science in the British Museum?—My first answer had reference entirely to the zoological collection; but if you wish to add the other collections I should say, speaking roughly, another couple of galleries, making, say, seven altogether, would be sufficient, but that is, of course, a mere estimate, and a very moderate one."

The plans show that the building proposed on this site covered about $3\frac{3}{4}$ acres, and there was little, if any, room for expansion, as the District Railway and wide roads had to be provided for, and it was proposed that the latter should bound the area available for museum purposes.

Ultimately this scheme was given up, and the South Kensington site was fixed upon, the building covering the same ground—$3\frac{3}{4}$ acres—as that proposed for the Hungerford Bridge site.

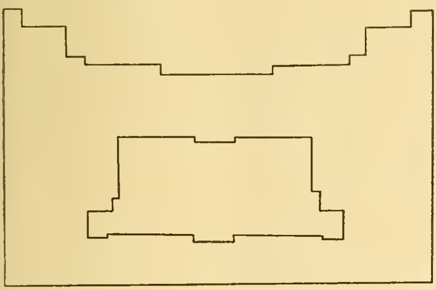


FIG. 1.—Plan of plot and building erected on it.

It would seem that between 1863 and 1869 the question of the Patent Museum had dropped into the background, for the plan ultimately adopted for the Natural History Museum was allowed to sprawl over nearly the whole of the plot as shown in the copy of the map published in the sixth Report of the Commissioners of 1851 (1879). It thus put difficulties in the way of using the unoccupied land. I give another plan, which shows that two museums of the same plan and size, say a Natural History Museum and a Patent Museum, could have been built on the land, leaving some eight acres for future extensions. Of course, if this had been carried out, any desirable change in the plan might have been made.

It would seem also that all the data collected in 1863 and 1869 had either been forgotten or shown to be worthless, for there is nothing that I know of in the shape of public documents to show, until long afterwards, of what part of the $16\frac{1}{2}$ acres bought the British Museum Trustees might consider themselves to be in possession. The land all round the museum was necessarily planted and laid out as gardens, because at the time it was not used for building purposes.

The first thought seems to have been given to this matter in 1881, after the erection of the building. A fence was erected to cut off the land to the north, and the new museum then found itself in the centre of a square containing more than $12\frac{1}{2}$ acres. Shade of Owen! shade of Huxley! The first had asked for three acres, and two more to cover the expansion of thirty years, and the latter three acres, in which "the largest zoological collection that can ever be formed may be displayed and preserved in a manner most advantageous to the public and to men of science."

The second thought was given to this subject in 1899, when a new north boundary was considered. This added one and a half acres more land, making more than fourteen acres in all.

There is no doubt that the Government *then* allocated this land for Natural History Museum purposes. In the recent "Correspondence" (Cd. 5650, p. 1) a letter of 1910 is printed, quoting a letter of 1899 "with reference to the boundary line between the ground which it was then contemplated should be allotted for the use of the Natural History Museum and that provided for the use of the Education Department (Science Museum).

"It was then arranged that a boundary should be fixed, as shown upon the plan, which was forwarded to your predecessor at that time, and it was decided that all the land to the south of that land should be regarded as ear-marked for the future of the expansion of the Natural History Museum."

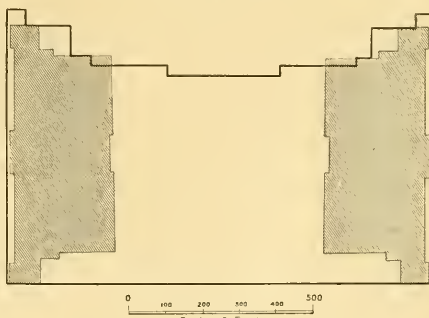


FIG. 2.—Plan showing what might have been.

As the building covers $3\frac{3}{4}$ acres, this allocation provided $10\frac{1}{4}$ acres for future expansion.

Incredible as it may seem, this is more by an acre than the area of the parent institution in Bloomsbury at the present time; an area required to garner all the collections on all subjects except natural history, made since 1753, say during a century and a half. Until 1907 it occupied seven and a half acres. In 1907 five and a half acres additional were bought, making thirteen in all.

To state this fact is to show that something had gone wrong somewhere. Had someone blundered?

This does not seem to be impossible, for the Government has recently been led to reconsider the matter. We read in the "Correspondence" referred to:—

"The Treasury and this Board [of Works] have had no desire to disturb the arrangement then [in 1899] arrived at so long as the occupation of this land by the Natural History Museum does not affect injuriously the interests of any other Department."

"The land and the Museum Buildings being vested in the Commissioners of Works, are the property of His Majesty's Government, and they are bound, therefore, in the interests of the public, as a whole, to consider without prejudice whether the time has not now arrived when some modification of that boundary [that of 1899] should be made."

The "Correspondence" goes on to say:—

"There can be no doubt that, whatever shape the new Science Museum may ultimately take, it will be necessary to build up to the boundary line, and it is probable that, in order to safeguard both the Science Museum and the Natural History Museum from fire, and to lay out the ground to the best advantage, it may be necessary to construct a road, to be used privately between the two buildings."

In later "Correspondence" (Cd. 5673, p. 3) a block plan is given in which the revised boundary is indicated by the proposed road.

This proposed road, if constructed, involves the proposed to construct the new private road for the special purposes of the Science Museum. This new road will have to run from Exhibition Road to Queen's Gate, a distance of 1170 feet, and will absorb *at least* three-quarters of an acre of ground. The architects of the Imperial Institute and the Imperial College between them absorbed three acres in their new road running between the same termini.

It must be pointed out that the proposed new road will run parallel to, and only fifty feet away from, the existing road, which has served the purposes of the Natural History Museum for the last thirty years. Curiously enough, this road is not shown on the block plan.

Even a Quartermaster-General proud of his department would scarcely recommend the construction of two parallel roads fifty feet apart, especially where every square foot of space is so precious and is being so hotly contested.

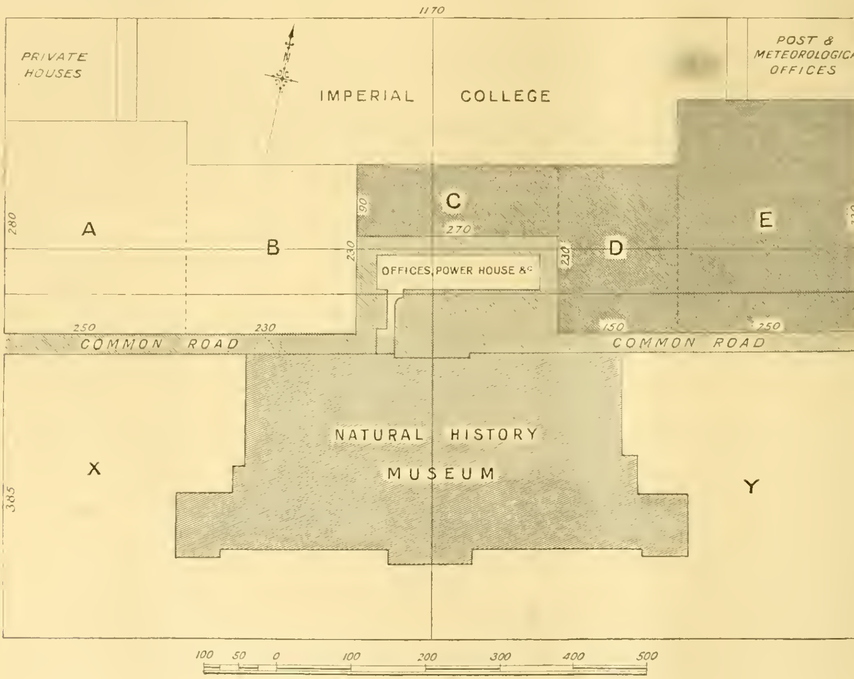


FIG. 3. Plan showing utilisation of the existing road and spirit museum building.

destruction of the building of the spirit museum. It is the inflammable nature of the contents of this building which has been objected to, and not the building itself, which might from its position be conveniently applied to many uses for one or both museums.

This action of the Government in changing the boundary has withdrawn the one and a half acres additional land included in the boundary in 1899; but that still leaves the Trustees in possession of twelve and a half acres, two and a half times what was asked for in 1869 by their responsible officer to provide for a thirty years' expansion.

The newly defined frontier is really the old line of fence erected in 1881, to the north of which it is

The question arises whether the existing road is not really the best boundary. This I referred to in my letter to *The Times* of May 30. It would serve the purposes of the two museums as regards fire precautions and other matters; no sacrifice of space for a new road, no breaking up of frontages, and no destruction of the spirit museum would be necessary.

Further, the existing road when the boundary was thus established could be made to enclose the *body* of the *spirit* museum, which might remain for use as offices, workshops, or other convenient use, in a central backyard, away from any frontage; this, as well as the road which would be carried round it, would be common to the purposes of both museums.

In the accompanying plan (Fig. 3) I have shown gardens, until they are built over, as an embellishment of the south front. I append photographs showing the present condition of the ground and how it would appear if the Science Museum were built to

FIG. 4.—Things as they are.

blocks A, B, C, D, E, which could then be used for the Science Museum; the area is six acres.

With regard to the Natural History Museum, it may be stated that with the three boundaries above referred to the included areas are as follows:—

	Feet	Acres
Boundary fixed in 1889	1170 × 530	= 14·2
Proposed road	1170 × 470	= 12·6
Existing road	1170 × 415	= 11·1

harmonise with the Victoria and Albert Museum across Exhibition Road.

In the photograph the frontage is shown broken by the road, but there is no necessity for this if for any reason it would be better to continue it for the purposes of either museum.

If the blocks C, D, E, were built on first, the combined area of the building, just over three acres, would be a little less than that of the Natural History

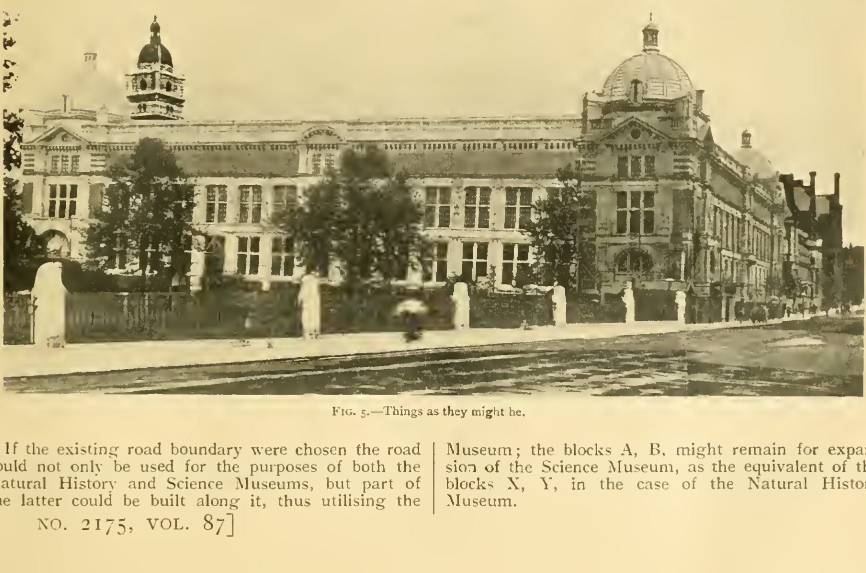


FIG. 5.—Things as they might be.

If the existing road boundary were chosen the road could not only be used for the purposes of both the Natural History and Science Museums, but part of the latter could be built along it, thus utilising the Museum; the blocks A, B, might remain for expansion of the Science Museum, as the equivalent of the blocks X, Y, in the case of the Natural History Museum.

I believe that if such a scheme as this were put forward as a compromise, those who declined to consider it as a way out of the present *impasse* would put themselves in the wrong, in the minds of straight-thinking people who know the history of the question and the requirements of science taken as a whole.

It must be remembered that these museums, to obtain their highest use, must be in close association with institutions in which teaching of the corresponding sciences is carried on, and reciprocally the institutions for higher teaching and research which are already housed at South Kensington require museums of the several sciences in the immediate neighbourhood. In view of these requirements, the removal of one or other of the museums to a distant site is not a practicable alternative. By the compromise here suggested a real Science Museum, in its widest sense, would be established, with two branches dealing respectively with the natural history and the physical and mechanical sciences, in immediate contiguity to the Imperial College. It only wants a consideration of the many memorials presented to the Government since 1858, and of the recommendations of the Duke of Devonshire's Royal Commission of 1871, to be perfectly certain that in the future the two museums will be under one master instead of two.

NORMAN LOCKYER.

EARTHQUAKES AND LUMINOUS PHENOMENA.

IN vol. xiv., No. 6, 7, and 8, of the *Bollettina della Societa Sismologica Italiana*, we find a very long paper by Dr. Ignazio Galli on the collection and classification of luminous phenomena observed at the time of earthquakes. After an introduction, he considers that which might be excluded and the difficulties first met with in the formation of a catalogue of the phenomena he discusses. The illustrations which he gives of luminosities and other strange phenomena which have appeared at or about the time of earthquakes are 148 in number. The date of the first is 89 B.C., and the last March 30, 1910. These descriptions occupy 184 pages. The various luminosities are classified under more than twelve heads, and to these are added the number of times that earthquakes have been associated with vapours, smoke, and odours of sulphur or bitumen.

Seismologists have known for years past that certain earthquakes are said to have been accompanied by appearances of the Aurora Borealis, glimmering lights in the sky, fire-balls, *ignis fatui*, lightnings, corrustations and emanations from the soil, but this is the first time so large a collection of these phenomena have been brought together for their consideration.

When resident in Japan the present writer made many experiments extending over some years on electrical and magnetic phenomena associated with seismic disturbances. He also collected material from all parts of the world which bore upon these associations. One conclusion arrived at is that it is an undoubted fact that at the time of certain large earthquakes, as, for example, the one which in 1906 destroyed Valparaiso, curious lights which, in this instance, were compared to those of chain lightning, have been seen playing across the hills in the epicentral region. Observations of this nature led the writer to make experiments at Shide, in the Isle of Wight, and at the King Edward VII. Mine at Camborne, in Cornwall. The object was to determine whether there was or was not at the time of a large earthquake a practically instantaneous transmission of energy to distant regions other than that recorded by seismographs. It was observed, and still is observed, by many persons that the face of a very large chalk pit at Shide exhibits, after dull damp days, a flaring luminosity. In a chamber at the end of a tunnel in this pit, a cylinder carrying photographic paper was installed. This cylinder was enclosed in a box, one end of which was a metal plate containing three holes. The plate touched a flat chalk surface. The cylinder took one week to turn; therefore parts of the paper before the holes were very slowly exposed to a chalk surface about 3/16th of an inch distant. On certain weeks the results were nil. Other weeks, after the development of the paper, there were three dark bands corresponding to the position of the holes, suggesting that the chalk had acted like an extremely feeble light. Another experiment was to place small pieces of photographic paper in envelopes, a certain number of which had a small glass window; these were placed against the face of the chalk. The image of the windows was frequently obtained, but nothing more than the effects of damp was found upon the others.

The conclusion arrived at was that the photographic effects were in no way connected with radio-activity, but they were probably electrical. The effects obtained in the granite of Cornwall were very marked and, like those observed in the Isle of Wight, varied in their intensity. As to the possibility of these effects being due to micro-organisms, a number of investigations were made, but there were no indications that organisms obtained from the chalk surfaces were connected with luminosity.

Whether these observations throw light upon differences in climate observed at different places, even though they may be near to each other, is a matter for conjecture, but future researches may show that the well-being of living things on the surface of our earth is more dependent upon its radiations than has hitherto been imagined.

I venture to refer to these experiments to show that the outcome of observations similar to those catalogued by Dr. Galli have not been overlooked in this country.

The 148 detailed descriptions which he has collected are used as subject-matter for twenty-six analyses. For example, did lightnings, thunderstorms, meteors, beams of light, luminous clouds, hot vapours, and other appearances precede, accompany, or were they noted after an earthquake? Dr. Galli says that sixteen of these analyses are nothing but the analytical *résumé* of the various phenomena which have been observed, and they therefore possess a real value which cannot be sensibly altered by any report that is ill-founded or untrustworthy. The remaining ten are provisional conjectures which await the judgment of physicists and seismologists. They will be confirmed or contradicted by future observations. If they fall, either partly or entirely, they will at least have the merit of having put the question as to certain probable causes of luminous phenomena connected with earthquakes. At the same time, as one heartily wishes, they may suggest hypotheses which are better, broader, and more synthetic than those the writer of the paper has brought forward.

Dr. Ignazio Galli is to be congratulated on his work, which directs attention to a neglected branch of seismology. When a face of rock 100 or more miles square is rudely pushed over another face, equal in area, it seems reasonable to suppose that such an adjustment should be accompanied by luminous and other phenomena.

JOHN MILNE.

NOTES.

THE arrangements for the meeting of the International Association of Seismology are now nearly complete. The following foreign States will be represented:—United States, France, Russia, Austria, Germany, Hungary, Belgium, Switzerland, Spain, Greece, Italy, Holland, Rumania, Servia, Bulgaria, and probably also Japan and Norway. At the opening meeting on July 18 the Lord Mayor of Manchester and the Vice-Chancellor of the University will welcome the delegates, and Prof. Schuster, as president, will deliver a short address. On the same day the Lord Mayor will hold a reception in the Town Hall. The council of the University will give a dinner, and Dr. Shaw, the director of the Meteorological Office, will invite the guests to an excursion to view the observatory at Eskdalemuir. Among British men of science, the following have signified their intention of being present:—Sir George Darwin, Dr. Milne, Prof. Perry, Prof. Lamb, Prof. Knott, Prof. Love, Mr. Oldham, Dr. Shaw, and Dr. G. W. Walker.

EARLY on the morning of Saturday, July 1, a school of cetaceans, numbering apparently between fifty and sixty head, was stranded on the beach at Mount's Bay, near Penzance. Judging from an illustration in *The Daily Mirror* of July 3, these cetaceans may be identified with the black-fish or pilot-whale (*Globicephalus melas*), which derives its name of ca'ing whale from the habit of entering bays or inlets in schools, and thus becoming stranded, as in the present instance. Although such events are not uncommon in the Faröes and Shetlands, they are rare further south, and the Mount's Bay case appears to be unique. When the tide rose several of the stranded creatures succeeded in making their escape, but those unable to get away, if not already dead, were shot. Such stranded cetaceans are, we believe, Crown property, and application was accordingly made to the Board of Trade for permission to obtain specimens for the Natural History Museum. This being granted, a taxidermist was dispatched by the night mail on Monday with instructions to prepare skeletons and make preparations of some of the viscera. The largest specimen is stated to be about 25 feet long.

THE fact that on July 3 eleven aëroplanes crossed the Channel from Calais to Dover between 4 and 5.15 a.m. without a mishap is a striking proof—if proof be now needed—of the growing trustworthiness of men, motors, and machines. Accidents rarely occur now to experienced pilots, though their experience is small compared with what is considered necessary to make a first-class motorist. The oldest European pilot now flying has barely three and a half years to his credit, while it is well known that double that time scarcely suffices to produce a racing motorist of the highest rank. The eleven aëroplanes included eight monoplanes: Morane (Védrines), two Déperdussins (Vidart and Valentine), Sommer (Kimmerling), two Blériots (Lieut. Conneau and Garros), R.E.P. (Gibert), and Train (Train); and three biplanes: two Maurice Farmans (Renaux, with a passenger, and Barra), and Bristol (Tabuteau). It is worthy of remark that all the machines had Gnome motors except those of Gibert, who used a 60 horse-power R.E.P., Barra, who had a 70 horse-power Panhard, and Renaux, who had a 60 horse-power Renault. The occasion was the seventh stage of the circuit of Europe—from Paris *via* Liége, Spa, Liége, Utrecht, Brussels, Roubaix, Calais, Hendon, Calais, back to Paris again, a total distance of about 1025 miles. At the time of writing, omitting Valentine, Train, Barra, and Tabuteau, all the above mentioned have completed all the stages up to Hendon. The total times of the first four from Paris stand at present as follows:—Conneau, 51h. 43m. 5s.; Garros, 55h. 37m. 7s.; Vidart, 67h. 47m. 57s.; and Védrines, 70h. 20m. 20s.

AN archæological discovery of some interest has been made at Corfu. Excavations carried on by M. Versakis, the local Ephor of Antiquities, on the site of the ancient city (Palæopolis) of Korkyra, at the expense of the Greek Archæological Society, have resulted in the discovery of fragmentary sculptures belonging to an early temple. The most important fragments are those of a Perseus and Medusa group, which reminds one very forcibly of the metope sculptures of Selinus. The remains of colour on them are reminiscent of the brilliant painting of the early sculptures from the Athenian Akropolis now in the Parthenon Museum. There are other fragments of sculpture, all of interest. The discovery having been made during the stay of the Emperor William at the Achilleion this year, naturally attracted the eager attention of his Majesty, who at once consulted Prof. Dörpfeld, the director of the German Archæological School at Athens, with regard to carrying on the excavations himself. This has now been arranged, and Prof. Dörpfeld will carry on M. Versakis' work at the expense of H.I.M. Prof. Dörpfeld is of opinion that the remains belong to a temple of Apollo, dating to the seventh century B.C., probably. The resemblance of the style of its sculptures to that of the Selinuntine metopes is interesting in view of the fact that both Selinus and Korkyra were colonies of Corinth.

THE International Congress of Naval Architects and Marine Engineers, which is being held in celebration of the jubilee of the Institution of Naval Architects, was opened by the Duke of Connaught on Tuesday, July 4, many delegates of foreign Ministries of Marine and foreign societies being present in the assembly. The congress was to have been held last year, but was postponed in consequence of the death of King Edward. The council of the institution, to do honour to their guests from abroad, has made the following additions to the list of honorary members:—The King of Norway, the King of Spain, the King of Sweden, Prince Henry of Prussia, the Archduke Ferdinand, the Duke of Connaught, the Duke of Genoa, Prince Roland Bonaparte, Lord Rayleigh, Admiral Dewey, Admiral Togo, and Admiral Ijuin. An account of the proceedings of the congress will appear in a subsequent issue of NATURE.

THE fortieth meeting of the French Association for the Advancement of Science will be held this year at Dijon from July 31 to August 5, when M. Charles Lallemand will be the president. The sections of the association and their presidents are as follows:—M. E. Belot, mathematics, astronomy, geodesy, mechanics; M. Galliot, navigation (civil and military), engineering; Prof. Hurion, physics; Prof. Georges Lemoine, chemistry; Prof. Violle, meteorology and physics of the globe; Prof. Collot, geology and mineralogy; Prof. Quéva, botany; Prof. Bataillon, zoology, anatomy, physiology; Dr. Henri Martin, anthropology; Dr. Paul Courmont, medical science; Dr. Delherm, medical electricity; Prof. Grimaud, odontology; M. Lucien Magnien, agriculture; M. Auguste Chevalier, geography; M. Paul Razous, political economy and statistics; Prof. Beauvisage, pedagogy and teaching; Prof. Jules Courmont, hygiene and State medicine; Dr. Simon, archæology. Inquiries may be addressed to the secretary of the association, Dr. Desgrez, 28 rue Serpente, Paris.

THE third International Congress for Sanitary Dwellings is to be held this year, on the occasion of the International Hygiene Exhibition at Dresden, on October 2–7. The congress is to be divided into nine sections, as follows:—Group A: *General.*—Section i. Town-planning (building, forms of country settlement, garden cities, width of streets, height of building). ii. Construction of buildings (planning, distribution of space, building material, foundations, basement, kitchens, lavatories, floors and ceilings, staircases, lifts and roofs). iii. Internal arrangements (lighting, heating, ventilation, furnishing). iv. Sanitation (cleaning, removal of refuse, disinfection). Group B: *Dwelling Houses.*—v. Dwelling houses in towns. vi. Dwelling houses in the country. Group C: *Special Kinds of Dwellings.*—vii. School buildings, boarding-schools, prisons, hotels, lodging-houses, hospitals, convalescent homes, baths, churches, theatres, and other public buildings. viii. Work-rooms and workshops, means of communication and transit (railways, tramways, ships, vehicles, &c.). Group D: ix. Legislation, executive, statistics, &c. Prof. Renk is the president of the congress, and Dr. Hopf the general secretary, and all inquiries should be addressed to him at Dresden, Reichsstrasse, 4. Other communications and money-orders should be addressed: Kongresskanzlei, Zimmer 156, neues Rathaus, Dresden.

So far as is at present known, no fresh cases of plague among the rats have been discovered in the last few days at the riverside wharves at Wapping and Shadwell (see NATURE, June 29, p. 592). *The Times* special correspondent in the issue of June 28 pleads for an organised inquiry into the incidence of plague among the rats in England. He points out that in East Anglia, where plague was present last September, no action had been taken by several of the rural district councils, and that in London only spasmodic attempts at rat destruction have been undertaken. He also condemns as unwise the attitude of the Local Government Board in attempting to suppress knowledge of these recurring outbreaks of plague among the rats. No other country has so much at stake as Great Britain, with her vast carrying trade, and a persistent, elaborate, and prolonged inquiry into the radius of rat-infection is urgently called for.

THE issues of *Travaux de Soc. Imp. des Naturalistes de St. Pétersbourg—C.R. des Sciences* from January to March contain several articles on various groups of invertebrates, for the most part in Russian, notably two by Mr. K. Derjugin on the scientific results of the cruise of the schooner *Alexander Kowalevsky* in the Kola-Fjord during 1908–9.

To the *Sitzungsberichte* of the Vienna Academy of Sciences for December, 1910 (vol. cxix., part i.), Mr. J. Tandler contributes an important memoir on the pectoral muscles of mammals, based on MS. left at his death by the late Dr. E. Zuckerkandl. The anatomy and relationships of these muscles are described in representatives of the various orders, from the opossum to the gorilla and man.

IN reference to the paragraph on African dinosaurs on p. 390 of NATURE of May 18, Mr. F. A. Lucas writes to say that the longest rib of a dinosaur from the western United States, described in 1904 by Riggs under the name of *Brachiosaurus altithorax*, measures 2·74 m., or somewhat longer than the corresponding bone of the African species. The length of the femur is 2·03 m., and that of the humerus 2·04 m. The latter is a little less than the length of the African humerus, but serves to show that the femur is not necessarily the longest of the limb bones. In Mr. Lucas's opinion Brachiosaurus and the African dinosaur may prove to be related.

THE migration of the godwit from eastern Siberia to New Zealand forms the subject of an article by Mr. R. W. Reid in the July number of *Chambers's Journal.* The birds leave the extreme north of New Zealand early in April, and reappear usually in the first weeks of October; and they appear to spend a couple of months in the far north, four months in travelling, and the remaining half of the year in their southern home. They thus enjoy two summers in succession. When they arrive in New Zealand the godwits are in their winter plumage, but those which remain when their fellows fly north assume the brilliant summer dress, although they never breed. These non-migrating birds thus wear a summer livery in winter. It would be interesting to ascertain whether the Antarctic affords suitable breeding-grounds for the species.

MUSK-RATS (genus Fiber) form an exclusively North American group of rodents, with a distribution extending from the neighbourhood of Bering Strait to Arizona and the Gulf of Mexico. With such a range, it is remarkable that they have not hitherto been detected in north-eastern Asia, either in the living or fossil condition. Full details of their taxonomy, distribution, habits, and commercial importance are given by Mr. N. Hollister in a memoir published by the U.S. Department of Agriculture as No. 32 of the North American Fauna. The typical species is divisible into a number of local races, but the Newfoundland musquash (*F. obscurus*) is recognised as a distinct species on account of its inferior size, relatively large hind feet, dark colour, and small and weak skull and teeth. A form from a small area on the coast of Louisiana is likewise ranked as a species (*F. rivalicius*), although it differs from the typical *F. zibethicus* mainly by its somewhat inferior dimensions, duller colour, and darker under-parts. Three extinct species are recognised. In spite of incessant pursuit for the sake of their fur, which is steadily increasing in value, musk-rats continue to hold their own, and, according to the author, will probably become in the future the chief American fur-producer.

INHERITANCE of heterostylism and colour in *Primula sinensis* have provided the subject of extensive experiments by Mr. R. P. Gregory, who presents his latest results in *The Journal of Genetics* (vol. i., No. 2). Colour has to be considered independently for the flowers and stems; when absent from the flowers they are white, and when absent from the stems they are green. Colour may also be distinguished as full or pale. Full-coloured flowers are only produced on deeply coloured stems, although in the horticultural class "Sirdar," where the petals are full-coloured but the pigment occurs in dots, the stems are green. Full colours are dominant to pale; magentas are dominant to reds, and both colours to blue; whites may be dominant or recessive to colours.

A MORE than ordinary amount of critical investigation has been undertaken by Dr. A. S. Hitchcock and Miss A. Chase in the compilation of the monograph on North American species of Panicum, published as vol. xv. of the Contributions from the United States National Herbarium, as may be surmised from the list of herbaria consulted, and is confirmed by examination of the details supplied. The authors take a restricted view of the genus, which is founded on the species *Panicum miliaceum.* In addition to the section of Eu-Panicum, under which seventy-five species are collected, a small subgenus Paurochætium with six species, and a large subgenus Dichanthelium, comprising 110 species, are segregated. The two larger sections are again subdivided into groups named after a leading species. Members of the Dichanthelium section are characterised by distinct vernal and autumnal habits.

The question having been raised whether the timber from teak plantations is as strong as that from natural forests, specimens from trees grown in Burma were subjected to a series of tests, with the results recorded by Mr. R. S. Pearson in Forest Bulletin No. 3 published by the Government of India. The samples were, of course, similar in dimensions, and care was taken to get them as uniform as possible with respect to moisture content. Only in the case of transverse strain did the timber of natural-grown teak give a higher coefficient, and then the difference was small enough to be negligible for practical purposes. Another Bulletin (No. 2), issued with the former, provides a set of diagrams and curves, prepared by Mr. F. A. Leete, to show the relation between age, girth, number of stems, and height of teak trees in fully stocked plantations. The data may be used to determine whether any given area is suitably stocked or if thinning is required.

In *La Géographie* for April M. C. Rabot summarises his own work and that of others relating to the superior limits in altitude of forest trees in Scandinavia, and comes to the conclusion that the retreat of these upper limits is to be attributed to climatic variation or, more exactly, a lowering of the summer temperature, which has been estimated at 2·5° C.

In the Transactions of the Royal Society of Canada Dr. W. Bell Dawson describes in general terms the scope of the investigations carried on by the Tidal Survey of Canada. An important portion of the work has been the establishment of local bench-marks and the determination of their relation to mean sea-level, since no general system of levels yet exists in the country. A number of these have now been fixed, and are described in a recent (1906) report of the marine department, but their connection by lines of precise levelling is still wanting.

Messrs. S. Nakamura and K. Honda contribute a lengthy paper to the Journal of the College of Science at Tokio University on seiches in some lakes of Japan. Starting with a Sarasin limnimeter, a simpler type of portable instrument was found desirable, and each of the authors produced one which was found to be well suited to the investigation in hand. Large-scale records of the curves obtained with these instruments are given in facsimile, and these show the very marked oscillations of the water set up by violent thunderstorms passing over the lake while the record was being taken.

In the *Arkiv för Matematik, Astronomi och Fysik* of Stockholm, Band 6, No. 40, Mr. O. A. Akesson puts forward a method for determining the direction of ice-drift in the neighbourhood of the Pole. Supposing such drift to be rectilinear and uniform, he utilises four altitudes of the sun taken in pairs at about six hours' interval, as long a period as practicable separating the first and last pair. The Greenwich times of the observations are supposed to be known, and, following the method employed by Prof. Charlier, the position of the first point and the direction and rate of drift are obtained. An example from the voyage of the *Fram*, when ice-bound from February, 1893, to August, 1895, is given in illustration of the method.

At a meeting of the Research Department of the Royal Geographical Society, Dr. Strahan presented the fourth report on the investigation of British rivers, which dealt with the Exe, the Creedy, and the Severn. Gauge readings and discharges had been taken frequently, and an interesting determination of the bottom-load moved by the Exe in each of the past seven years was included. The rainfall has also been studied to obtain the ratio of the run-off for the river system and for different tributaries. This most important investigation can only advance slowly on account of the lack of local observations having any considerable continuity and being satisfactorily comparable. Even under the present arrangements, it is difficult to ensure brief flood waves being adequately recorded at all stations, but the results testify the importance of the inquiry and the need for continuing it on as wide a basis as possible.

The meteorological charts for July issued by the Meteorological Committee contain, *inter alia*, timely and useful notes on the cyclonic storms of the Indian Ocean. During that month the south-west monsoon dominates the weather conditions over the Bay of Bengal and the Arabian Sea, and storms over the head of the bay are of comparatively frequent occurrence; the force of the monsoon in the Arabian Sea attains at times thirty to forty-four miles an hour. In the South Indian Ocean cyclonic storms are (so far as available observations show) practically non-existent in July; only one trustworthy storm track is shown there on the chart during a 38-year period. The interesting synoptic weather charts over the North Atlantic for June 8–14 show that a cyclonic area which was formed off Newfoundland on June 11 moved steadily eastward, and at the close of the period was beginning to influence the weather on our extreme western and south-western coasts.

An interesting contribution to *Symons's Meteorological Magazine* for June, by Mr. R. C. Mossman, now attached to the Argentine Meteorological Office, refers to the probable rainfall in the north-east of England during the present summer. On comparing the rainfall at Cordoba for the first quarter of the year for the thirty-three years 1878–1910 with that of the north-east of England for the third quarter, it is seen that the values are generally the reverse of each other, *i.e.* when the rainfall at Cordoba is in excess of the normal during the first quarter, it is in defect over the north-east of England in the third quarter, and *vice versa*. During the first quarter of this year the rainfall at Cordoba was only 46 per cent. of the normal. So far as these statistics go, therefore, there is a distinct suggestion that the present summer (July to September) will have a rainfall in excess of the normal over the north-east of England.

The summary of the weather for the first six months of the present year, which has just been issued by the Meteorological Office, shows that the mean temperature was slightly in excess of the average in all parts of the United Kingdom, taking the period as a whole. The absolute highest temperature in any district during the six months was 84°, in the north-east of England, and 80° has been exceeded in every district except in the north of Ireland and in the Channel Islands, whilst the lowest temperatures are below 20° in every district except in the Channel Islands, the absolutely lowest reading being 11°, in the east of Scotland. The largest aggregate rainfall for the six months January to June inclusive is 24·02 inches, in the north of Scotland, which is 0·58 inch more than the average; but this is the only district with an excess of rain except the east of England, where the aggregate was 10·33 inches and the excess 0·15 inch. The smallest aggregate rainfall in any district is 8·31 inches, in the Midland counties, where the deficiency for the six months amounts to 3·30 inches. The greatest deficiency is in Ireland, amounting to 3·97 inches in the north and 3·88 inches in the south. In the south-east of England, which includes the London area, the aggregate rainfall was 9·97 inches, which is 1·38 inches fewer than the average. The greatest number of rainy days is 106, in the north of Scotland, and the least 73, in the Midland counties. The total duration of sunshine was nowhere very different from the average; there was an excess in all districts except in the north-east of England, the Midland counties, and the Channel Islands, but the deficiency nowhere exceeded twenty hours. The rainfall for the first month of summer was generally in excess of the average; but the difference from the normal was nowhere very great except in the north-east of England, where the excess amounts to 2·20 inches. The duration of bright sunshine for June was generally in excess of the normal. At Greenwich the mean temperature for June was 60·8°, which is 0·5° above the average of the previous sixty years; the first half of the month was much warmer than the latter half, and the rain during the latter half was very much heavier; the aggregate for the month was 0·1 inch more than the normal, whilst the duration of bright sunshine was about twenty-five hours more than usual.

SOME interesting photographs are described by M. Flammarion in the June number of *L'Astronomie*. Apropos of Prof. R. W. Wood's recent experiments in photographing the lunar surface in ultra-violet light, M. Flammarion shows pictures of ordinary objects taken with the sun's invisible radiations, infra-red, and ultra-violet. In one set, taken in full sunlight with the less refrangible rays, white trees are seen projected against a dead-black sky, giving the appearance of a nocturnal snow scene. Another pair of photographs, one ordinary and one ultra-violet, are simultaneous photographs of a man standing; his shadow, very pronounced in the ordinary photograph, has disappeared, through lack of contrast, in the second. But perhaps the most striking pictures are a similar pair in which the camera was pointed towards a landscape so that a part of the latter is seen through a glass window. In the ultra-violet picture the window and the landscape beyond have both disappeared, the window-glass being entirely opaque to the shorter radiations solely transmitted by the screen and the quartz objective.

As a preliminary to the study of the magnetic properties of some slightly magnetic alloys, Mr. H. C. Hayes, of the Jefferson Physical Laboratory of Harvard University, has investigated the errors to which the cooling curves taken in the metallurgical study of an alloy are subject. As these errors are obviously greater the more rapid the cooling, Mr. Hayes has constructed a new crucible which allows the process to be accelerated at will. It is of steel, and to prevent contamination of the melt is lined with a thin coating of lime, which is applied in a special way. The crucible and its contents can be quickly transferred from the furnace to a tank of water. Using an Einthoven string galvanometer with thermo-junctions of copper-constantan, the author finds that with the usual arrangement of the couple in a protecting tube of, quartz or porcelain the lag of the thermo-junction behind the temperature of the melt may, during a rapid cool, exceed 400° C. By using a copper tube deposited electrolytically on the end of the constantan wire, and protecting it by means of a thin coating of lime, he finds that the lag is reduced to a very small quantity, even for the most rapid cooling curves.

A COPY of a report on the analysis of potable spirits by the Government analyst for Western Australia has reached us. Its chief feature is a table setting out in detail the analytical results obtained in the examination of eighty-seven specimens of whisky, of known origin and age, selected from distilleries and other places in Scotland. The author considers, in reference to the evidence given before the recent Royal Commission on Whisky, that there is really less difficulty than was supposed in forming analytical standards for distinguishing between various classes of whisky, namely, "pure malt, pot still" whisky, "grain, patent still" whisky, and "blended" whisky, a mixture of the two. He suggests that definitions should be based, not upon any one constituent, but upon three taken conjointly, the furfural, esters, and higher alcohols being the three chosen. Further, not only should the quantities of each of these reach a stipulated minimum, but the three should bear a certain proportional relation to one another. On these principles definitions are formulated for (1) pure malt pot-still whisky, and (2) for blends containing, respectively, not less than 75 and not less than 50 per cent. of the pure malt pot-still product. The actual figures proposed as standards presume that the particular analytical methods described are employed, and it is admitted that they would exclude some spirits from their proper classes, though the number would be few. There is nothing new in the principle of forming a judgment on the character of a spirit by considering all three of the constituents indicated; probably most alcohol analysts do it, and certainly some have done so for years past. The data now given, however, obtained as they are from a considerable number of whiskies all analysed under strictly similar conditions, will be very useful in any discussion of standard values, whether the particular limits suggested by the author are accepted or not. A similar series dealing with Irish whiskies would be valuable.

THE first part of the fifth volume of the Journal of the Institute of Metals has been received. The first section of the book, which runs to 423 pages, contains a full account of the annual meeting held on January 18 last, and reported in the issue of NATURE for January 26 (vol. lxxxv., p. 429). The report of the council for the year 1910 is included, and the presidental address by Sir Gerard A. Muntz, Bart., entitled "'The Reason Why': the Quest of the Institute of Metals," is printed in full. The second section is devoted to abstracts of papers relating to the non-ferrous metals and the industries connected therewith; while the third contains the Memorandum and Articles of Association and a list of members.

MESSRS. J. AND A. CHURCHILL have in preparation, for publication early next year, a new annual entitled "Who's Who in Science," to be edited by Mr. H. H. Stephenson, and to contain the names of leading representatives of science throughout the world, as well as statements of their chief works.

OUR ASTRONOMICAL COLUMN.

WOLF'S COMET, 1911*a*.—In No. 4508 of the *Astronomische Nachrichten* Prof. Max Wolf states that he rediscovered his comet, on June 20, on a plate taken for that purpose. The position, for 1855·0, was 18h. 43·7m., +13° 25′, at 12h. 4·9m. Königstuhl M.T., on June 19. 18h. 43·7m., +13° 25, at 12h. 4·9m. Königstuhl M.T. The object has a stellar nucleus of magnitude 15, or brighter, lying eccentrically in an extremely faint nebulosity of 20″ diameter. According to M. Kamensky's ephemeris, the positions for July 6 and 14 are 18h. 31·6m., +15° 0·5′, and 18h. 24·5m., +15° 15′, respectively.

THE RADIAL VELOCITIES OF NEBULÆ.—Prof. Campbell, writing to the *Astronomische Nachrichten* (No. 4508), urges that as many radial velocities of nebulæ should be determined as is possible.

Keeler's observations of the radial velocities of twelve planetary nebulæ show that these objects probably have very high actual velocities, something of the order of 25 km. per second. On the other hand, observations of the Orion nebula, and others, indicate that these extended nebulæ have very low radial velocities, or are at rest relatively to the stars of our system. If these facts can be accepted as a generalisation, many problems connected with stellar evolution are opened up. For example, it is suggested that the extended, amorphous nebulæ are masses of primordial substance antecedent to the stellar state, whereas the quickly moving planetary, or condensed, nebulæ are the results of collisions, or near approaches, &c., of rapidly moving aged stars. Some support is given to this suggestion by the observation that helium (early) stars show but small radial velocities (6 km.), whereas the older, reddish stars give much higher (16 or 17 km.) velocities.

THE INTERFEROMETER IN THE STUDY OF NEBULÆ.—In the June number of *The Astrophysical Journal* (vol. xxxiii., No. 5, p. 406) MM. Fabry and Buisson describe an apparatus they have employed in the spectroscopic study of nebulæ. This apparatus is compact and light, and can readily be attached to any telescope of sufficient aperture for the work. They have used it with the Marseilles refractor of 10 inches (26 cm.) aperture and 10 feet (3·1 metres) focal length, and have secured useful observations of the Orion nebula; but a reflector of large relative aperture would be much better for the work, because of its achromatism.

The method is capable of giving very accurate measures for the wave-lengths of the different nebula lines, and, therefore, using the hydrogen lines should give the radial velocity with great precision. By finding the variations of wave-length from one part of the nebula to another, the circulatory movements of the gas might be determined.

THE ROTATION OF STARS ABOUT THEIR AXES.—In a note published in No. 7, vol. lxxi., of the Monthly Notices (p. 578), Prof. George Forbes makes an interesting suggestion on the possibility of determining the rotation of stars about their axes and the direction of the axes. In the case of the sun this rotation causes a displacement of the lines in the limb spectra, which in the case of the integrated light of the stars would become a broadening of the lines. But if the star is an Algol variable the light from each limb is periodically arrested by the eclipsing satellite, and the spectral lines should then show broadening on one side only. When the other end of the bright star's equator is eclipsed, broadening on the other side of the line would result. Relatively this would amount to a periodical displacement of the lines about a mean position, such as has been observed in some cases, and a measure of the displacement might provide material from which the direction of the star's axis and the velocity of equatorial regions of the star could be approximately deduced.

THE TAILS OF COMET 1910*a*.—From Prof. K. Pokrowski, of the Dorpat Observatory, we have received an interesting monograph dealing exhaustively with the several tails of comet 1910*a*. From fifty-nine observations made by various observers—many of which were recorded in these columns—Prof. Pokrowski determines the positions of different points in the tails, and then calculates the time at which the matter forming them was ejected and the value of the repulsive force which drove them away from the nucleus. He thus finds that the chief tail conforms to Bredichin's second type, the repulsive action being about equal to the gravitational attraction; the western branch of the tail was probably ejected, under rather greater repulsive force, from the nucleus about January 18.

The second, smaller tail, belongs to the third type, being formed under a repulsive force considerably less than the gravitational repulsion by particles which left the nucleus about January 16. The anomalous tail, directed towards the sun, is likened to those of comets 1844 III., 1862 III., and 1882 II., where the particles left the nucleus with a very small velocity, in this case about 0·5 km. per second.

CONFERENCE ON EDUCATION AND TRAINING OF ENGINEERS.

THIS conference, organised by the Institution of Civil Engineers, held its meetings at the rooms of the institution on June 28 and 29, under the presidency of Mr. Alexander Siemens. The subjects were discussed under three sections, general education, scientific training, and practical training, the chairmen of these being respectively Mr. Anthony G. Lyster, Dr. W. C. Unwin, and Mr. R. Elliott-Cooper. There were very large attendances at all of the meetings.

In opening the conference, the president stated that the council of the institution had endeavoured to define the scope of discussion by declaring that its object was to consider the methods of preparation to be adopted by those who contemplate entering the engineering profession in compliance with conditions laid down by the by-laws for election into the institution. In addition to a sound general education, to a competent knowledge of science and to practical training, there is the necessity common to all professions, which Prof. Max Müller defines thus:—"... No science and no art have long prospered and flourished among us, unless they were in some way subservient to the practical interests of society ... that interest depends on the practical advantages which society at large derives from these scientific studies." This principle may be expressed by saying that a young engineer should be educated so as to become a dividend-earner for his employer, for this is the most trustworthy indication of his merit. He should possess some knowledge of business methods and of law, and he will find one or more modern languages very useful in obtaining remunerative employment. No definite resolutions would be taken on the subjects under discussion, as the object of the conference is rather to form opinion than to arrive at and to record definite conclusions.

Sir Wm. White directed attention to the danger of too much devotion to the theoretical side. At one time training in engineering science could scarcely be obtained, but there was a modern tendency to go too far in the other direction at the expense of the practical side of the engineer's training. The evils of coaching for examination purposes were also pointed out by the same speaker. Sir J. Wolfe Barry justified the introduction of admission to the institution by examination, and considered that in the engineer's course of training the general education of an accomplished gentleman should not be lost sight of.

Mr. Anthony G. Lyster considered that education, to be of real value, should not only furnish information and knowledge, but should also train and expand the intelligence and develop that type of character which fits a man to lead the best and most useful life. The demand for special training for the engineer becomes increasingly urgent, and unless he is to be debarred from our universities or public schools, it behoves the authorities to bring their educational standards into line with modern requirements. There is no desire that members of the engineering profession should be engineers and nothing else; on the contrary, every opportunity should be given to the best type of man that the university and public school can produce to start with the best intellectual equipment as an engineer.

In the general education section, Dr. James Gow, headmaster of Westminster School, opened the discussion on literary education and engineering by stating that his experience as examiner in Latin for the institution showed that Latin is seldom included in the preliminary education of an engineer, or that boys who intend to be engineers pay little attention to this subject. It is probable that, where Latin is neglected, no very close study is given to any other language. He did not contend that literary studies are of any direct or immediate use to the engineer; his work must be largely deductive and mathematical, on which a literary education has no bearing. But presumably there are occasions when he is called upon to make use of chemistry or geology, or some other deductive science, and he is not properly equipped unless he has a fair knowledge of these sciences. Now it is notorious, at least to schoolmasters, that a boy who passes from the classical side to the modern side of a school has an immense advantage in inductive science over those who have been educated entirely on modern lines. Latin, as taught with grammar and dictionary, is inductive science almost in the abstract. Again, the engineer is doubtless often called upon to command a gang of foreign workers. The sooner and the better he learns their language the more easily he will control them and direct their labour. The language may be wholly alien to any that is spoken in Europe, yet the necessary elements of language must always be the same. It is undoubtedly the business of the engineer to understand contracts, and to give and receive orders accordingly. These transactions require a careful and exact appreciation of words by whomsoever used. It is too often forgotten that the whole profession of lawyers lives, in the main, on the inability of other people either to say what they mean or to understand what is said to them. Dr. Gow suspects that the time is at hand when it will be advantageous to the engineer to mingle the *utile* with the *dulce*, to discern not only what is mathematically possible, but also what is artistically impossible, not only what is cheap, but also what is nasty. For this purpose some general culture is necessary, such as makes a man liberal in mind and sympathetic to the common run of his fellows. Dr. Gow considers that the best plan is to give a boy a general education, mainly literary, up to sixteen years of age, and at that point to watch him closely and put him to what he wants to learn. If he is clever he will be successful; if he is not clever he will, at least, be happy and proud of his calling.

Prof. Silvanus P. Thompson initiated a discussion on the extent to which mathematical and scientific subjects should share with other subjects of literate education the attention of schoolboys who intend to enter later the engineering profession. In the present chaos of secondary education, the schools of the type which chiefly furnishes boys to the engineering profession are almost wholly destitute of any organisation adapted to that end. Not one, so far as the speaker knew, has any definite educational goal to set before the majority of its boys. In general, schoolmasters devote their energies to preparing a few scholarship candidates, and have no definite educational aim whatever for the bulk of the boys. Until this hopeless state of things is radically altered, and until the goodness or badness of a school is adjudged, not by the triumphs of a few, but by the proportion of all its scholars whom it brings to a maturity test, British education will continue to be in a bad way. In all German secondary schools there is a perfectly definite goal before every boy in the school. Before he reaches the topmost class he will have to pass the Einjährige examination, or pass out disgraced. Three years later, if he passes the Abiturient examination, the way is open for him to any university and to any professional career; otherwise he is marked as unfit for professional life. Here, with us, the State (save in Scotland) has not yet organised the secondary schools. Each university wastes its energies over holding matriculations and the like. Almost all the professional bodies hold amateur matriculations or preliminary examinations of their own. The result, educationally, is muddle, waste, inefficiency. The schoolmasters, in despair at the multitude of twenty conflicting matriculations, fix upon none, and let chaos work.

Prof. Thompson is in agreement with the recommendations of the report of the committee of the Institution of Civil Engineers, given 5½ years ago, on the studentship examination. These briefly are:—(1) specialisation at school is undesirable; (2) a leaving examination for secondary schools, similar to that in existence in Scotland and in Wales, is desirable throughout the United Kingdom; (3) instruction in mathematics should be by somewhat modified methods; (4) a general knowledge of elementary physics and chemistry or natural philosophy is preferable to the pursuit in detail of some particular department in science.

At school, the first object of science teaching should be to evoke interest, not to impart the facts or data of science, still less to systematise their rediscovery. All that has its place later. Even the driest subject can be made thoroughly attractive by a live teacher who handles his subject in a human way. A bad teacher can make even electricity as dull and distasteful a subject as the conjugation of irregular verbs. One difficulty which has been explained by masters of progressive tendencies in seeking to introduce mathematical reforms such as that which has come about in the past few years has been the stupidity of inspectors, who have not yet grasped the importance of the reforms. The benumbing influence of all the older Cambridge traditions is also felt. Bad teaching is responsible more than anything else for distaste for mathematics. A really capable teacher will make his boys enthusiastic over matters that in the hands of others are deadly dull.

The greatest change which has come over the teaching of mathematics is the almost complete disappearance of Euclid. Prof. Thompson is not sure whether the loss is not greater than the gain. The teaching of Euclid was in one respect absolutely invaluable. If approached rightly, after practice in geometrical drawing, the study of Euclid constitutes an unrivalled training in methodical and cogent reasoning. But Euclid is gone, and there has been no satisfactory substitute for it. It is the opinion of Prof. Thompson that boys nowadays are less capable of following a sustained train of thought than they used to be.

In the conflict of subjects, one is apt to lose sight of the fact that training in thinking and in the correct expression of thought is more essential than the study of any particular subject. In all studies—science, mathematics, language, or literature—there should be cultivated precision in the use of words and cogency in modes of thought. These things are vastly more important in the ultimate making of a professional engineer than the acquisition of a hoard of scientific facts. The secondary school must not degenerate into a house of cram.

Sir John Wolfe Barry agreed with Dr. Gow that specialisation should not commence too early. A general training should be given in early life, as it was impossible to attain to such later. His own early training had not been directed towards engineering, and he considered that this had been to his advantage.

Mr. Theodore Reunert, of Johannesburg, hoped that the conference would lay down a definite course of training for engineers. In other professions parents could obtain definite information regarding the course of study and training through which their sons must proceed; in engineering no such information is available.

Dr. W. H. D. Rouse thought that specialisation before sixteen or seventeen was wrong. In his opinion, Prof. Thompson had not spoken too strongly in regard to the evils of examinations. Examinations were generally of an undesirable character, and their continued multiplication was a great evil. Prof. Thompson's remarks about German examinations being conducted by cooperation between the State and the teachers were of value, and he considered that such was the only way that was fair to the teachers.

Mr. W. Whitaker, F.R.S., could not confirm the view that culture could be obtained only in early life. Dr. Gow had emphasised the educational value of literature; there was nothing like leather, and he noticed that Dr. Gow was a Doctor of Literature. Mr. Whitaker agreed with Prof. Thompson's remarks on the teaching of Euclid. He believed that English was taught very badly, and that scientific men in this respect were as badly trained as the majority of people, and worse than most.

Dr. R. Mullineux Walmsley thought that the lack of a definite educational aim in England was due to defective public opinion. In this respect matters were much better in Scotland. The statement which had been made that universities had to hold matriculation examinations because they wanted the fees was true, and if the London University gave its examinations up it would be bankrupt —a scandalous state of affairs.

Prof. W. S. Abell considered Euclid to be the basis of the English system of mathematics, and that the Institution of Civil Engineers should insist on its being taught.

Colonel J. E. Capper said that a mechanic might be able to lay a railway, but an engineer, in addition, should be able to say if it was necessary to lay it at all. To answer such questions, a general literary education was necessary.

Mr. T. H. Bailey suggested that Prof. Thompson had missed the aim of public-school life, which was not to turn out professional men, but to give a general grounding and moral training.

Both Dr. Gow and Prof. Thompson in their replies agreed on the undesirability of having a rigid examination for all students. But schoolmasters certainly desired the laying down of a general course which might be available for the information of parents.

Prof. Alfred Schwartz opened the question of specialised entrance examinations for university or college courses of study in engineering, and is of opinion that a satisfactory standard of general education should be attained, and should not include specialised subjects germane to engineering science. This examination should admit to all faculties. The secondary-school training of the engineer should be on as liberal lines as possible, since his subsequent training is largely materialistic. What is wanted in the engineering courses is a supply of students with a wide mental outlook, whose faculties have been well trained and evenly developed, and any specialisation in the secondary schools at the expense of this liberal training is to be deprecated.

Mr. J. T. Jackson considered that entrance examinations should be so framed as to be capable of being passed by students of good general education only. His own experience was that men who commenced engineering at an early age were less successful generally than those who commenced at a later age.

Prof. W. C. Unwin considered that some early specialisation was desirable. Boys of eighteen, without such specialisation, had to look forward to three years of study and three years of practical work before being in a position to take responsible posts. This would bring them to twenty-four years of age before they were capable of earning a living. Not much was asked for, but he thought that a boy of eighteen might be expected to be prepared in part for his future career. He did not agree, as the result of his experience at Coopers Hill and at the Central College, with Mr. Jackson's remarks regarding non-success being due to an early start in engineering. Prof. H. J. Spooner pointed out, in regard to mathematical training, that students were now generally given courses in practical mathematics. The result is that few students now took mathematics as a regular study, necessitating much special cramming for mathematical examinations.

In closing the discussion, Mr. B. Hall Blyth said that he thought it would bear some good fruit if it resulted only in the restoration of Euclid to its old place in the schools. He agreed with the many speakers on the dangers of cramming, and thought that the institution, whose own examination was open to the charge, might take these remarks to heart.

Mr. R. Elliott-Cooper, as chairman of the section on practical training, opened the proceedings in this section by saying that it was of importance that all should be agreed, if possible, as to what practical training really means. Real and useful practical training can be obtained only under the actual or commercial conditions which cannot be found in educational establishments. The knowledge which young engineers may obtain from, say, two years in the workshops of a contractor after his college course is completed, should be supplemented by the experience to be gained in an engineer's office. Such experience would include designing, drawing, specifying, and estimating. In a few branches of the profession pupilage does not occupy its former place, but, taking the profession as a whole, inquiry shows that it still holds an important position.

Mr. Alfred F. Yarrow, in dealing with the apportionment of training between practical work and scientific study, took up the social aspect of the question, and gave some suggestions applying to apprentices in or on works far distant from their homes. He was of opinion that a sandwich system of six months in the works and six months at college was desirable. The student living at home during his college term would be under good influences and affectionate surroundings such as were impossible during a lengthy apprenticeship away from home. London colleges especially should so arrange their courses as to render this system available for their students. Further, some member of the staff in the works should be looked upon as an adviser to the apprentices. He should be accessible at all times, and should make a point of interviewing each lad at least once in three months and ascertain if he could be of service to him. He should also keep in touch with the work of lads attending evening classes by personal visits to the local technical schools. This system is of advantage both to apprentices and employers, and would enable the latter to select wisely those apprentices whom it is desirable to retain after the termination of their apprenticeship. It is a notorious fact that employers have often lost the services of many capable men through being ignorant of the talent that has passed through their works.

Mr. William H. Allen, dealing with the case of a student determining to go both to college and to works, was of the opinion that the college course should be taken first. In his experience this is the order of procedure in which will be found the best chance of success. As regards how much study should be undertaken by a pupil during the period of his practical training, Mr. Allen thought that, if a young man does his duty conscientiously in the works from 6 a.m. to 6 p.m., he will find that as much as his health can stand, without burdening it by further serious study at night. A period of training in the workshops extending over three years is desirable, and should not be specialised too greatly.

Mr. F. E. Robertson referred to the deficiencies in the knowledge of elementary science in young men trained in locomotive works who present themselves to him for examination for posts in India. Prof. Arnold said that his experience had been quite different, and cited the case of the Midland Railway, who handle the training of their apprentices in an excellent manner. Prof. Arnold regretted the modern drifting apart of the engineering side and the metallurgical side in the training of engineers. Mr. E. R. Dolby thought that too much was being attempted in the training of an engineer, and that better results would be obtained by subdivision, as is done in the architectural profession.

Mr. E. Benedict thought that people who accepted premiums should also accept responsibility, and advocated the deputing of someone to look after apprentices.

Prof. E. G. Coker regretted the loss of engineering establishments in London, and favoured a six months' sandwich system. Prof. W. E. Dalby found that teaching was much easier to workshop-trained youths than to others. The sandwich system is best if it can be worked; he had asked works to take pupils on this system, but had not always met with success. The premium question presented a difficulty.

Mr. W. B. Worthington, dealing with the question of training in the engineer's office, said that engineering as an art and profession is based upon the matter of design. However good a man's training and experience on constructional works or in the shops may be, it will not, without experience in the engineer's office, make him a civil engineer, although it may make him a good mechanic or contractor.

Dr. W. C. Unwin presided over a joint meeting of the sections on scientific and practical training, and in opening the proceedings gave a carefully considered statement of the relations between the employers and college-trained youths. This is printed in full elsewhere in the present issue.

Dealing with the relation of engineering employers and colleges from the point of view of the practical training of college students, Prof. J. E. Petavel thought that the employer can cooperate in the educational work of the university by a frank and friendly criticism of the methods adopted, and by offering to take college graduates on a six months' trial.

Mr. James W. Horne directed attention to the cases of engineering firms who have developed a keen interest in the better education of those apprentices who start at sixteen years of age. Every encouragement is given to attend evening classes, and several give facilities for attending college on one or two afternoons a week. By these means many have reached a standard of education which enables them to proceed to a college for two or three years' courses. Such apprentices are a valuable asset to the nation.

Mr. Alexander Siemens did not consider it possible to allow apprentices off on one or two afternoons a week. Mr. Hall Blyth referred to the mistaken idea which some engineering professors have that their students are ready, on leaving college, immediately to take a responsible place in the works. Sir Wm. White directed attention to the many cases of swelled-head in college graduates, a matter which interferes with their employment in a good many instances. Reference was also made in the discussion to the plan followed at Bristol, whereby unsuitable students are advised, through their parents, to withdraw from college at the earliest possible moment. (It may be said here that other colleges also follow this procedure.)

Prof. Archibald Barr advocated a six months' sandwich system, and pleaded that engineering institutions should allow a wide latitude in the systems of training that they will recognise. Prof. Henry Louis did not think that the six months' sandwich system is satisfactory, and suggested the course followed by mining students of three years' college followed by three years' practical work.

Mr. John A. Brodie had little sympathy with those who think it necessary that young engineers should work a reduced number of hours in the workshop in order to enable a greater time being given to study. If the youths of our day cannot or will not stand the strain of the severe training which has given good results in the past, they will probably have to take a position behind those who are prepared to do so. There are other lines of life in which young men can acquire both money and position more easily and quickly than in the engineering profession.

Prof. Stephen M. Dixon opened the subject of the value of a university degree in engineering science in relation to professional competence. There is a feeling in some quarters that the university graduate is rather in the way in an engineer's office. Matters, however, in this respect are improving. When engineering firms recognise the advantage of having assistants thoroughly trained in the principles underlying practice, and whose training also specially fits them for adopting new ideas rapidly, they will be only too glad to cooperate with the universities in completing the education of the engineer.

In dealing with the same subject, Prof. Charles F. Jenkin said that an engineering degree may be looked at in three lights: as a guarantee that the holder has had the best theoretical training and has profited to some extent thereby; as the final step in that type of liberal education at the universities of which England is justly proud; as a broad basis on which State recognition of the engineering profession may be founded.

Prof. Fleming attacked vigorously the whole system of degree examinations as being wrong and as liable to pass candidates whose knowledge was of a very scrappy nature, a view which was promptly controverted by another speaker, who said that he had five degree men in his London office and was entirely satisfied with the results. The same speaker had a good word to say for men who had been trained in evening classes; he was of opinion that swelled-head accounted for some failures in graduates, but that these men were of use after they had been got in hand.

Profs. Dalby, Hopkinson, and Goodman dealt with the subject of the position and uses of engineering laboratories in relation to education at college. All agree that small units are of more service in the work of education than the very large pieces of apparatus—steam engines of large power and the like—which used to find favour.

In closing the conference, Mr. Alexander Siemens suggested that schoolmasters should try to agree on a common syllabus for leaving examinations. University teaching should be scientific and wide in its scope; the training of the mind is all-essential. He was of opinion that practical training should begin by a year in the workshops to be followed by the college course, and then back to the workshops again for completion of the practical training.

TOTAL SOLAR ECLIPSE, TASMANIA, MAY, 1910.[1]

IN a short introduction the author and leader of the expedition explains his motive in publishing in full this account of a solar eclipse expedition which was, unfortunately, unsuccessful in its main object. The site chosen for the camp was in very wild, mountainous country on the southern shores of Tasmania, and in these circumstances it is evident that, going as a private party, exceptional provision had to be made for the many details of equipment, transportation, and maintenance of the observers during the period of preparation for the observations. It was with the hope of giving useful information on these questions that the author decided to present the log of his journey at length.

In chapter i. a very interesting account is given of the general preparations for the eclipse, the prospecting journeys for selection of site, that finally occupied being on Hixson Point, Port Davey. After this was settled, some time was occupied in arranging for and purchasing tents, camp equipment, food and drink, and other details necessary for nine persons during a stay of one month. At the camp, nothing was available for food except fish, wallaby, wombats, and kangaroos. A complete list is given of the details of the equipment and stores; in the case of foodstuffs, &c., both the quantities taken out and the amount unused are given, from which future pioneers in this class of work may learn wisdom; for instance, lime juice was evidently not the beverage most sought after, as out of eighteen bottles taken, thirteen are recorded as unused. A very useful item is the actual cost of the expedition, reckoned from Hobart out to Port Davey, the stay there, and back to Melbourne—347*l.*

As a more or less detailed account of the instruments taken out for the work on the eclipse has already appeared in NATURE, it is only necessary here to say that, in spite of most trying and tempestuous weather, the whole apparatus was adjusted ready for the eclipse time. Details of the work involved for each section are given, with very clear photographic illustrations of the progress and methods adopted in transporting the heavy cases over the difficult ground from the shore to the camp site. Provision had been made for obtaining photographs of the corona with telescopes of various apertures and focal lengths, and for the spectrum of the chromosphere and corona with a powerful concave grating spectrograph.

Included is a report on the observations made by J. Brooks for the determination of the astronomical position of the site, and a description of the corona photographs obtained by another party at Queenstown. After examination of these plates, on which the diameter of the moon's image is 4·4 mm., Mr. W. H. Wesley reports that the extensions of the corona were very small, in no part reaching beyond one quarter the moon's diameter from the limb. On a plate submitted by another observer, with a smaller image still, 1·5 mm., the extensions reach about one diameter. The most striking feature was a wide rift, fairly symmetrical with the South Pole, extending for nearly 50° along the limb. There was also a long ray of synclinal character on the east of this southern rift.

The form of the corona appears to be of the type associated with the period intermediate between the maximum and minimum of solar activity.

The volume is illustrated by thirty-five excellent photographic reproductions showing the interior of Port Davey Harbour, incidents in the transportation and erection of the various instruments, a scrub fire which very nearly destroyed the camp, and the photographs of the corona obtained at Queenstown by the Rev. L. S. Macdougall and Mr. J. Booton.

CHARLES P. BUTLER.

[1] Report of the Solar Eclipse Expedition to Port Davey, Tasmania, May, 1910. By F. K. McClean and others. Pp. 42+35 plates. (London: Printed by R. Clay and Sons, Ltd. Plates reproduced by A. E. Dent and Co., Ltd., 1910.)

THE CAMBRIDGE ANTHROPOLOGICAL EXPEDITION TO WESTERN AUSTRALIA.

IN the early part of last year plans were made for an anthropological expedition to Western Australia, and Mr. A. R. Brown, Fellow of Trinity College, Cambridge, who had been re-elected to the Anthony Wilkin studentship, was appointed leader, the main object of the expedition being to study the social organisation and magico-religious beliefs and observances of the natives. Mr. Brown left England at the end of July, 1910. Soon after his arrival in Perth, mainly through the instrumentality of Mrs. D. M. Bates, a donation of 1000*l.* was made to the expedition by Mr. Samuel P. Mackay of that State. This munificent gift is a notable example of public spirit, and it proves that, despite the manifold claims of a very new State on its citizens, there are individuals who have the advancement of pure science at heart. The benefaction was particularly acceptable, as Mr. Brown's modest resources consisted only of the studentship, a gift of 200*l.* from Sir John Murray, and a grant from the Royal Society of 100*l.* Field investigation is very expensive in Australia, partly owing to the great distances that have to be traversed in order to come into contact with the natives, who even then may be in very small bands.

On his first excursion Mr. Brown was accompanied by Mr. E. L. Grant Watson, of Trinity College, Cambridge, who assisted in taking photographs and measurements of natives, and by Mrs. Bates, who for some years has been employed by the Government of Western Australia to collect information concerning the aborigines of the State. Mrs. Bates has a very considerable knowledge of the natives, and her valuable MS. notes have been placed at Mr. Brown's disposal.

In the south-west corner of the State the natives are extinct; the greater portion of the western half of the State is unopened, and mainly desert country; the natives are quite wild, and it is at present almost impossible to get into touch with them. There remains a broad band of country to the east and the Kimberley gold-field district which have been opened up for pastoral purposes or for gold mining. The gold-field blacks are for the most part beggars, and suspicious and treacherous; they are constantly moving from place to place.

In the eastern part of the region, between the Fortescue and Gascoyne Rivers, there are eleven tribes which belong to one type of social organisation. They never practise circumcision or subincision; they have the usual four-class system with the kinship system commonly associated therewith, but cross-cousin marriage is prohibited, and there are specific kinship terms to distinguish own mother's brother's children from tribal mother's brother's children. The members of a clan may eat their totem, which is inherited in the male line, and ceremonies of the *Intichiuma* type are performed for the increase of the totem. Each tribe is divided into definitely circumscribed local groups, the descent of the local group being in the male line. A local group consists mainly, and perhaps in some cases entirely, of persons of the same totem. In most cases the spot at which the ceremonies for the increase of a totem are performed is within the territory of the local group of the men of that totem, but in a few cases a local group contains no totem centre, and the men of the group must journey to some neighbouring group to perform these ceremonies. The totemic groups are united into larger social divisions, for which Mr. Brown has not yet found a suitable name. During the last two or three generations many irregular marriages have taken place, which have resulted in the distribution of totems through the four classes. In such cases the children take the totem of the father, but enter the class to which they would have belonged if the mother had taken her proper husband. To the south the tribes are, on the whole, very similar to the above; to the east, north-east, and south-east circumcision and subincision are not usually practised: they have the four-class system, and in some tribes every person has several totems (as many as twelve or more), which are inherited in the male line; these may be eaten, and *Intichiuma* ceremonies are performed. Inland between Fortescue and De Gray Rivers, cross-cousin marriage is not permitted, and no distinction is made between own mother's brother's children (and own father's sister's children) and tribal mother's brother's children.

Scattered sporadically all over the area investigated are found the beliefs that children are the result of food eaten, or that they may be projected by magic into a woman. In all cases these beliefs exist side by side with ordinary totemism and entirely independent of it, and also with a perfectly clear recognition of the normal method of procreation.

Mr. Brown is at present on a six months' visit to uninvestigated tribes, mainly in the north-east of the State.

A. C. Haddon.

EXPLORATIONS IN DUTCH NEW GUINEA.

On Monday, July 3, Captain C. G. Rawling lectured before the Royal Geographical Society on the geographical results of the British expedition in Dutch New Guinea, which was organised by the British Ornithologists' Union, and was led by Mr. Goodfellow until illness compelled his return. The dense tropical jungle of the low plain between the mountains and the coast, the heavy rainfall, and the sickness which incapacitated their carriers, prevented the travellers from reaching the higher portions of the range, but the scientific results, zoological, ethnographical, and geographical, are most valuable. Captain Rawling and Dr. Marshall stayed for some time with the pygmy tribes of the lower hill ranges, and obtained much information concerning their customs, habits, and general character. Subjoined are some extracts from Captain Rawling's paper.

From inquiries made before leaving England, it was decided that the Oetakwa, the mouth of which river was known to lie due south of Carstenz peak, the greatest of the snow-peaks, should be utilised as our line of communication. Prior to our advent but two rivers on the whole of the south-eastern coast of New Guinea had been visited, the Oetakwa and the Mimika, and these had only been explored for a few miles from their mouth. Further inquiries made in Batavia induced Mr. Goodfellow to change his objective from the Oetakwa to Mimika, and this, little as we suspected it at the time, sealed our fate as to all possibility of ever reaching the Snows.

Almost coal-black in colour, and rather exceeding the average European in height, the Mimika coast native, with his splendidly developed muscles, is physically an almost perfect man. But the brutal features of his face, accentuated by the closely cropped head, makes him anything but an attractive creature. The mass of fuzzy curly hair, in which the natives of other districts take so much pride, is here cut off by means of sharpened shells, split bamboo, or an old piece of hoop iron. What remains is closely plaited in ridges. With the loss of hair nearly all love of decoration or ornament seems to have vanished, their dress consisting of a large white shell worn on the stomach, a hollow carved bamboo, or a narrow strip of tree bark beaten soft and pliable. Round the neck a few beads may be strung, while below the knees and around the biceps a narrow band of plaited grass may often be seen. As a further attempt at ornament, a few white feathers of the hornbill may be stuck into the hair, or if a fierce expression is desired, the split beak of the same bird is pushed through a hole in the septum nasi. The women are even less given to trinkets, for, besides the narrow strip of bark hanging down in front and behind, they are as bare as nature made them: poor creatures, they have little time to think of anything but work. Widows are rather favoured in this respect, for their weeds consist of a great poke bonnet, in addition to a bodice and skirt, all of grass. The instinct of self-adornment is, however, very strong, for trade articles, such as beads and cloth, were subsequently not only eagerly sought for but worn on all important occasions. Absolute nakedness was rare amongst the Wakatimi people, for girls wore some form of dress from an early age, and boys took on the garb of manhood at the age of fifteen or sixteen.

The front teeth of the men, but not the women, are in many instances sharpened to a point, a painful process, for the operation is carried out, not by filing, but by chipping the sides away with a piece of iron, or, if this is not available, a hard shell used after the manner of a chisel. The custom of sharpening the teeth is often put down as a sign of cannibalistic practices, but we have no reason to believe that the habit of eating human flesh is ever here put into practice. Certainly during our sojourn amongst these tribes we saw no signs of cannibalism, nor when examining the human bones preserved in every house, did we find any evidence pointing to such a custom. When questioned on this subject, some natives showed abhorrence, whilst others exhibited, at any rate, no great disgust at the suggestion.

Wakatimi, as we afterwards found, was but a sample of other coast villages, consisting of a long row of huts made of pandanas and palm leaves held up by poles cut from the forest. Each new-comer added on his hut to the last, at the same time removing the partition, by this means turning the village into one endless habitation, broken by their respective doorways. The floors were of sand brought from the seashore, and, with the exception of the crudest of fireplaces, other furniture there was none. Skulls and the bones of departed relatives dangled in grass bags from the roof, blackened by the smoke of the fires. Now and again a wood pillow might be seen, otherwise the interior was bare. Outside there stood, ready for instant use, a stone club, a few spears—the heads fashioned from the leg-bones of pig or human beings—or a bow and a sheaf of arrows, to which weapons they flew on the slightest provocation.

The natives of this portion of New Guinea are divided into three classes or tribes. First come the people inhabiting the low-lying ground near the coast and extending inland for about twelve miles, and known to us as the coast natives. Then comes a strip of land practically uninhabited, and above this again, on a level with the headwaters of the Mimika, a race known to us as the up-river natives. Still further north, and inhabiting the foothills, are the pygmies. These three tribes are entirely distinct from one another, having no communication in the north and south direction—even though living on the same river—but passing freely to the east and west. The dividing line is hard and fast, and is not crossed except for occasional purposes of trade.

With the latitudes of Atabo at the coast and Parimau known, and the azimuth obtained, it was easy to fix all the points in the range from Carstenz in the east to Mount Darwin in the west. The height of Carstenz, formerly assumed to be about 18,000 feet, was found to have an altitude of rather more than 16,000 feet, while to the west three more great snow-peaks were discovered, with a height of about 15,500 feet, and these we named Mount Idenburg. Beyond and between these two mountains two other great snow-peaks were visible, evidence that the ground to the north does not fall abruptly away. But more interesting than all was the discovery that the great range, stretching from Carstenz in the east to the Charles Louis mountains in the west, a distance of eighty miles, formed one immense unbroken precipice, culminating in its greater sheer height at Mount Darwin. We were never in a position to measure with the theodolite a greater sheer height of more than 6500 feet, but from many views obtained while climbing, I have no hesitation in stating that the greatest perpendicular height is, at this spot, not less than 10,500 feet, or two miles.

The snow-line is at about 14,500 feet, the glaciers on Carstenz descending lower and falling over the precipice to the south. From a letter received from Lieut. Postema, the naval officer in charge of the survey of the Dutch Expedition on the Oetakwa river, I understand that he is of like opinion that Carstenz mountain is not climbable. The extreme wetness of this district is, without doubt, due to the great altitude and proximity of these mountains, the rainfall being in excess of any other portion of New Guinea.

To sum up the final results of the expedition: large and valuable collections of birds, mammals, reptiles, butterflies, and moths had been formed, together with botanical and ethnographical specimens; a new and unknown race of pygmies discovered, studied, measured, and photographed; a range of mountains, containing the greatest precipice in the world, together with 3000 square miles of country, surveyed and mapped, new snow-mountains found, and many great rivers explored; and a long stretch of coast-line surveyed. We had accomplished the longest cross-country journey ever undertaken in Dutch New Guinea, *i.e.* eleven marches from the up-river camp, had proved the impossibility of the Mimika river as a line of advance to the Snows, and, on the other hand, the value of the great rivers to the east if the same goal is intended. From experience, and our heavy death-roll will bear me out, I have no hesitation in saying, first, that the land is an impossible one to any but a Papuan: and secondly, that, unless most carefully picked, no natives of the East Indies, with the exception of Dyaks from Borneo, are of the slightest value as carriers in South Dutch New Guinea.

WORKSHOP AND COLLEGE.[1]

It is now agreed that engineering training should include scientific instruction and practical and commercial experience. But very divergent views are held as to the relative importance of the different components of such a training and as to the order and duration of each. We must recognise at once that the field of engineering employment is a very wide one, and that different capacities are required in different parts of that field. It is therefore in no way surprising that persons, whose opportunities of observation give them every right to express a definite opinion as to what is best for one special branch of engineering, have arrived at conclusions very different from those held by others, whose field of work has been in a different branch. No system of engineering training can be arranged to meet all special demands, and it is the object of such a conference as this to find out what is most essential in all courses of training and what modifications are practically possible to meet different cases.

First of all, I think it must be assumed that the engineering education we are specially charged to consider is that of young men whose aim it is to arrive ultimately at a professional status, such a status as membership of this institution implies. Their hope is to be employed ultimately in the design and control and direction of engineering work. Of course, some of them may fail in capacity or may lack opportunity, and may drift to one of the many more commercial occupations allied to engineering; and even there the knowledge they have acquired will be a valuable asset. But at the outset a professional career is aimed at, and the system of engineering education must be arranged to meet that condition. It is probably only by educating many that the few can be found who have the capacity and character necessary to achieve considerable advances and to do work of national importance.

Now, very few young men at eighteen can foresee into what line of employment they may be driven, and consequently the first or undergraduate stage of education must be broad, so as to fit students for widely different spheres of work.

Perhaps the greatest defect of engineering education at present is the want of more provision for the higher and more specialised education of the few students of real capacity discovered in the sifting process of an undergraduate course.

In spite of the general acceptance of the view that a study of scientific principles and their application is a necessary preliminary to a practical course in field or workshop, a certain jealousy of college education is still obvious in some practical engineers. While conceding in words that some scientific education is necessary to an engineer, they would, in fact, confine it to very elementary matters. They would greatly restrict the time given to it, and they are disposed to depreciate the value of any higher teaching, and even to regard it as mischievous and likely to unfit a man for the strenuous life of the manufacturing workshop.

I believe the idea that a college course unfits a man for practical work is a wholly mistaken one. There may be students who prove unfit for practical work in spite of college education. They would equally fail if their education was purely practical. There may be college courses, I am afraid it must be said there have been college courses, badly arranged, and teachers in colleges less competent than is desirable. But such things are inevitable. Nothing is more certain than that there has been a great improvement of college teaching of applied science in the last twenty years.

An employer who takes into his works college students is, I think, often disposed to expect from them an immediate availability which is unreasonable. It is not the main object of a college course to make a student acquainted with the details of any particular business; that is the proper object of the first year or two of practical work. It is not the main object of a college course to fit students specially for such work as will fall to them

[1] Opening remarks at a Conference on Education and Training of Engineers (joint meeting of Sections II. and III., Scientific and Practical Training), held at the Institution of Civil Engineers, by Dr. W. C. Unwin, F.R.S., chairman of Section II.

while in the lowest rank of the profession. The college course must contemplate the fitting of a student for his whole career, and provide him with an intellectual equipment which will only gradually become useful as he rises to higher rank in his profession. The view of the employer who looks only to the immediate usefulness of the student is a short-sighted one.

Nevertheless, a college course is an unpractical and badly designed one if, at the end of it, a student is not more capable and useful from the first, in any type of workshop, than a lad without such a training. The college discipline is bad if he has not much more character and energy than the raw lad. His training has been a failure if he does not pick up the specialised details of any business to which he may be put far more rapidly than an untrained lad. I should like to suggest to those practical engineers who are implicitly, if not openly, hostile to college training, who would, at any rate, greatly restrict it, and who advocate lengthened periods of workshop apprenticeship, that they exaggerate the value of such workshop experience as an ordinary apprentice gets. I am not, of course, considering artisan apprentices, but young men expecting to rise to positions of trust. Here and there are works where special trouble is taken with apprentices; but in general apprentices are left to pick up what knowledge they can with very little help, and in many cases, I think, a good deal of their time is absolutely wasted. Some skill of handicraft is no doubt acquired. But the engineer works with his head, not with his hands, and manual skill is of use to him only in very exceptional cases.

I hope I do not in any way underrate the value, to mechanical engineers especially, of that kind of knowledge of materials, of tools, of processes, and of cost which can only be learned in the workshop. But I think practical engineers forget how little of this valuable knowledge really comes to the works apprentice. The engineer of higher rank who discusses matters with foremen and draughtsmen, who has responsibility for design and cost, and is, moreover, in a position to know the reason of all decisions, is learning in the workshop all his life, and naturally sets a high value on the knowledge slowly acquired by years of constant and close observation. So high a value that perhaps he ignores the importance of the scientific knowledge which was, somewhere and by someone, applied in bringing his business to a state in which it can be carried on successfully as a mere manufacture. But the knowledge which comes to those in responsible positions is not open to the ordinary apprentice, and he learns slowly, if at all, unless he brings to the works such a knowledge of principles and methods that he can interpret for himself what he sees. No system of workshop apprenticeship can, I think, be considered satisfactory unless someone is specially charged with care of the apprentices, whose duty it should be to make sure that they have opportunity of seeing a great variety of work and of helping them over their difficulties.

I believe employers will find—some of them have found already—that they owe a debt to the colleges, and that the college-trained student will prove, with a minimum of special experience, a valuable assistant, and in some cases the originator of a real advance in practice. I should like to plead that in return the employer might be a little more ready to give college students a year or two years' run of the works, either without remuneration or with a small remuneration just enough for disciplinary purposes. I do not think there would be any loss in the case of a properly trained student, and the employer would in many cases find an assistant worth keeping and promoting.

GOLD MINING IN THE TRANSVAAL.[1]

THE discovery of gold on the Witwatersrand was made in the year 1885. The growth of the field was at first slow. Some of the earliest workers believed that the auriferous gravel, exposed in shallow open workings, was a superficial deposit of the nature of the alluvial "placers" of California and Australia. The true character of the conglomerate beds was, however, soon realised by those who were fortunate enough to possess some geological knowledge, and by 1887 stamp-mills were in operation, the output from the Witwatersrand mines for that year being 81,045*l*. From 1887 onward the progress has been rapid.

Down to the permanent water-level, at a vertical depth varying from 200 to 300 feet, the conglomerate beds were "free-milling," that is to say, the iron pyrites, with which the gold is intimately associated, had been destroyed by oxidation, thus setting free the gold. Below the water-table the colour of the rock changes from red to blue: the ore becomes pyritic; and the gold is no longer so amenable to recovery by amalgamation, as is the case with the oxidised ore. This was the first difficulty that had to be overcome. Up to the year 1890 the treatment of the Rand ore had consisted of crushing in stamp-mills, and the recovery of 50 to 60 per cent. of the gold, by amalgamation on mercury-coated copper plates. The tailings received no further treatment; they were considered to be valueless, and, where the ground permitted it, were allowed to flow away.

The successful introduction of the cyanide process in 1890 inaugurated a new era in the history of Rand gold mining. It is no exaggeration to say that the great success of the Witwatersrand gold industry is a direct result of the introduction of the cyanide process. For the majority of the mines, the gold won by this process represents the difference between profit and loss, and without it the profitable working of the vast quantity of low-grade banket now being mined on the Rand would be impossible.

At first the pulp from the stamp-mills was run into retaining dams, from which the sand was afterwards dug out and conveyed in Scotch carts or in mine-trucks for treatment in the cyanide vats. On account of the slime-content, only 30 per cent. of the gold left in the pulp from the amalgamating tables was recovered, the remainder being in the untreated slimes and in the residues.

The next step was the introduction of hydraulic classifiers, by means of which a considerable proportion of the slime was eliminated and a sand product obtained, which could be run direct into leaching tanks.

A process was then evolved for the treatment of the slimes. It consisted in causing the slime, overflowing from the sand-collectors, to settle, by the addition of lime, the bulk of the water being subsequently removed by decantation. The concentrated slime so obtained was then agitated with cyanide solution, which was ultimately drawn off by decantation.

The separation of sand from slime by the old-fashioned inverted pyramidal form of hydraulic classifier, and the decantation method for the removal of water or cyanide solution from sand or slime, are now giving place to the use of diaphragm cones and vacuum filters. In the most modern plants the separation of sand and slime in a mill product is effected by feeding the mill-pulp into a cone-shaped collector or diaphragm cone; the sand is drawn off as a thickened pulp from the bottom, while the slime flows over at the periphery, and after passing through a secondary washing cone is freed from most of its remaining water on a Caldecott filter-table, which is a slowly rotating horizontal vacuum filter.

The treatment of slime has been much facilitated by the recent introduction of air-agitation tanks and vacuum-filters, which enable the enriched cyanide solution to be rapidly drawn off from the slime-residue and sent as a clear liquid to the extractor boxes. The precipitation of the gold was effected in the original MacArthur Forrest process by zinc shavings, and this method is still preferred for the rich solutions; but for weak solutions, such as are obtained in the treatment of slimes, zinc dust is employed as a precipitant.

One important result of the perfection of the slimes-treatment process has been the introduction of fine grinding in tube-mills, with consequent increased extraction and shortened treatment period. Further, the adoption of tube-mills has modified the function of the stamp-mill. Stamps are no longer employed for fine crushing, and amalgamation in the mortar-boxes has been completely abolished; and even such plate-amalgamation as took place in front of the stamp-mills has in many cases been done away with. Concurrently with the limitation of the effective range

[1] Abridged from the nineteenth "James Forrest" lecture delivered on June 28 before the Institution of Civil Engineers by Dr. F. H. Hatch, vice-president of the Institution of Mining and Metallurgy.

of the stamp-mill, the weight of individual stamps has been increased by lengthening the heads, until, with the 2000-lb. stamp of the new mill of the City Deep mine, the economic limit of the cam-lifted gravitation stamp appears to have been reached.

Underground, efforts have been made to solve the dust problem. With few exceptions, the Witwatersrand mines are dry mines, and the processes of machine-drilling, blasting, and shovelling consequently create and distribute through the air great quantities of fine dust. The inhalation of the dust-laden air causes a peculiar disease, known as miners' phthisis, a deadly complaint which is responsible for a high mortality among the white miners. By the proper application of water at the point of origin, the formation of dust can, to a large extent, be prevented; and several ingenious contrivances have been invented for catching the dust from the upward holes, into which water cannot be poured from a can, in the manner usually adopted with downward holes. The chief difficulty, however, appears to be to get the men to use the dust-arresters and to water-down the stopes and other working places after blasting. By better supervision and a stricter enforcement of regulations, such difficulties will doubtless be overcome.

In the early days of the Rand, and, indeed, up to quite recently, it has not been found necessary to employ any artificial system of ventilation, the numerous shafts and outlets to the surface of the outcrop mines having sufficed to maintain an ample supply of fresh air. But with deeper levels, fewer communications with the surface, and an increased rock-temperature, artificial ventilation is destined to play an ever more and more important part in the future. It will be impossible to work the deep levels economically without carefully thought-out schemes of ventilation, and for the success of these it will be necessary to have shafts with small frictional resistance and large air space, and to carry the air-current through special ventilating roads.

The ventilation problem has been seriously attacked on the Rand, and already ventilating fans, varying in capacity from 50,000 cubic feet per minute at 1 inch water gauge to 250,000 cubic feet at 4 inches water gauge have been installed at many of the mines. In splitting the air current, the numerous dykes of igneous rock that traverse the Witwatersrand mines in a north and south direction (*i.e.* across the strike) can be made to serve as natural brattices, since they cut up the mines into air-tight compartments. The levels which penetrate these dykes must be permanently closed, or, if used for tramming purposes, closed by double swinging-doors.

Under the changed conditions now prevailing on the Rand, due to the enormously increased size of the properties brought about by recent amalgamations, and the consequent possibility of concentrating a large output on fewer main hoisting shafts than heretofore, the evolution of an entirely new system of underground transport is being accomplished. It is becoming recognised that the rock, broken in the stopes, can only be economically dealt with by handling it on a few main haulage-levels, situated at great intervals apart and driven straight, from point to point, in the footwall of the reef. These main haulage-roads, which are intended to serve also as the intake of the fresh-air current, can, on account of their economic importance, be constructed of large dimensions. They can also be carefully graded and equipped with heavy rails.

The handling of the broken rock in the stopes is, from an economic point of view, scarcely less important than its haulage on the levels. Everything depends on the angle of dip of the reef. In many of the outcrop mines of the Central Rand the high dip of the reef permitted the rock, broken in the stopes, to find its way by gravitation to the tramming-level, where it was drawn off as required from the stope-boxes; but with the dips of from 25° to 30° obtaining in most of the deep-level mines, the broken rock requires to be assisted down the stope-floors by shovelling. Only in the extreme East Rand, where the reef lies very flat (dipping at from 8° to 10°) is it possible to fill the trucks at the stope-faces and to run them thence direct to the tramming-levels. Hand-shovelling is uneconomical, and, moreover, is detrimental to health, on account of the dust it raises. Consequently, several attempts have been made to substitute for it some conveyer system of handling the broken rock. Stope-conveyers are shaking chutes consisting of iron plates. They are suspended by short chains from the roof next to the working face of the stope, and are kept in motion by ropes attached to the upper ends of the conveyers. Many of these shaking chutes are now in use on the Rand.

In the past, the use of machine-drills for stoping has not been looked upon with much favour. For this there are several reasons: first, the machine used was the heavy drill employed for development work, and with this type it was impossible to work in narrow stopes without breaking a large amount of waste; secondly, the bands of barren quartzite, with which the payable conglomerate is often interstratified, suffered such pulverisation by reason of the large blasting charges used that often it could not afterwards be eliminated by sorting; and, thirdly, the large blasting charges were found to weaken the roof, so that a greater number of pillars had to be left for its support than was the case with hand-drilling. Only in wide stopes, on a large homogeneous reef with good walls, could these drills be used to economic advantage. The necessity for a good stoping drill for narrow reefs, however, has become more and more pressing with the extension of the mining industry, with which the supply of native labour for hand-drilling has not kept pace.

By a series of competitive trials carried out under Government supervision, it has been established that machine-drilling in moderately narrow stopes costs no more, and perhaps even less, than hand-drilling by natives. Hundreds of small drills (drilling a hole to take a ⅞-inch explosive) are already employed for stoping on the Rand, and their average duty is three-quarters of a fathom per shift. To stope very narrow and low-grade reefs hand-labour has still to be used; but it is hoped that a drill capable of doing even this class of work will eventually be evolved.

Another important problem which has recently forced itself on the notice of those responsible for the mining operations on the Rand is the support of the hanging wall. The removal of the gold-bearing conglomerate bed, which, except for its somewhat steeper dip, may be compared to a coal-seam, leaves an open space, which is not allowed to fall in, as in a coal mine worked on the long-wall retreating system, but is supported over enormous areas by pillars of unworked conglomerate in the stopes, by ribs left above and below drives, and by pillars left to ensure the safety of the shafts, supplemented in some cases by the stowing of waste rock. These methods have sufficed in the past to keep open the stopes and drives and to protect the shafts; but owing to the robbing of the stope pillars in the outcrop mines, and more especially to the increased pressure of the superincumbent rock mass in the deep levels, serious movements of the hanging wall have lately been making themselves felt, crushing the pillars in the stopes, destroying the ribs above and below the drives, and in some cases even affecting the shaft pillars.

To arrest this untoward movement, which at one time threatened the loss of the main thoroughfares of some of the mines, a system of sand-filling has been adopted. By this system the abandoned stopes and other working places in the mines are filled with sand taken from the residue dumps. The sand is mixed with sufficient water to cause it to flow down pipes in the shafts and to be discharged in the stopes prepared for its reception. Underground, the pulp is conducted by wooden launders to the stope to be filled. Barricades are used to keep the sand in place; but it drains well, and soon packs solid enough to bear the weight of a man. The effluent water is pumped back to the surface. At first it was feared that the cyanide remaining in the sand would be dangerous to the mine-workers; but a little research has eliminated this source of danger. The effluent water from the sand-packs underground shows no trace of cyanide, and no hydrocyanic acid has been found in the air of the stopes which are being filled. The filling of the worked-out stopes will also assist ventilation, since it will prevent the dissipation of the fresh-air current. The system is already in use at many mines, and there is little doubt that it will be universally adopted.

One of the most remarkable economic changes on the Rand is now being brought about by the concentration of the steaming plant at two or three centres, from which power is distributed to the mines by electric transmission or in the form of compressed air. This has largely been the work of the Victoria Falls and Transvaal Power Company. Electrically transmitted power is rapidly supplanting independent steam power for mills, winders, sinking engines, underground hoists, pumps, &c., owing to the favourable rate at which it can be purchased from the power company. The price has been fixed by agreement at 0·561 pence per unit until October, 1912, and thereafter at 0·525 pence. Transmission is effected both by overhead lines (at 40,000 volts along the Rand, and at 80,000 volts from Vereeniging, a distance of 30 miles) and by underground cables (at 20,000 volts). The length of the overhead lines is 150 miles, that of the underground cables 35 miles. A portion of the power supplied by the company is in the form of compressed air for rock-drills.

A considerable economy will be effected by this centralisation of power generation, and the consequent reduction in the number of independent steaming plants. From the price per unit at which the Victoria Falls and Transvaal Company are supplying power, the cost of a horse-power per annum, utilised continuously day and night, can be calculated: it works out at 14*l*. It is not so easy to arrive at the average cost of a horse-power year on the mines prior to electrification, but it is stated to have been 28*l*. In any case, the saving due to the substitution of electric motive-power for steam-power is undoubted, and there is, moreover, the indirect advantage of greater flexibility and more perfect control.

The present position of the industry and the progress to be expected in the future may be illustrated by a few statistics.

Since the discovery of the Field in 1886 to the end of 1910 the Rand has milled 155 million tons of ore, and produced gold to the value of 276,000,000*l*., this being an average of 35·6*s*., or 8·4 dwt. of fine gold to the ton milled. During the same period dividends amounting to 72,416,550*l*. have been distributed, equivalent to 9·3*s*. per ton milled.

During 1910 gold to the value of close on 31,000,000*l*. was produced by crushing 21,500,000 tons of ore; this is equivalent to an average yield of 28*s*. 6*d*., or 6·7 dwt. of fine gold per ton milled. The working costs averaged (from the returns of fifty-six companies) was 17*s*. 7*d*. per ton, giving an average profit of 10*s*. 9*d*. per ton milled.

Seven of the largest companies, crushing close on a quarter of the whole tonnage, are working at an average cost of 13·8*s*. This very remarkable result has been brought about by increasing, to their economic limit, the size of the units used in the various operations, such as trucks, stamps, tube-mills, vats, pumps, &c.; by the simplification of the methods of handling ore; and by replacement, so far as it is economy to do so, of hand-labour by mechanical appliances. Larger units of development and the centralisation of power plant have also contributed to this result; while the amalgamation of the properties into larger units has helped to lower working costs, by permitting a reorganisation of the transport and hoisting arrangements, and by reducing the standing charges.

Future of the Goldfield.—Working at a cost of 13·8*s*. per ton means that the cost of development, extraction, and reduction, including administration, is covered by a recovery of 3¼ dwt. of fine gold per ton. On 5 dwt. ore, therefore, this would allow of a profit of nearly 7*s*. 6*d*. per ton: and over a considerable area of the Rand the average grade of the ore-bodies is not much above 5 dwt. The inclusion of large tonnages of relatively poor reef, which formerly were considered outside the range of practical mining, has been made possible by lower operating costs. The grade of the ore crushed has fallen in consequence. This does not necessarily imply that the increased depth of the mines has (*per se*) caused a falling-off in the actual value of the ore-deposit considered as a whole.

The effect of this increased tonnage and diminished grade on the life of the Rand goldfield as a whole is an interesting subject for speculation. From the data available the production of gold to be expected from the Main Reef series, if worked down to a vertical depth of 6000 feet, may be estimated.

It figures out at 1,046,000,000*l*., which, on the basis of an average output of 30,000,000*l*. per annum, is equivalent to a life of thirty-five years, *i.e.* down to a vertical depth of 6,000 feet. But, if at still greater depths the banket should contain sufficient gold to yield a profit, after deducting the cost of working, we may rest assured that it will be worked. What, then, are the limiting factors? They are generally considered to be (1) the mechanical difficulty of raising the ore to the surface from such great depths, and (2) the effect of the temperature gradient. With regard to the mechanical question, the electrical transmission of power applied to stage-winding has so modified the mining engineer's conception of the depth from which deep hoisting is practicable, that it is now generally assumed that there are no mechanical difficulties that cannot be overcome if it pays to do so. As to the temperature question, figures based on Mr. Marriott's careful experiments, which showed that the rise is only 1° F. for every 208 feet of depth, indicate that the rock-temperature at 7000 feet would not exceed 97·5° F., and with efficient ventilation the air temperature would of course be considerably lower. It follows, therefore, that for all practical purposes the whole question turns solely on the gold content, and what that may be at a vertical depth of 7000 or 8000 feet, no one can tell. This much, however, may be said: the geological structure of the country clearly points to the continuance of the conglomerate or banket beds to still greater depths than even 7000 or 8000 feet, before the bottom of the great synclinal basin of the Witwatersrand is reached; and, beyond that point, the beds must still continue until they rise to form the southern lip of the basin known to exist beyond the Vaal River.

THE FUNDAMENTAL PROPERTIES OF THE ELEMENTS.[1]

THE mystery that enshrouds the ultimate nature of the physical universe has always stimulated the curiosity of thinking man. Of old, philosophers sought to solve the cosmic problem by abstract reasoning, but to-day we agree that the only hope of penetrating into the closely guarded secret lies in the precise estimation of that which is tangible and visible. Knowledge of the actual behaviour of material and of energy provides the only safe basis for logical inference as to the real essence of things. Faraday was deeply imbued with this conviction; and it is widely recognised as the basis of all modern experimental science. The subject of my lecture to-night concerns the methods and general results of several extended series of investigations, planned with the hope of adding a little to the foundations of human knowledge by means of careful experiment.

At the outset let me remind you of an old saying of Plato's, for it sounds the keynote of the lecture:—"If arithmetic, mensuration, and weighing be taken away from any art, that which remains will not be much."[2] In other words, the soundness of all important conclusions of mankind depends on the definiteness of the data on which they are based.

Lord Kelvin said:—"Accurate and minute measurement seems to the non-scientific imagination a less lofty and dignified work than looking for something new. But nearly all the grandest discoveries of science have been the rewards of accurate measurement and patient, long-continued labour in the minute sifting of numerical results."[3] The more subtle and complicated the conclusions to be drawn, the more exactly quantitative must be the knowledge of the facts.

Measurement is a means, not an end. Through measurement we obtain data full of precise significance, about which to reason; but indiscriminate measurement will lead nowhere. We must choose wisely the quantities to be measured, or else our time may be wasted.

Among all quantities worthy of exact measurement, the properties of the chemical elements are surely some of the most fundamental, because the elements are the vehicles of

[1] Abridged from the Faraday lecture delivered before the Chemical Society by Prof. T. W. Richards on June 14.

[2] Plato, "Philebus" (trans. Jowett), 1875, vol. iv., p. 104.

[3] Sir W. Thomson (Lord Kelvin), address to British Association, August, 1871, "Life," ii., 600.

all the manifold phenomena within the range of our perception.

Weight is clearly one of the most significant of these properties. The eighty or more individual numbers which we call the atomic weights are perhaps the most striking of the physical records nature has given us concerning the earliest stages of the evolution of the universe. They are mute witnesses of the first beginnings of the cosmos out of the chaos, and their significance is one of the first concerns of the chemical philosopher.

Mankind is not yet in a position to predict any single atomic weight with exactness. Therefore the exact determination of atomic weights rests upon precise laboratory work; and in order to arrive at the real values of these fundamental constants, chemical methods must be improved and revised so as to free them from systematic or accidental errors.

What, now, are the most important precautions to be taken in such work? These are worthy of brief notice, because the value of the results inevitably depends upon them. Obvious although they may be, they are often disregarded.

In the first place, each portion of substance to be weighed must be free from the suspicion of containing unheeded impurities; otherwise its weight will mean little. This is an end not easily attained, for liquids often attack their containing vessels and absorb gases, crystals include and occlude solvents, precipitates carry down polluting impurities, dried substances cling to water, and solids, even at high temperatures, often fail to discharge their imprisoned contaminations.

In the next place, after an analysis has once begun, stance into the balance case.[1] Every substance must be collected and find its way in due course to the scale-pan. The trouble here lies in the difficulty in estimating, or even detecting, minute traces of substances remaining in solution, or minute losses by vaporisation at high temperatures.

In brief, "the whole truth and nothing but the truth" is the aim. The chemical side of the question is far more intricate and uncertain than the physical operation of weighing. For this reason it is neither necessary nor advisable to use extraordinarily large amounts of material; from 5 to 20 grams in each experiment is usually enough. The exclamation, "What wonderfully fine scales you must have to weigh atoms," simply indicates ignorance; the real difficulties precede the introduction of the substance into the balance case.[1] Every substance must be assumed to be impure, every reaction must be assumed to be incomplete, every measurement must be assumed to contain error, until proof to the contrary can be obtained. Only by means of the utmost care, applied with ever-watchful judgment, may the unexpected snares which always lurk in complicated processes be detected and rendered powerless for evil.

That the atomic weights may be connected by precise mathematical equations seems highly probable; but although many interesting attempts have been made to solve the problem,[2] the exact nature of such relationships has not yet been discovered. No attempt which takes liberties with the more certain of the observed values is worthy of much respect. It seems to me that the discovery of the ultimate generalisation is not likely to occur until many atomic weights have been determined with the greatest accuracy. No trouble being too great to attain this end, the Harvard work will be continued indefinitely, and attempts will be made to improve its quality, for the discovery of an exact mathematical relationship between atomic weights would afford us an immeasurably precious insight into the ultimate nature of things.

But weight is only one of the fundamental properties of an element. Volume is almost, if not quite, as important in its own way, although far more variable and confusing. All gases, indeed, approach closely to a simple relationship of volumes, defined by the law of Gay Lussac and the rule of Avogadro, and well known to you all. In the liquid and solid state, however, great irregularities are manifest, and very little system as regards volume is generally recognised.

About twelve years ago, the study of such small irregularities as exist among gases led me to the suspicion of a possible cause for the greater irregularities in liquids and solids.[1] On applying van der Waals's well-known equation to several gases, in some tentative and unpublished computations, it seemed clear that the quantity b is not really a constant quantity, but is subject to change under the influence of both pressure and temperature. This conclusion has also been reached independently by van der Waals himself.[2] But if the quantity b (supposed to be dependent upon the space actually occupied by the molecules) is changeable, are not the molecules themselves compressible?[3]

The next step in the train of thought is perhaps equally obvious. If changes in the bulk of molecules are to be inferred even from gases, may not the expansion and contraction of solids and liquids afford a much better clue to the relative expansion and contraction of these molecules?

Most physical chemists refer all changes in volume to changes in the extent of the *empty space* between the molecules. But are there, after all, any such empty spaces in solids and liquids? Solids do not behave as if the atoms were far apart within them; porosity is often conspicuous by its absence. Take, for instance, the case of glass; the careful experiments of Landolt on the conservation of weight[4] show that glass is highly impermeable to oxygen, nitrogen, and water for long periods. Such porosity as occurs in rigid, compact solids usually permits the passage only of substances which enter into the chemical structure of the solids themselves. Thus nitrogen cannot free itself from imprisonment within hot cupric oxide, although oxygen can escape;[5] again, water cannot evaporate into even the driest of atmospheres from accidental incarceration in crystals lacking water of crystallisation.[6] Palladium, on occluding hydrogen, is obliged to expand its bulk in order to make room for even this small addition to its substance. The behaviour of platinum, nickel, and iron is probably analogous, although less marked.[7] Fused quartz, impermeable when cold, allows of the passage of helium and hydrogen at high temperatures;[8] but most other gases seem to be refused admission, and very many solid substances appear to act as effective barriers to the passage of even hydrogen and helium, especially when cold. In these cases, as in so many others, the so-called "sphere of influence" of the atom is the actual boundary by which we know the atom and measure its behaviour.[9] Why not call this the actual bulk of the atom?

From another point of view, the ordinary conception of a solid has always seemed to me little short of an absurdity. A gas may very properly be imagined with moving particles far apart; but what could give the rigidity of steel to such an unstable structure? The most reasonable conclusion, from all the evidence taken together, seems to be that the interstices between atoms in solids and liquids must usually be small even in proportion to the size of the atoms themselves, if, indeed, there are any interstices at all.

Very direct and convincing evidence of another sort is at hand. The idea that atoms may be compressible

[1] Richards, "Methods Used in Precise Chemical Investigation," published by the Carnegie Inst. of Washington, 1910, No. 125, p. 97.

[2] See especially Rydberg, *Zeitsch. anorg. Chem.*, 1897, xiv., 66.

[1] Richards, "The Significance of Changing Atomic Volume," Proc Amer. Acad, 1901, xxxvii., 1; 1902, xxxvii., 300; 1902, xxxviii., 293; 1904, xxxix., 581; *Zeitsch. physikal. Chem.*, 1902, xl., 169, 597; 1903, xlii., 129; 1904, xlix., 15.

[2] Van der Waals, *Zeitsch. physikal. Chem*, 1903, xxviii., 257. His earlier publication on this topic (Proc. R. Akad. Wetensch. Amsterdam, 1898, xxix., 138) was unknown to me at that time. See also Lewis, Proc. Amer. Acad., 1899, xxxv., 21.

[3] Van der Waals speaks cautiously, but with some conviction, as to the probable compressibility of the molecules on p. 283 of the paper cited above.

[4] H. Landolt, "Über die Erhaltung der Masse bei Chem. Umwandlungen," *Abhandlung der konigl preuss. Akad. der Wissenschaften*, 1910.

[5] Richards, *Zeitsch. anorg. Chem.*, 1892, i., 196; Proc. Amer. Acad., 1893, xxviii., 200.

[6] Baker and Adlam, Trans., 1911, xcix., 507.

[7] Richards and Behr, Publ. Carnegie Inst., 1906, lxi.

[8] Jacquerod and Perrot, *Compt. rend.*, 1907, cxliv, 135.

[9] Since these ideas were first advanced, Barlow and Pope have brought forward much interesting evidence concerning the significance of the volumes of solids and liquids, which supports the idea that the atoms are closely in contact with one another (Trans., 1906, lxxxix., 1675; 1907, xci., 1150; 1908, xciii., 1528; 1910, xcvii., 2308).

receives striking confirmation from a recent interesting investigation of Grüneisen[1] concerning the small effect of low temperatures on the compressibility of metals. The average compressibility of aluminium, iron, copper, silver, and platinum falls off only 7 per cent. between the temperature of the room and that of liquid air. Extrapolation of the curves indicates that at the absolute zero very little further diminution should occur. So far as we can guess, therefore, the hard metals are almost as compressible at the absolute zero as at room temperatures. But at the absolute zero all heat-vibration is supposed to stop; hence this remaining compressibility must needs be ascribed to the atoms themselves.

If the atoms are compressible, all mathematical reasoning which assumes them to be incompressible rests upon a false basis. The kinetic theory of *gases* remains unmolested by these considerations, except as they indicate the changeability of b in the equation of van der Waals, but the new views affect seriously the application of this equation to solids and liquids.

Let us proceed to trace a few of the outcomes of our hypothesis. If atoms may really be packed closely together, the volumes of solids and liquids should afford valuable knowledge concerning the relative spaces occupied by the atoms themselves under varying conditions. The densities of solids and liquids then assume a significance far more interesting to the chemical philosopher than before, because they have a more definite connection with the fundamental nature of things.

An apparent objection at once suggests itself; if the particles in condensed material are really touching one another, how can we account for heat within the material? Would such closely packed atoms be able to vibrate?

The theory of compressible atoms supplies as one of its own corollaries the immediate answer to this question. If atoms are compressible throughout their whole substance, they may contract and expand, or vibrate within themselves, even when their surfaces are prevented from moving by being closely packed together. It is thus possible to conceive of a vibrational effect, even in contiguous atoms, provided we can conceive of these atoms as being elastic throughout all their substance. Agitation sufficient to produce even the Brownian movement might easily exist in such a system.

Clearly there is nothing impossible or obviously contradictory to experimental knowledge in the notion that atoms are compressible; indeed, the old idea of small, hard particles far apart is really more arbitrary and hypothetical than the new conception. The obvious simplicity of the latter is rather in its favour than otherwise, as in Dalton's atomic theory. In general, the more simply a hypothesis interprets the phenomena of nature, the more useful the hypothesis is likely to be, provided, of course, that the interpretation is adequate. The modern philosophy of pragmatism is a good guide in such matters; a theory not obviously illogical should be judged by its usefulness. Let us, then, test the new hypothesis by applying it to other aspects of physical chemistry.

If pressure produces a change in the sizes of the atoms and molecules themselves, may not the actual volumes of liquids and solids be used as a guide to the unknown internal pressures within them? Cannot we thus discover whether or not chemical affinity exerts pressure in its action? To follow this clue, the simplest possible case was chosen at first, namely, the comparison of the contractions taking place on combining several elements in succession with a single very compressible one. The changes of volume occurring during the formation of oxides were first computed; later, chlorides and bromides were studied. According to the theory of compressible atoms, we should expect to find greater contraction in cases of greater affinity. A diagram depicting typical data concerning certain nearly related chlorides strongly supports this inference.[2] One line shows the total change of volume which occurs when a grain-molecule of chlorine combines with the equivalent weight of metal; the other gives the heat evolved during combination. The lines show distinct parallelism; that is to say, reactions evolving much heat manifest great contraction. In cases of this kind, the heat of reaction is usually not very different from the change of free energy; therefore we may infer that greater *affinity* is associated with greater contraction; and it is but a small leap in the dark to guess that the change of volume is *caused* by the pressure of affinity. Since chemical affinity holds two elements firmly together, why should it not exert pressure? And if it exerts pressure, why should not the volume of the system be diminished by this pressure?

Evidently the change of volume in any case must depend not only on the intensity of the pressure exerted by the affinity, but also, among other things, on the compressibility of the substances concerned. The greater the compressibility, the greater should be the change of volume caused by a given pressure of affinity. Before any definite conclusion can be drawn, the differences in compressibility must be taken into account.

These thoughts led to the measuring of the compressibilities of a large number of elements and simple compounds. The previously employed methods for solids and liquids being unsatisfactory, a new and highly satisfactory method was devised for the work done at Harvard. The compressibilities of thirty-five elements and many single compounds were studied by this method with sufficient care to leave no doubt as to their relative values. It became at once manifest that the formation of a compound of a compressible element was attended with greater decrease of volume than the formation of a similar compound of a less compressible element, other things being equal.[1] This is just what the theory leads us to expect, and is a fact inexplicable by any other hypothesis as yet known to me.

Another essential aspect of the theory of compressible atoms is that which concerns cohesion.[2] If the pressure of chemical affinity causes atomic compression, may not the pressure of cohesive affinity also have the same effect? Traube suggested this possibility, but looked at the whole question from a different point of view.[3] The affinity which prevents solids and liquids from vaporising is generally admitted to produce great internal pressure; must it not tend to compress the molecules into smaller space? Molecules with high cohesive affinity (those of substances hard to volatilise) should be much compressed and possess small volume, whereas molecules with a slight cohesive affinity should be more bulky. Moreover, those molecules already much compressed by their own self-affinity would naturally be but little affected by additional pressure. Thus, as regards two substances otherwise similar, the less volatile one would be less compressible, denser, and possess greater surface tension.[4] These outcomes of the theory correspond with the facts in a majority of cases thus far studied; for example, *o*-xylene is denser, less volatile, less compressible, and possesses a greater surface tension than either *m*-xylene or *p*-xylene. Differences of structure and differences of chemical nature sometimes conceal these relations; the parallelism appears most strikingly among isomeric compounds. In brief, the bulk of evidence strongly indicates that cohesiveness as well as chemical affinity exerts pressure in its action, and hence that each plays a part in determining the volumes occupied by molecules.

Thus the computation of the space occupied by either a solid or a liquid becomes a very complex matter. Not only must the various chemical affinities at work be taken into account, but also the cohesive attraction of both factors and products, and the compressibilities over a very wide range of all the substances concerned. Discoverable parallelism in volume changes is to be expected only when one alone of these forces is the chief variable.

The exact mathematical working out of the consequences

[1] E. Grüneisen, *Ann. Physik.* 1910, [iv], xxxiii., 1239. The relative values for the compressibilities recorded in this investigation are doubtless trustworthy, although the absolute magnitudes are somewhat uncertain because they depend on the rather inadequate theory of elasticity.

[2] Richards, Proc. Amer. Acad., 1902, xxxvii., 399; also especially J. Amer. Chem. Soc., 1909, xxxi., 188.

[1] Richards, Proc. Amer. Acad., 1904, xxxix., 581. [2] *Ibid.*

[3] See especially Traube, *Ann. Physik.*, 1897, [iii], lxi., 383; 1901, [iv], v., 548; 1902, viii., 267; 1907, xxii., 519; *Zeitsch. physikal. Chem.*, 1910, lxviii., 289; also Walden, *Zeitsch physikal. Chem.*, 1909, lxvi., 385 Their interpretation depends largely on the application of van der Waals's equation and the complicating assumption of a *co-volume*; however, Walden's very recent paper presents a number of interesting and important relations concerning internal pressure, which seem to demand the assumption of atomic compressibility for their explanation.

[4] Richards and Mathews, *Zeitsch. physikal. Chem.*, 1908, lxi., 449.

is very far in the distance, if, indeed, it can ever be attained. This fact does not, however, militate in the least against the plausibility of the idea. Although mankind has not yet been able to devise a method of mathematical analysis which will solve at one stroke the gravitational relations of three bodies, nature is not on that account prevented from causing three or more bodies to act on one another with the force of gravity, or astronomers from calculating as nearly as may be the consequences by a process of approximation.

Carried through to its logical conclusion, the idea that atoms are compressible gives one quite a new conception of the molecular mechanics of the universe. The influence of atomic compressibilities may be perceived everywhere, and in most cases each fact seems to fit easily and without constraint into its place in the hypothesis. Even apparent exceptions, such as the abnormal bulk of ice, may be ascribed in a reasonable fashion to superposed effects. A detailed discussion of many applications of the theory is impossible here, but a few may be suggested in order to make clearer its possibilities.

The satisfying of each valence of an atom would cause a depression on the atomic surface, owing to the pressure exerted by the affinity in that spot. The stronger the affinity, the greater should be this distortion. Evidently this conception gives a new picture of the asymmetric carbon atom, which, combined with four other different atoms, would have upon its surface depressions of four unequal magnitudes, and be twisted into an unsymmetrical tetrahedron. The combining atoms would be held on the *faces* of the tetrahedron thus formed, instead of impossibly perching upon the several peaks. According to this hypothesis, the carbon atom need not be imagined as a tetrahedron in the first place; it would assume the tetrahedral shape when combined with the other four atoms. One can easily imagine that the development of each new valence would change the affinities previously exercised, somewhat as a second depression in the side of a rubber ball will modify a forcibly caused dimple in some other part. Thus a part of the effect which each new atom has on the affinities of the other atoms already present may be explained.

Many other physico-chemical phenomena assume a new aspect when viewed from the point of view of this idea. New notions of the mechanism of the critical phenomena, surface tension, ductility, malleability, tenacity, and coefficient of expansion are gained. The peculiar relations of material and light, such as magnetic rotation, fluorescence, partial absorption, and so forth, may be referred to the modified vibrations of distorted atoms. The deviations from the exact fulfilment of many older generalisations concerning volume (such as the equation of van der Waals already cited, the comparative volumes of aqueous solutions, especially of electrolytically dissociated substances,[1] and the variations in the crystal forms of isomorphous substances) are seen to be a foregone conclusion. Moreover, the theory, although not necessarily dependent on the modern belief that atoms are built up of numbers of much smaller corpuscles, is consistent with that belief; for would not such an entity be compressible?

The more closely the actual data are studied, the more plausible the hypothesis of compressible atoms appears. Ten years' experience with its interpretations leads me to feel that the idea is highly suggestive and helpful in stimulating new search after truth and in correlating and codifying diverse facts. By such fruit are hypotheses justified.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The following is the text of the speech delivered by Prof. Love in presenting Sir W. T. Thiselton-Dyer for the degree of D.Sc., *honoris causa*, at the Encaenia on June 28:—

Adest nobis ornandus Willelmus Turner Thiselton-Dyer, vir magnam in Botanica laudem adeptus, huius Academiae olim alumnus. Qui cum Dublinii, Corinii, Londonii hanc scientiam profiteretur, docendi rationes ita novavit ut florentissimis totius Europae scholis schola Britannica par fieret. Idem postea regalibus hortis Kewensibus praefectus varia negotiorum genera ad Botanicam pertinentia promovit. Testis est India, Cinchonae Peruvianae, in medendo potentissimae, nunc ferax: testes etiam Taprobane insula et Chryse Chersonesus Heveae Brasiliensis cultrices, cuius arboris virtutes omnibus notissimae sunt. Adeo non solum saluti, sed etiam rei familiari civium hic noster sua opera inserviit.

[1] Baxter has very recently discussed this matter from the point of view of the theory of compressible atoms (J. Amer. Chem. Soc., June, 1911).

MR. J. H. PRIESTLEY, lecturer in botany at the University of Bristol, has been appointed professor of botany at the University of Leeds.

MR. JOHN BLAKEMAN, head of the mathematical department of the Leicester Technical School, has been appointed as principal of the Northampton Technical School.

AN endowment fund of 200,000*l.* has been presented to University College, Reading, with a view to enable it to apply for a charter as an independent university. Of the amount mentioned, Lady Wantage has given 50,000*l.*, Mr. and Mrs. George W. Palmer 100,000*l.*, and Mr. Alfred Palmer 50,000*l.* Mr. Alfred Palmer has, in addition, presented to the college the freehold of four acres of land contiguous to the college site, at present held and used for horticultural purposes by the college under lease from him.

WE learn from *Science* that a gift of 4000*l.* to aid general research in the study of diseases at the Yale Medical School has been announced from an old student. Further gifts of 2000*l.* toward the endowment of the University clinic, and to the Peruvian exploration fund, for the Yale expedition under Prof. Hiram Bingham, have also been announced. From the same source we find that gifts of 20,000*l.* in lands by Messrs. James B. and Benjamin N. Duke, of 10,000*l.* for a new building by Mr. James B. Duke, and of 2000*l.* by Mr. B. N. Duke for improvements, were announced recently at Trinity College, Durham, N.C.

THE General Assembly of the State of Illinois has granted to the University of Illinois for the next two years the sum of 703,860*l.* *Science* says that this is the largest grant ever made by a State legislature to a State educational institution. The General Assembly has not only recognised the immediate needs of the University, but has looked ahead and made provision for the future by levying a one mill tax for the continued support of the University. It is estimated that this tax will yield an income to the University, two years hence, of about 450,000*l.* a year. In addition, the University will receive from the Federal Government and other sources funds that will bring its income to about 400,000*l.* per annum for the next biennium.

SOCIETIES AND ACADEMIES.

LONDON.

Mineralogical Society, June 13.—Prof. W. J. Lewis, F.R.S., president, in the chair.—G. S. **Blake**: Zirkelite from Ceylon. The results of five analyses made on fragments grouped together according to their specific gravity, which ranged from 5·2 to 4·4, showed remarkable variation in the percentage composition, the densest containing about 20 per cent. thoria and little uranium, and the lightest 14 per cent. U_3O_8 and little thorium; the precise formula is uncertain. A few crystals, some simple and some twinned, were met with; they apparently belong to the hexagonal system ($cr = 53° 22'$), the observed forms being $c(0001)$, $m(10\bar{1}0)$, $r(10\bar{1}1)$, $s(20\bar{2}1)$, $d(10\bar{1}2)$, $e(20\bar{2}3)$, and r the plane of twinning; they were opaque in mass, but translucent and isotropic in splinters.—Rev. Mark **Fletcher**: Note on some crystals of artificial gypsum. The crystals, which were formed in the condensing plant of a distillery at Burton-on-Trent, were twinned about 101, and the forms 100, 110, 230, 111 were observed.—L. J.

Spencer: The larger diamonds of South Africa. Historical notes relative to the "Excelsior," "Jubilee," and "Imperial" diamonds were given, together with a tabular statement of the weights of the rough and cut stones in carats and grams, and the percentage yield of the cut brilliants from the rough.—F. H. **Butler**: Brecciation in mineral veins. In vein-breccias due to fracture *in situ* (crush-breccias) replacement of country-rock is a characteristic feature. Where the coarse fragments in a brecciated fissure-vein indicate erosion, removal of fine rock débris may be inferred. Fragments that are angular and uneroded and completely isolated by encrusting material often indicate by shape and position their former existence as a single mass. The quiet removal of such fragments into a vein-cavity after reunion, and also the banding, with concomitant contortion of adjoining soft country-rock, by their cement-substance, may be ascribed to the hydrostatic pressure and the solvent and mineralising properties of the waters which furnished that substance. The coarse constituents of breccia may have been crushed *in situ*, or forced from fissure-walls by earth movements, or detached therefrom by aqueous pressure and solution.—Arthur **Russell**: Prehnite from the Lizard district. Two distinct types of crystals, tabular and prismatic, were recently found by the author on hornblende-schist at Parc Bean Cove, Mullion, Cornwall, the former showing the forms 001, 302, 061, and the latter 100, 001, 110, 061, and the rare form 301.

Royal Meteorological Society, June 14.—A. J. **Makower**, W. **Makower**, W. M. **Gregory**, and H. **Robinson**: Investigation of the electrical state of the upper atmosphere. The object of the experiments described was to measure the electrostatic potentials at various heights above the ground and the currents that flow down an earthed kite-wire. The method adopted was to send up kites or, in still weather, balloons attached to steel wires, provision being made for detaching sections of the wire from the winding drum so that the lower end might be anchored to a long rod of ebonite in order to insulate it from the ground. When this had been done the wire could either be earthed through a galvanometer to measure the current flowing down the wire, or else be connected to an electrostatic voltmeter having a range of 100,000 volts by means of a metallic line passing through glass tubing supported on long insulators to prevent brush discharges to the surrounding air or leakage to earth. Curves are given embodying the results of a series of flights made during the month of August, 1910, the potentials and currents that were measured being plotted as functions of the heights above the ground. The values obtained for the potential gradient near the ground lie between 0·5 and 1·5 volts per centimetre, and are in agreement with those deduced from the tests of previous experimenters using water-droppers or radium collectors, but it is found that the potential gradient diminishes rapidly as the height above the ground increases. Flights are recorded up to 4000 feet above the ground, at which height the potentials ranged between 40,000 and 60,000 volts, and the currents between 40 and 100 microamperes. Measurements were also made of the time taken by the kites and balloons to attain the full potential of the surrounding air from the moment at which the wire was disconnected from earth. This rate of charging is of interest in aëronautics in connection with the devising of suitable methods of preventing dangerous electric discharges from taking place between a balloon and the surrounding medium after a sudden change of height. The tests showed that the kites and balloons, the collecting area of which was about 150 square feet, charged up according to an exponential law, the exponential coefficient having values lying between 0·1 and 0·23, showing that a potential of half the full value was reached in about 5·5 to 7 seconds. It is argued that the rate of charging up is probably proportional to the radius of the balloon, and so the rate of charging up of large passenger balloons might be deduced from the rates determined with the small balloons used in these investigations. Attempts were made by the authors to discover a connection between the electrical state of the atmosphere and the prevailing temperature, barometric pressure, humidity, and wind velocity as registered on self-recording instruments sent up at each flight, but it was found that the amount of data collected was not sufficient to make such deductions possible. It seems that such conclusions will not be able to be drawn until continuous experiments extending over a considerable period of time have been made.

Geological Society, June 14.—Prof. W. W. Watts, F.R.S., president, in the chair.—Prof. W. S. **Boulton**: A monchiquite intrusion in the Old Red Sandstone of Monmouthshire. An unrecorded monchiquite, intruded into the Upper Old Red formation of Monmouthshire, is described. The manner of its intrusion is doubtful. The disturbance and metamorphism of the contact-rocks are dealt with, as also the rounded lumps of marl and subangular chips of sandstone incorporated in the igneous rock. The monchiquite contains large phenocrysts of augite and biotite, generally much corroded. Rounded "nodules" of olivine-augite rock with chromite are also included. A second generation of augite, biotite, and decomposed olivine occurs porphyritically in the ground-mass. The ground-mass is a felt of minute elongated augite prisms, magnetite grains, and flakes of biotite. A complete analysis of the rock is given, which bears out the petrographical evidence that it is a very basic lamprophyre belonging to the monchiquite group. Its age and connection with the only other known intrusion into the Old Red Sandstone of the South Wales area are referred to.—Notes on the Culm of South Devon: Part i.—Exeter district, by F. G. **Collins**, with a report on the plant-remains by E. A. N. **Arber**, and notes on the Cephalopoda by G. C. **Crick**. The paper is to show that the fauna of the Culm Measures of South Devon proves these beds to be the equivalents of the Pendleside series of the Midlands. The actual fossiliferous localities are eighteen in number, but often the fossils are too poor for determination. It seems advisable to seek more evidence, and an attempt will be made by working due north from Waddon Barton, a point farther to the west.

British Psychological Society, June 24 (held at Manchester).—Dr. T. Graham **Brown**: Note on the perception of movement in the environment.—C. **Burt**: The experimental investigations of emotional dispositions.—Dr. H. **Watt**: A new classification of experiences.—Prof. C. S. **Sherrington**: A simple teaching apparatus for illustrating Listing's law.—Prof. J. Lorrain **Smith** and Dr. W. **Mair**: A chemical comparison of the brain substance of the child and the adult.

DUBLIN.

Royal Irish Academy, June 26.—Rev. Dr. Mahaffy, president, in the chair.—C. F. **Rousselet**: Clare Island Survey: rotifera. Mr. Rousselet collected all the rotifera except the Bdelloida, which are embodied in a special report by Mr. James Murray. The report shows that the rotifer fauna of Clare Island and the neighbouring parts of the mainland differs in no special features from that of many other parts of the British Islands. Mr. Rousselet gives a list of 103 species with their distribution. Some of these had not previously been recorded from the British Islands.—Eugène **Penard** and G. H. **Wailes**: The freshwater rhizopoda obtained during the Clare Island Survey. The first collections of the fresh-water rhizopoda of Clare Island and the neighbouring districts of the mainland of Ireland were made by Dr. E. Penard, the work being continued later by Mr. G. H. Wailes. The present report has been drawn up under the joint authorship of these two investigators. The total number of species and varieties recorded is 140, of which *Cryptodifflugia eboracensis*, *Euglypha cirrata*, *E. rotunda*, and *E. armata*, as well as several varieties, are new to science. Seven other species are new to the British Islands.—D. J. **Scourfield**: Freshwater entomostraca. In a preliminary report Mr. Scourfield states that 41 species of Cladocera, 23 species of Copepoda, and 13 species of Ostracoda have been observed on Clare Island and the neighbouring parts of the mainland. No new species have as yet been definitely identified, but a couple may eventually prove to be new to science. The great majority of the species recorded are common types in the British Islands; only a few are to be considered as rarities.—Miss A. Lorrain **Smith**: Lichens (Clare Island Survey). The lichen flora of the Clare Island district is extremely abundant, especially as regards rock and ground species. The rarity of trees renders bark species less widely distributed than usual. The present report deals with some 280 species and 40 subspecies, &c. Of these, between thirty and forty are hitherto unrecorded from Ireland, and several are new to the British Isles or only once previously found therein. A summary of previous work in the district shows that while the neighbouring county of Galway has been well explored by Larbalestier, Mayo was practically unworked until the present investigation.

PARIS.

Academy of Sciences, June 26.—M. Armand Gautier in the chair.—E. **Guyou**: Solution of problems of altitude. New tables of navigation.—J. **Boussinesq**: Calculation of the absorption in translucent crystals for plane waves, laterally undefined.—P. **Villard** and H. **Abraham**: A large electrostatic machine. A description of a specially constructed Wimshurst machine of twenty plates, capable of yielding 1 milliampere at 250,000 volts.—A. **Müntz** and E. **Lainé**: Considerations on the employment of sewage in agriculture. Analyses of the Paris sewage are given, showing its value when applied directly to various crops. It is deficient in phosphates, and to use it to the best advantage these should be added.—L. **Maquenne**: Concerning a recent communication by M. L. Cailletet (on the origin of the carbon assimilated by plants).—E. L. **Bouvier**: New observations on evolutionary mutations.—Édouard **Heckel**: The action of cold, of chloroform, and of ether on *Eupatorium triplinerve.* No odoriferous substance exists preformed in this plant, but such a substance is formed after desiccation for several hours, and much more rapidly after exposure to cold or to the action of anæsthetics.—J. Ph. **Lagrula**: A triple meteor observed at Nice.—Luigi **Giuganino**: Effect of the movement of the earth on light phenomena.—M. **Chanoz**: Images physically developed after fixing exposed gelatine-silver bromide plates.—J. **Gardner**: Apparatus for the telephonic reception of submarine signals. This consists of a microphone connected with a metal ring of carefully specified proportions, and attached to the armour of the ship. The signals can be perceived at increased distances, and their directions ascertained.—G. **Sagnac**: Movement of the earth and the optical phenomena in an entirely terrestrial system.—H. **Buisson** and Ch. **Fabry**: Measure of the intensities of the different radiations in a complex ray. The radiations from a quartz mercury vapour lamp were allowed to fall upon a thermopile after passing through various absorbing media, such as water, solution of potassium chromate, solution of quinine sulphate, solutions of oxalic acid, glass, &c., thus obtaining the amounts of energy carried by radiations of different groups of frequencies.—Georges **Meslin**: Circular polarisation.—L. **Bloch**: Some general theorems in mechanics and thermodynamics.—L. **Houllevigue**: Kathode rays produced in electric incandescent lamps. Conditions are described under which it is possible to obtain pencils of rays, easily deviable by a magnet, in the interior of incandescent lamps.—M. **Dussaud**: Economical incandescent lighting. Description of the great efficiency of a coiled filament of tungsten as compared with a carbon filament.—A. **Besson**: Action of the silent discharge on dry and damp ammonia. Small quantities of a substance which reduces copper salts are formed. This is probably hydroxylamine, produced according to the equation

$$NH_3+H_2O=H_2+NH_2OH.$$

—Paul **Pascal**: A method of optical control of magnetochemical analyses.—J. B. **Senderens** and J. **Aboulenc**: Catalytic esterification of aromatic acids in the wet way. The yield of ethyl benzoate produced in presence of sulphuric acid was found to depend upon the amount of the latter added. Acids such as the toluic acids, and salicylic acid, resemble benzoic acid in this respect, and in having the carboxyl group attached directly to the benzene nucleus; whereas such acids as phenylacetic and phenylpropionic, in which this group is not directly attached to the nucleus, do not yield increasing amounts of ester with increase in the quantity of sulphuric acid used as catalyst. The effects of potassium bisulphate and of aluminium sulphate as catalysts were also examined.—G. **André**: The diffusion of saline substances through certain organs of plants.—H. **Astruc**, A. **Couvergne**, and J. **Mahoux**: The adherence of insecticides of arsenate of lead.—V. **Balthazard**: Identification by finger-prints.—Léon **Pigeon**: Measure of the degree of strabismus.—M. **Odier**: The part played by mercury and some of its salts in certain cancers.—M. **Foveau de Courmelles**: A cause of X-ray dermatitis.—MM. **Sollaud** and **Tilho**: The presence in Lake Chad of *Palaemon niloticus*.—E. **Kayser**: The influence of humous substances on micro-organisms.—M. **Lemoigne**: Denitrifying bacteria of filter-beds.—Jean **Bielecki**: The part played by mineral matters in the formation of the protease of anthrax.—Stanislas **Meunier**: Influence of the structure of certain fossil shells on the production of a new variety of fibrous silica.—M. **Lantenois**: The advance of geological knowledge concerning Indo-China.—Henry **Hubert**: The mechanism of rains and storms in the Soudan.

CONTENTS.

THURSDAY, JULY 13, 1911.

A GREAT NATURAL PHILOSOPHER.

Life and Scientific Work of Peter Guthrie Tait. By Cargill Gilston Knott. Pp. x+379. (Cambridge: University Press, 1911.) Price 10s. 6*d.* net.

TWO large quarto volumes of Prof. Tait's collected papers were published some time ago by the Cambridge University Press, and these have now been supplemented by an exceedingly interesting account of Tait's life and work, from the pen of his pupil and friend, Dr. C. G. Knott. Every Edinburgh student must recognise the fidelity of the picture which Dr. Knott has drawn, and feel that his book is in all respects a worthy memorial of the great Edinburgh professor. The book will appeal very directly to many of the readers of NATURE, who remember the searching and trenchant reviews of books on physical mathematics, and the articles on such subjects as the physics of golf, and on questions connected with physical mathematics, which appeared in these columns from time to time, and were signed with the initials "P. G. T." Many of these less formal papers were of much scientific interest, which was not lessened by the eminently human personality of the writer, which appeared in every sentence, and the humour, a little grim at times, with which he illustrated or drove home his conclusions.

In a review of Tait's "Thermodynamics" in NATURE (January 31 and February 7, 1878, vol. xvii.) Clerk Maxwell said, "Science has enough to do to restrain the strong human nature of the author, who is at no pains to conceal his own idiosyncrasies, or to smooth down the obtrusive antinomies of a vigorous mind into the featureless consistency of a conventional philosopher." These words are a true description of Tait, the outspoken and uncompromising controversialist, the critic unsparing of error, but not without regard for the feelings of the advocates of views which he combated or denounced, the philosopher who said hard things regarding professed metaphysicians, but who thought of the foundations of dynamics and did not disdain to adduce metaphysical considerations for the justification of a fundamental principle of quaternions. Such men are rare at the present time. Everybody is superficially and laboriously polite; the old broadsword play of word and phrase is too often replaced by suggestion and innuendo. But a good knockdown blow or cut is better than a sting that empoisons the blood and festers.

Tait was a native of Dalkeith, near Edinburgh, and studied his rudiments in the grammar school of that town. At the age of ten, on the death of his father, he was brought with the family to the city in which his life-work was to be done, and became a pupil of the Edinburgh Academy, a day school which from its foundation in 1824 has always been famous for the soundness of its classical and mathematical instruction. There he had as schoolfellows Clerk Maxwell, Lewis Campbell, Fleeming Jenkin, and several others who achieved eminence or fame in after life. Maxwell was his senior by a year. It is foolish to attach very great importance to school examinations—some minds begin to mature sooner than others—but it is interesting to note that Tait, Campbell, and Maxwell seem to have been nearly equally distinguished in mathematics. All were soundly drilled in classics; the rector of the academy was an eminent classical scholar—the Ven. John Williams (curiously enough at the same time Archdeacon of Cardigan), who was chosen first rector in 1824, mainly at the instance of Sir Walter Scott. Tait had an excellent verbal memory, and used in after life to repeat much Greek and Latin poetry learned in the forms of the academy.

It is rather remarkable that at the University of Edinburgh neither Maxwell nor Tait excelled the best of their fellow-students in natural philosophy. Perhaps in music alone does early precocity precede the highest excellence in maturity; but then musical genius is much less dependent on the ripening of the logical powers. For original work in mathematics and physics a natural gift or instinct is, of course, essential.

Tait's career at Cambridge, and his initiation in the following years into experimental work in the laboratory of Dr. Andrews at Belfast, were incidents in the scheme of things which led to his return to Edinburgh in 1860 as the successor of Forbes. Tait entered at Peterhouse in 1848, Maxwell in 1850, but afterwards migrated to Trinity, and both, like Thomson (afterwards Lord Kelvin) before them, had William Hopkins as their private tutor. Each had his own strong personality, but the influence of that great teacher seems to have been of the best possible kind for the minds of all. Tait was Senior Wrangler and First Smith's Prizeman in 1852, and his first act when the Tripos result was declared was to telegraph home and ask that the news should be told to Gloag, his old mathematical master at the academy.

While professor of pure mathematics in Queen's College, Belfast, and working in the laboratory of Dr. Andrews, he was introduced by Andrews to Rowan Hamilton, at that time in the full tide of his quaternion work, and busy with the preparation of the "Elements" for publication. Then began an interchange of letters on quaternions, of which Dr. Knott, *con amore* as himself an ardent and accomplished quaternionist, has given a most interesting account. Apparently Tait's first letters, which were chiefly on difficulties raised by his perusal of the "Lectures on Quaternions," attracted Hamilton's attention to the writer as one likely to cultivate the new calculus and extend it to fields of physical research. Hamilton's own applications were mainly geometrical; Tait saw in quaternions a powerful instrument for the dynamical study of various branches of physics, which, in fact, placed at once in a new light all that analysis, applicable to so many different problems, in which Green's analytical theorem plays a prominent part. The result was his paper on Green's theorem, and, later, many of those physical investigations which form the latter part of his "Treatise on Quaternions."

Hamilton was a willing and voluminous correspondent, and his letters (the first was forty-five pages long, divided into thirty-two paragraphs), here printed, so far as they are quoted, with all the italics, small capitals, &c., which he used, even in his books, to mark different degrees of emphasis, abound in acute and suggestive remarks, which were no doubt due to the inspiration of the moment. The humour which he displays here and there, as in his "mortal leap from Chaucer to Moigno," and his description of the Abbé, is of a truly Irish flavour, and has the merit of unexpectedness.

The absence of quaternions from Thomson and Tait's "Natural Philosophy" has been the subject of some remark. It is now well known that the senior author could not be convinced that the quaternion calculus, or indeed any form of vector analysis, was of advantage in physical work. To this conservative view he adhered to the end of his life, and in a private letter of his later years, written, as he described it, politely and mildly as to a stranger, he states his adverse opinion with remarkable vigour. And there is the letter to Chrystal, quoted by Dr. Knott on p. 185, on the thirty-eight year war over quaternions.

It is somewhat remarkable that vectors should have led to so much correspondence of an animated sort. The respective merits of quaternions and the systems of Grassmann and others seem not merely to have kindled the intellects, but to have stirred the emotions of the various advocates to a surprising extent. The playful paraphrase by a physicist of the famous saying of Tertullian into "Behold, how these vector-analysts love one another!" suggests with a touch of irony that after all the differences may not be so fundamental as they appear, that perhaps each sees the truth, and may safely be left to fight its battle in his own way. Let each go on using the armour and weapons he has proved; no man can tell to whom the victory may be; perhaps after all to someone whose equipment seems lamentably inadequate. But nobody can help admiring the steadfast fidelity of Tait to the notation of the master, and his chivalrous defence of quaternions against all comers. He had a right to speak with authority: no man with the exception of Hamilton himself did more for quaternions or with them. And if the linear vector function ever yields its whole secret to the student of vector analysis, it will be because Tait has made the disclosure possible. Often light suddenly comes to a man who has turned a subject over in his mind for weeks or months or years. It is surely also possible that one explorer may enter into the labours of another, and quickly behold the promised land which the instinct and faith of the first pioneers told them lay beyond the mountains.

Cambridge had no more systematic student than Tait, and no university had a more faithful and duty-doing professor. The work to hand, the daily task, the common round of teaching, it was his joy to perform. In the opinion of some it is waste to keep such a man lecturing to elementary students; but Tait inspired his students, and that was surely a very great thing. As a lecturer on experimental physics he was well-nigh unapproachable; and he was well aided by his mechanical assistants, who understood his methods and knew that he could be depended on to take everything in the carefully thought-out and prearranged order. Without such order and close adherence to it, no man, however eminent, however great his genius even, can teach a university class effectively.

In his introductory and other occasional addresses, Tait often dealt with more or less controversial subjects. The tract which he wrote on "Thermodynamics" contains a sketch of the theory of energy, in which questions of priority of complete logical proof, for example, Joule's establishment of the equivalence of heat and work, are discussed with great force and cogency of argument, albeit with a dash of patriotism. Such things he also discussed in his popular lectures and lighter papers. His book on "Recent Advances in Physical Science," was a course of such lectures, taken down by a shorthand writer, and carefully revised. Its title is out of date now, but as a clear statement of the true foundations of the science of heat, and of the work done by Joule, Kelvin, Balfour Stewart, and others in that field, it cannot be excelled.

In thermodynamics he insisted always on the importance of Kelvin's idea of absolute temperature. Kelvin was undoubtedly behind Clausius in accepting the consequences of the equivalence of heat and work; but when his first scruples had been overcome, and Carnot's function had disappeared in the idea of absolute temperature, the scheme of relations of heat and work stood forth in a logical clearness, which no other mode of treatment has ever approached. The imperfectly specified thing called a "perfect gas," by means of which temperature is defined in many continental treatises, he cordially disliked, and he lost no opportunity of denouncing the treatment founded upon it. In the cause of accuracy Tait was zealous almost to slaying. No one who heard his lecture on "Force," to the British Association at Glasgow in 1876, will ever forget his dramatic denunciation of slipshod popular science and its professors.

Tait's association with Kelvin in the composition of the "Natural Philosophy" has been referred to. Not the least interesting chapter in Dr. Knott's book is the account of this collaboration. The two men had much in common, they were both pupils of Hopkins, their great mathematical power and sure physical instinct well fitted them to work together, but in other respects the combination was not so successful. Tait was orderly and methodical—that can be seen in his neat penmanship and clear and precise composition, which was fit, with scarcely an erasure or substituted word, to be sent to the printer. On the other hand, the perusal of matter in clear print on a proof-sheet, showed Kelvin so many opportunities of extension and amendment, that he immediately overflowed in new sections on the margins, to the dismay of the printers, and the augmentation of the bill of costs. Then Kelvin had so many irons in the fire; his thoughts were being carried away continually from the "Natural Philosophy," and that, of course, stood still, for there come times when one partner in such an enterprise cannot advance without the other. No wonder the book stopped at the end of the first volume.

For many years Tait was the general secretary of the Royal Society of Edinburgh, and of the 365 papers, the titles of which are enumerated in Dr. Knott's bibliography, by far the greater number were communications to the society's Proceedings or Transactions. Unlike most secretaries of learned societies, he was himself the most prolific contributor.

He never joined the Royal Society of London, though he was a royal medallist in 1886, and was often asked to allow his name to be submitted. Indeed, his heart was in Edinburgh and his work there. For the last twenty-five years of his life he never crossed the Tweed; the only occasions on which he left the city were his visits to St. Andrews, ten days in spring and six weeks in autumn, with one exception, when he went to Glasgow to deliver a lecture on thunderstorms.

Though not himself a great golfer, he was the recognised authority on the physics of the game. His explanations of the "carry" of a golf ball, of the action of toeing, heeling and slicing, all examples of his theory of the effect of spin, stood the severe test of his own experiments, and are beyond cavil. His papers on this subject—in NATURE and elsewhere—would form an interesting book on the dynamics of a spherical projectile in air, if they were collected.

Failing health, and the death of his son, Lieut. F. G. Tait, the great amateur golfer, at Koodoosberg in 1900, brought the toil of his strenuous life to a close. But at the last, only two days before his death, he was busy with his beloved quaternions, and wrote a sheet of notes of investigations on the linear vector function.

This notice is already too long, and yet nothing has been said of Tait's work on thermoelectricity, on mirage, or of "The Unseen Universe," and the "Paradoxical Philosophy." The two last-mentioned works, written in conjunction with Balfour Stewart, are interesting as an attempt to apply the principle of continuity to infer, and to some extent explain, the existence of an unseen system of things to which in some sort we stand in physical relation. Incidentally they show the strong yet unobtrusive religious faith of their authors.

A. G.

AUSTRALIAN PLANTS.

Australian Plants Suitable for Gardens, Parks, Timber Reserves, &c. By W. R. Guilfoyle. Pp. 478. (Melbourne and London: Whitcombe and Tombs, Ltd., n.d.) Price 15*s.* net.

THIS work, prepared, as we learn, at the request of a special committee, embodies the practical experience of its author during the past thirty-six years. Except for some five-and-twenty pages of preliminary matter, the book is not one that admits of being read. But this fact in no way detracts from its merits as a work of reference, or lessens the debt to Mr. Guilfoyle of Australians who care either for gardening or for Australian plants. The feeling, its author explains, which has inspired its publication, is a desire to arouse increased enthusiasm in regard to the native species. The introduction should at any rate have the effect of directing the attention of his compatriots to the fact that Australia is richly endowed with what is wonderful and beautiful in the vegetable kingdom. If it does have this effect, it will have well served its purpose, since all that can be needed to evoke the enthusiasm which is desired is some intelligent attention to the plants themselves.

Granted the existence of such enthusiasm the work before us must prove invaluable in guiding and controlling it. That some control will be needed an examination of Mr. Guilfoyle's lists abundantly shows. The value of the lists for this purpose is enhanced by the self-restraint which has enabled the author to confine to a couple of lines references to individual plants which those who are not themselves Australians would gladly have seen expanded to as many pages.

It is scarcely strange that the inhabitants of an autonomous State like the Australian Commonwealth should be less enthusiastic over their native plants than the inhabitants of Britain. The wattles and gums, the myrtles and honeysuckle trees, the Boronias, Brachycomes, and Epacrids of Australia do not yet arouse feelings and memories so keen as those aroused by the oak and thorn and gorse, the primrose or the daisy or the heather of Britain. There is, however, more than the mere absence of literary allusion or historical association to account for the fact. In Australia the number of forms capable of awakening interest or provoking admiration is so immeasurably greater than in Britain that the observer's attention is distracted. Even where, in spite of greater or less botanical differences, the plant-forms of the two countries are sufficiently alike to be comparable from an æsthetic point of view, as, for example, in the case of the Epacrids or Australian heaths and our familiar ling, the manifest superiority of the Australian plants scarcely suffices to produce the expected effect. Perhaps the fact that the enthusiasm of the Australian has to be extended to a dozen different forms, while we can concentrate ours on one or two, may be some explanation. Should Mr. Guilfoyle's own enthusiasm enable his fellow-countrymen to overcome this difficulty, he may truly be said to have deserved well of the Commonwealth.

The attempt made in a special list to bring some order out of the chaos which prevails in respect of the common names applied to Australian Eucalypts in different parts of the country, deserves especial attention. How great the prevailing confusion is will be readily appreciated if the Eucalyptus names recorded in Mr. Gerth van Wijks's "Dictionary" be examined. Mr. Guilfoyle's courage in endeavouring to deal with this troublesome question compels our admiration. It is perhaps too much to expect that everyone all over Australia will be willing to abandon the use of names to which they personally have become accustomed, and to be guided by what, after all, must at best be a somewhat eclectic set of substitutes. But if in this particular matter it can scarcely be hoped that Mr. Guilfoyle's action will receive the universal approval of his own generation, there is no doubt that some such action, if only on grounds of public convenience, is necessary, and it is more than probable that Australians of another generation will be grateful for the prescription of a stereotyped list of names.

THE CHEMISTRY OF CALCAREOUS CEMENTS.

The Chemistry of Testing of Cement. By Dr. C. H. Desch. Pp. xi+267. (London: E. Arnold, 1911.) Price 10s. 6d. net.

THE "cement" treated of in this volume is the group of calcareous cements—that is, the plastic materials employed to produce adhesion between stones and bricks in the construction of buildings and engineering works. The book deals, shortly but clearly, with the manufacture of the various kinds of calcareous cements, with their components, constitution, and properties, and with the mechanical and chemical methods of testing them.

Owing to the extending employment of concrete the production of cement is becoming more and more important, and the demands upon its qualities increasingly stringent. These more exacting requirements have so far been met with a remarkable degree of success, partly by improvements in mechanical processes, but also to no small extent through the cooperation of the chemist. For two reasons the services of the latter are likely to become of yet greater value in the industry. On one hand a still higher standard of quality may be demanded in the finished product, and, on the other, a larger variety of raw materials may be found to be utilisable in the production.

The complex character of the substances entering into the composition of calcareous cements, and the obstacles in the way of ready experiment with the products, have in the past greatly limited our knowledge of the chemical reactions which occur in the making and "setting" of these bodies. In modern practice, however, two things are helping to shed light upon the dark places. One is the introduction of "etching" methods, similar to those employed in metallography, for studying the structure of cements in their various phases; the other is the conception of cements as, essentially, colloids. Both these matters are fully explained and their importance emphasised in the volume before us.

The view adopted by the author as to what takes place during the setting of Portland cement is substantially that of Dr. Michaëlis. Assuming for the purpose of discussion that the cement materials consist of lime, alumina, and silica only, then the essential hydraulic constituent, alite, is formed from these by the action of heat during the process of manufacture. It is regarded as a solid solution of calcium silicates and aluminates. When water is added to the cement, it partly decomposes the alite, hydrolysing the aluminates in the first instance. The solution thus produced is a supersaturated one, and it presently deposits tricalcium aluminate. According to the quantity of water in the mixture, the deposit is either mainly colloidal or mainly crystalline; if the proportion of water is small it favours the production of a colloidal "gel." The excess of lime above that required for tricalcium aluminate remains in solution, or a part may be deposited as crystals of calcium hydroxide. This process is regarded as probably corresponding with the "initial set" of the cement.

As regards the subsequent gradual hardening, the argument is that water acts much more slowly on the calcium silicate contained in alite than on the aluminates, but when hydrolysis does occur the calcium silicate separates out in the colloidal form. The gel thus produced forms a coating round the cement particles, protecting them from further direct action of the water. But as the latter slowly diffuses through the colloidal coating, more and more of the alite is slowly hydrolysed, and the lime set free is absorbed by the gel, which thereby increases gradually in density and hardness, and loses its plastic qualities. To this gradual desiccation of the gel, which takes place even when the cement is immersed in water, is due the eventual hardening of the mass.

Evidence for the actual existence of colloid products in hardened cements is found in the fact that some of the components can be stained with eosin. Etching with acids shows the structure of the unchanged cement in the interior of the particles, around and between which lies the dyed colloidal gel.

The volume embodies the chief results of modern inquiries into what is admittedly a difficult subject. It is written in a true scientific spirit, and would be an excellent book to place in the hands of a chemist with progressive ideas, who wishes to study carefully the chemistry of calcareous cements. C. S.

GEOPHYSICS.

Physik der Erde. By Prof. M. P. Rudzki. Pp. viii+584. (Leipzig: Chr. Herm. Tauchnitz, 1911.) Price 14 marks.

THE course of lectures at the University of Cracow published by Dr. Rudzki in the book under review covers a wide range. The subject-matter lies on the border-line of astronomy, mathematics, geography, and geology, and the lectures have coordinated these different sciences very successfully. By readers in this country, where specialised studies so largely cramp workers into one narrow domain, the book should be greatly appreciated. It is much to be desired that more opportunity could be found for similar work in British educational methods; for those who agree with this view Dr. Rudzki's work will prove a useful stimulus.

In saying that the lectures have successfully coordinated the different subjects represented, the reviewer does not wish to suggest that the treatment is necessarily the happiest from the point of view of a student in this country. For instance, while the mathematical reader will find much to interest him and very little that he cannot follow in the subjects outside his own domain, he will find the mathematical part of the work occasionally incomplete or sketchy. At the same time the reader who is not a professed mathematician must frequently find the mathematics beyond his reach. Rather more or rather less mathemathics would probably suit a larger class of students. A second weakness of the book, and one which robs it of some value as a systematic treatise, lies in the somewhat arbitrary way in which certain branches of geophysics have been neglected, while others have been accorded very full treatment.

In general, however, the ground has been very thoroughly covered. Many valuable references are given throughout, and save for the last few years they seem very fairly complete. In his preface the author refers with regret to several interesting investigations which have appeared too late to be made use of in the text of the book. The reviewer has found few instances of work overlooked. Taking the work of this country alone—work which has in general received a full and generous treatment—the only important omissions that he has noted have been some of the investigations on wave problems of Prof. Lamb and the scientific results of Sir Ernest Shackleton's last Antarctic voyage. But all students reading the book must find many references which will be new to them, and the book has been made more serviceable by a useful index of authors and subjects.

Throughout the whole range of subjects considered—and there are included geodesy (practical and theoretical), seismology, isostasy, and the theories of tides, ocean currents, waves, seiches, rivers and glaciers—the treatment is fresh and full. As a type of the questions discussed in a most interesting manner the winding form of a river-bed may be selected for mention, also the problem of glacial epochs and the differing views as to the nature of the earth's interior. The general answer which Dr. Rudzki gives to the solutions so far offered for most of the problems he discusses is "Not proven," and no fault can be found with him for adopting so cautious a position. The book is replete with suggestions of unsolved problems, and would supply fruitful reading to many a student on the look out for a piece of research off the ordinary lines.

F. STRATTON.

THE EVOLUTION OF MAN.

(1) *Anthropogenie oder Entwickelungsgeschichte des Menschen, Keimes- und Stammesgeschichte.* By Prof. E. Haeckel. Sechste Auflage. Erster Teil, Keimesgeschichte des Menschen. Pp. xxviii+432+xvi plates. Zweiter Teil, Stammesgeschichte des Menschen. Pp. x+(433–992)+(xvii–xxx) plates. (Leipzig: W. Engelmann, 1910.)

(2) *Der Mensch: sein Ursprung und seine Entwicklung.* By Prof. W. Leche. (Nach der zweiten schwedischen Auflage.) Pp. viii+375. (Jena: Gustav Fischer, 1911.) Price 7.50 marks.

(1) BOTH these books are popular treatises discussing "man's place in nature" (to use the title of their English prototype), his origin, and development. They cover practically the same ground, and both aim at presenting the results of highly technical biological investigations in a form that will be intelligible to the educated layman. Nevertheless there is a marked contrast between them, one that in a measure reflects the influence of the difference in the attitude of the educated public towards the problems of evolution and the descent of man thirty-seven years ago and now. One of them is a weapon, forged in times of struggle, for the purpose of carrying offensive operations into the camp of those who were using every influence that casuistry and sentimentality could arouse to discredit Darwin and all his works. The other was written in more peaceful circumstances, long after such foolish animosities were buried, as one of the innumerable series of tributes which every country and class united in paying to Darwin's memory, on the occasion of the fiftieth anniversary of the publication of "The Origin of Species," two years ago.

This is the sixth edition of Haeckel's famous book. It first saw the light in 1874, in the days when the mere suggestion of the idea of evolution, in reference to man, was still regarded as "insulting" by many people. Its author was the most ardent and combative upholder of evolutionary ideas on the Continent, and he made no attempt to soothe the susceptibilities of his readers, preferring rather to set forth unpalatable views in the frankest and certainly not the least distasteful way. The book was originally flung as a challenge to the opponents of Darwinism, who replied by describing it as "a fleck of shame on the escutcheon of Germany."

Since then a vast change has taken place in the attitude of educated men towards the problem of evolution; but Haeckel has made surprisingly few changes in his book. From time to time, in the various successive editions, he has added liberally to the supply of illustrations, and tacked on a variety of tit-bits of new information, such as references to Pithecanthropus, the recent work on "the demonstration of the blood-relationship" of apes and man, and the results of investigations on the fate of the tail in man; but these are mere scraps of corroborative detail—embellishments to the edifice built in 1874, without altering the plan of the building or enlarging its dimensions. The great modern movements of biological thought in reference to heredity and evolution, and the results of recent morphological research, have made little or no impression upon Haeckel's book; its scope has not been enlarged to include the new learning; in spite of its veneer of modernity it is still a typical product of thirty years ago. But it is a wonderful tribute to its excellence that a book which does not claim to represent the present state of knowledge should maintain its position in competition with more recent works; it has, in fact, now attained the venerable rank of a classic.

The present edition is little more than a reprint of the fifth edition, which has appeared in an English translation. Slight additions have been made to the accounts of Amphioxus and the embryology of the chick, and a few more illustrations have been inserted; but these are mostly taken from old sources.

The author does not even provide a new preface; but in his introduction to the previous edition (1903) he frankly admitted that the literature relating to the problems discussed in his treatise had become so extensive and intensive that he made no pretence of keeping pace with it.

(2) Prof. Leche's book made its first appearance in Swedish at the time of the Darwin celebrations in 1909, and when the time came for the preparation of a second edition he made his interesting work available to a wider circle of readers by issuing this German edition.

The book is a simple and lucid description of the growth of evolutionary ideas, with an account of the men to whom we are indebted for this new learning.

Unlike Haeckel's treatise, which takes the form of lectures addressed to students of biology, but in virtue of its lucidity has become, nevertheless, a popular treatise, Leche's book is obviously written for the educated public in general, and therefore omits certain topics discussed by Haeckel, which are properly included in a treatise on biology, but not in works for wider circulation.

It is somewhat disappointing to the biologist familiar with the author's important contributions to comparative anatomy that Prof. Leche should have chosen to cast his book in so popular a mould. It would have been instructive to have had more information concerning the higher primates from one who is so great an authority on the other end of the mammalian phylum. But Prof. Leche has chosen the *rôle* of expositor, mainly of other people's work, and we are duly grateful for his clear statement of generally accepted views regarding man's origin and developmental history.

The book opens with an exposition of the growth of the theory of evolution, with an account of the work of Charles Darwin, his predecessors, co-workers, and followers, and it discusses the modern conflict between the teaching of Weismann and "Neo-Lamarkismus," expressing the opinion, for which he claims the support of Darwin himself, that the origin of species can be explained only by admitting the potency of the essential factors emphasised by both schools.

The second chapter is a simple exposition of man's place in the vertebrate series, explained by reference to the facts of comparative anatomy and embryology. Chapter iii. gives an account of the nature of the palæontological record, and deals at some length with the histories of the various vertebrate groups that have been recovered by this means, most of the space devoted to mammals being filled by the familiar story of the horse. The next three chapters deal respectively with man's structure as illuminated by comparison with that of other vertebrates; the light thrown on man's development by comparative embryology; and the nature and significance of rudimentary organs in the human body, the pineal body, the third eyelid, the palatal ridges, the coccyx, superfluous hair and teeth, and the vermiform appendix being the vestigial structures selected for discussion. There is a brief chapter on the brain, which can scarcely be considered adequate when it is remembered that it is the organ which has played the chief part in making man what he is.

The closing chapters are perhaps most useful to the zoological reader. They deal with man's nearest relatives, the primates, fossil-man and Pithecanthropus.

It is gratifying to find that Prof. Leche lends the weight of his support to the view, first set forth in NATURE in the year 1907, that Tarsius is the slightly specialised living representative of a very primitive group of primates, from which the lemurs and the apes were derived by specialisation along divergent lines; that in this sense Tarsius is the connecting link between these two suborders, because it is the least modified descendant of the common parents of all three suborders of primates.

There is a very useful summary of the circumstances of the discovery of the remains of Palæolithic man and Pithecanthropus, with an unbiassed account of the nature and significance of these much-discussed relics of fossil-man. In the chapters dealing with this subject he follows Schwalbe in most matters, and describes the recent trend of opinion on the Continent in reference to Palæolithic man, without committing himself, however, to any of the extreme views that are so much in evidence at the present time.

The volume closes with a brief statement in reference to certain points in the anatomy of modern man that have some wider significance of racial or sociological importance.

Prof. Leche's book can be heartily recommended as a calm and dispassionate summary of the present state of our knowledge of the structure of man, as it is interpreted by comparative anatomy. G. E. S.

GEOLOGY AND BUILDING STONES.

(1) *The Geology of Building Stones.* By J. Allen Howe. Pp. viii+455. (London: E. Arnold, 1910.) Price 7*s*. 6*d*. net.

(2) *British and Foreign Building Stones: a Descriptive Catalogue of the Specimens in the Sedgwick Museum, Cambridge.* By John Watson. Pp. viii+484. (Cambridge: University Press, 1911.) Price 3*s*. net.

(1) THERE has long been a demand for a book such as that now produced by Mr. Howe. It would be well for all architects, and also engineers, to go through some short course of geological training, leading up to the understanding of a geological map. Mr. Howe has to meet those cases where no preliminary work has been possible, and he describes in a clear manner the essential characters of rock-forming minerals. Quaintly, but properly enough, he includes ice, the mineral most utilised by the Eskimo. Knowing as he does the utility of the microscope, he introduces extinction angles in the table of the felspars on p. 20, but these are left unexplained, and the variation in the angle between the cleavages would surely be more interesting to the beginner. Thin sections of typical rocks are well illustrated in the later pages. The work of Dr. Flett, Mr. Lovegrove, and the author, has probably introduced the microscope to many "practical" men with good effect.

The classification of rocks employed is commendably simple. Trachyte seems to have slipped out of the table on p. 43, as a parallel with rhyolite and andesite, though it is described on p. 103. Mr. Howe does very well in avoiding local and specialised rock-names, though we suppose "kentallenite" (p. 89), the incorrect but accepted use of "granophyre" (p. 92), and "keratophyre" could scarcely be kept out. A large part of the book is naturally devoted to sedimentary rocks, and no reader will fail to appreciate their structure, and the interesting way in which structure records their modes of origin. The treatment of slate is an excellent example; we note that chemical composition is here so dominated by the compactness and by the fissile structure of the rock as to have no effect on relative durability (p. 287). Limestones are also adequately dealt with, the important oolitic stones of England being described in considerable detail. Among sandstones, we may direct attention to the interesting account of the Surrey "firestone" on p. 166. There is much in this book which will enable the professional geologist to give a "practical" touch to his teaching, and thus in turn to attract the technical student towards the broader aspects of geology. One of the chief rewards of the instructor in a modern college is to note the pleasure aroused when some familiar feature is explained. The "practical man" may know a good deal already about a stone, but he now sees it taking its place in the history of a world of stones.

Mr. Howe's chapter on the decay of building stone is especially to the point. He uses chemical symbols at times in his text in place of words, which is scarcely literary; but he shows well how sodium chloride and other salts increase the attack of rain-water on a stone, and how the acids liberated in towns also play their destructive part. A special section is devoted to the decay of limestones. The deleterious formation of gypsum in parts of buildings sheltered from the rain, or even beneath rain-washed surfaces, is impressively pointed out. Crystalline dolomites (p. 353) decay in the country through the more rapid solution of any calcite granules that are present, while in towns a worse evil befalls them, from the fact that magnesium sulphate is even more soluble than gypsum. The sulphuric acid in towns, of course, arises from the iron pyrites contained in coal. Mr. Howe's remarks as to our love for limestone (p. 9) should be taken to heart by architects.

There is a useful chapter on the testing of stones; but we question if the appendices which follow, containing lists of quarries, were worth compiling in view of the far more complete lists issued by the Home Office, and referred to on p. 435. A liberal description, however, not merely an enumeration, is given of the sandstones of Ireland (the heading accidentally calls them limestones). The reason for this treatment is not apparent, since a reference to the source of information, Kinahan's "Economic Geology of Ireland," would show that a similarly detailed essay might be written on any class of Irish stone.

It is one of the curses of curators that manuscript labels lead to cumulative errors in the names of places. Mr. Howe has succeeded far better than any copyist would have done. We do not know if his variations from Kinahan are accidents or corrections, for Kinahan was indifferent to proof-reading; but such words as Dundale, Geradmer, Blekinje, Thuringewald, Böhm-Brod, and Maenturog require emendation. Why write "the Tyrol," and also "Steiermark" and "Mähren"? But at such a book—the metaphor is obvious—we would not willingly cast a stone. We are additionally grateful for an index of twenty pages.

(2) Mr. John Watson's work represents an immense amount of patient application, behind which lies real enthusiasm. He has brought together a collection of building stones for the Sedgwick Museum in Cambridge, in which he aims at representing the whole world. He has presented a large number of the specimens, and furnishes a catalogue of rocks used in construction, leaving those used for decoration, road-making, and roofing for future work. On p. 8 he approves "a suggestion" that the University of Cambridge might be a fit place for "a national bureau, where building stone could be examined, tested, and reported on." The existence of the Geological Survey of Great Britain, as a public body of the first standing, would no doubt occur to our legislators, and the difference of outlook adopted in an economic and in a university museum is at once seen by Mr. Watson's choice of a classification. His stratified building stones are arranged according to their geological age, and are then grouped under their countries of origin. It is a question if this appeals even to the university student of petrology, and it certainly conveys no useful information to the seeker after building stones. The admirable index of fifty pages, surpassing that of the diligent Mr. Howe, does not set matters straight. There are thus twenty-six references to oolites, even though the Caen stone of p. 184 is omitted; but the seeker after sandstone will have to turn the pages of the volume. Granites, however, are copiously indexed as a group. The universities, having adopted law and medicine, have proceeded to engineering, mining, and distilling. It may now be too late to leave building construction and building stones to great technical colleges, of the type of the Royal School of Mines. Mr. Watson's book, issued at so very moderate a price, is a treasury of information for the inquirer. It is not the author's fault if it seems to emphasise that overlapping of functions which threatens to impoverish British centres of education.

G. A. J. C.

SUPERNORMAL PSYCHOLOGY.

(1) *New Evidences in Psychical Research. A Record of Investigations, with Selected Examples of Recent S.P.R. Results.* By J. Arthur Hill. With an introduction by Sir Oliver Lodge, F.R.S. Pp. xii+218. (London: Wm. Rider and Son, Ltd., 1911.) Price 3*s*. 6*d*. net.

(2) *Personality and Telepathy.* By F. C. Constable. Pp. xv+330. (London: Kegan Paul and Co., Ltd., 1911.) Price 7*s*. 6*d*. net.

IT was in the early 'seventies of last century that men of scientific training began to take an interest in certain mental and physical phenomena which appeared to transcend the ordinary laws of psychology and biology. It has taken a generation to acclimatise some of these phenomena in the realm of serious and orthodox scientific pursuit, and the two present volumes represent further attempts, along two different lines, to win recognition for apparently supernormal facts, and to frame theories capable of bringing them into line with general knowledge.

Mr. Hill's book (1) is an eminently temperate and dispassionate statement and analysis of selected cases of clairvoyance and automatism, the former including the sayings of a professional clairvoyant, and the latter dealing with the "cross-correspondences," now fairly well known, between the automatic writings of Mesdames Thompson, Forbes, Holland, Verrall, and Piper. It is not difficult to perceive that the author inclines to the agency of disembodied human intelligences as the simplest explanation of many of the phenomena dealt with. When, in circumstances which exclude collusion as a reasonable hypothesis, phrases and allusions are simultaneously written out automatically by two or more persons in different continents, different phrases which only become intelligible on being pieced together, the case for assuming the operation of some intelligence different from that of the writers becomes strong. When, in addition, these phrases are characteristic of a Gurney, Myers, Sidgwick, or Hodgson, the temptation to attribute them to those deceased personalities is obvious. On the other hand, if telepathy and clairvoyance are real faculties, the proof of identity is faced with apparently insurmountable difficulties. Nevertheless, Mr. Hill's book is a valuable contribution to our knowledge of this difficult subject, and it is rendered particularly acceptable by the author's "careful and responsible truthfulness" and "unemotional habit of mind," to which Sir Oliver Lodge testifies in his introduction.

(2) Mr. Constable's book is an ambitious attempt to colligate the same range of facts by a new theory of personality. Experimental telepathy is assumed to be fully established, and is accounted for by the existence of an "intuitive self," which is in "timeless and spaceless" communion with all other intuitive selves. A large part of the book is taken up with a criticism of Kant and his transcendental dialectic, and the new departure claimed is the proof of the existence of the intuitive self from facts of ordinary human experience, chiefly relating to telepathy, or the reception of impressions otherwise than through the normal organs of sense.

The book as it stands can scarcely be said to succeed even in its main object, for even if telepathy were fully established, the possibility of some form of physical vehicle is becoming, if anything, increasingly obvious in these days of wireless transmission; and the whole conception of the "intuitive self" tends to remove these matters from all scientific procedure. An author who confesses his inability "to distinguish between time and space" (p. 34) is scarcely likely to convert physiologists or even psychologists to his views on crystal-gazing, or "psychometry," or communion with the disembodied. Any theory of survival likely to appeal to the scientific mind must be based upon physiological rather than metaphysical reasoning, and must, above all, remain in touch with the facts of racial and individual development. A physical scheme of immortality cannot be ruled out as an *a priori* impossibility while so many unknown forms of matter and energy remain to be discovered. Meanwhile, a transcendental self, independent of space and time, makes too great a demand on our powers of conception to be of any living scientific interest.

E. E. F.

OUR BOOK SHELF.

A Star Atlas and Telescopic Handbook (*Epoch* 1920). *For Students and Amateurs.* By Arthur P. Norton. Pp. 19+16 star and 2 index maps. (London and Edinburgh: Gall and Inglis, 1910.) Price 5*s.* net.

For the general use of amateur astronomers this is the best atlas and handbook we have yet seen. The sixteen maps are printed exceptionally clearly, and, while not overcrowded, show more than 7,000 objects. Each map is about 10 in. by 8 in., and is part of a lune, covering, exclusive of overlap, four hours of R.A., and 60° N. or S. of declination. The atlas opens out flat, and shows two maps joined together at the equator, so that about one-fifth of the whole sky is seen at once. Meridians and parallels mark every hour of R.A., and every tenth degree of declination, while marginal divisions enable a position to be fixed to the nearest 5m. or 1°. The polar regions are shown on two pairs of maps.

In addition to these excellent maps there are a large number of tables and a quantity of letterpress giving practically all the information the amateur is likely to require for ordinary work. The list of star catalogues, astronomical abbreviations and symbols, and the notes on astronomical terms are to be confidently recommended for their lucidity and trustworthiness. Then there is a number of notes on the planets, comets, meteors, eclipses, &c., which are very interesting, concise, and informative. The sun and moon are awarded rather fuller treatment, and a useful sketch-map of the latter forms the frontispiece.

All this is good, but what will probably appeal more strongly to the average amateur possessing a telescope is the section devoted to hints. These are eminently practical, and the observer is told how to take care of and to use his instrument, how to get to know its constants and capabilities. Should he wish to determine the focal length of his objective or mirror, or of his eyepiece, or the diameter of the field, or should he wish to clean the different delicate parts or undertake special work, he is advised tersely how to do it.

Then preceding each pair of regions there are a few notes directing attention to any special telescopic objects found therein; double stars, variables, nebulæ, and star clusters are located, and their special characteristics briefly described.

The whole work suggests that the author undertook a congenial task; the result shows he did it well.

W. E. Rolston.

Triumphs and Wonders of Modern Chemistry. A Popular Treatise on Modern Chemistry and its Marvels, Written in Non-Technical Language for General Readers and Students. By Dr. G. Martin. Pp. xx+358. (London: Sampson Low, Marston, and Co., Ltd., 1911.) Price 7*s.* 6*d.* net.

The author of this book has sought to make chemistry attractive to readers untrained in the methods of science, by offering them an account of some of the most surprising achievements of modern practical chemistry, and of the most startling deductions from recent chemical and physical speculations. These two subjects alternate throughout the book, but their treatment is of unequal value. Such practical matters as the liquefaction of air, the preparation of oxygen, and the artificial production of nitrogen compounds, are described in an interesting manner, and in an easy and popular style. The wisdom of the plan adopted in dealing with theoretical points is more questionable. The reader is presented, almost on every other page, with numbers intended to impress by their vastness. Such statements as that "in such an inconceivably short interval of time as the millionth part of the millionth part of a second there occur no less than 2,800,000,000,000,000,000 collisions between the little atomic worlds which make up a [candle] flame!" abound in every chapter, and the latest hypotheses concerning electrons and the æther are utilised freely to supply similar data. The exclamatory style of these portions, and the excessive attention given to the sensational and the marvellous, render much of the book fatiguing to the reader, and injure its value as a means of instruction, especially as no clear distinction is made between those wonders which are facts of experience and the most hazardous guesses as to the structure of the universe.

Some of the most interesting sections deal with natural marvels, such as the caverns of limestone districts, the diamond mines of Kimberley, and the sulphur deposits of Sicily and Japan, and the author's reading has enabled him to bring together a mass of curious information in which most readers will find something new or unfamiliar.

In spite of the defects on the scientific side, to which attention has been directed, it is evident that the author has a real enthusiasm for his subject, much poetic feeling, and considerable facility of expression, and that his book represents a genuine effort to communicate his enthusiasm to others.

Plant-Life on Land, considered in Some of its Biological Aspects. By Prof. F. O. Bower, F.R.S. Pp. ii+172. (Cambridge: University Press, 1911.) 1*s.* net.

THE first part of this book deals with the problem which the author has expounded more fully in his large work on the origin of a land flora. The life-histories of Ulothrix and Pteris, the flower of Cycadeoidea, and the motile sperms of Zamia are the central points in the earlier chapters. Then after discussing the limitations imposed upon plants by fixity of position, the author turns towards the golf links, noting by the way the incidents connected with plant increase and the biological features of sand-dunes. The golf links are introduced to serve as an object-lesson in plant colonisation. Finally, it is explained in the concluding chapter how the various themes treated as separate essays converge upon the all-important problem of descent. The facts and opinions set forth can scarcely fail to interest the general reader, who desires to become acquainted with modern views regarding the origin and development of the plant world, but he is likely to find the information somewhat disjointed and sketchy; thus he would certainly desire to learn more, if only hypothetical, of the transition from the fern to the flowering plant, and also of the evolution of the flower. Botanists are, of course, familiar with the subjects discussed, but to some the tale of the Culbin sands may be new, and all will appreciate Prof. Bower's "dicta" on golf links.

Butterflies and How to identify them. By the Rev. S. N. Sedgwick. Pp. 63. (London: Charles H. Kelly, n.d.). Price 1*s.* net.

THIS is an excellent little book for the beginner, and contains a quantity of useful information, for which we might often seek in vain in more pretentious works. There is a coloured frontispiece, representing three butterflies and two moths, and thirty-five photographic illustrations (some of them including a whole page of figures), representing scales, eggs, larvæ, and pupæ, besides perfect insects. Some of these are natural size, and others reduced or (occasionally) enlarged, and those of perfect insects are generally good, but the figures in some of the plates representing the butterflies of each month are rather too small, and have scarcely come out very recognisably.

The first chapter deals with metamorphoses, collecting, &c., and the second includes a complete list of British butterflies, with Latin and English names, and a sketch of the contents of the five families. In chapter iii. we find a table giving the month of appearance, food-plant, name, and locality, &c., of each butterfly, then a series of plates, to which we have already referred, showing the butterflies of each month from April to September, then notes on typical larvæ and pupæ, of which a representative series is figured, and, lastly, another table, giving name, brief descriptions of image, larvæ and pupæ, food plants, and locality; and a few pages of ruled paper for notes.

A few doubtful species are included, such as *Argynnis dia* and *Erebin ligea,* but if this is an error, it is an error on the right side. Altogether the book should be specially useful to schoolboy entomologists.

The Open Book of Nature: an Introduction to Nature-Study. By the Rev. Chas. A. Hall. Pp. xi+268. (London: A. and C. Black, 1911.) Price 3*s.* 6*d.* net.

VARIOUS allusions and the general tenor of the book indicate that the author's early proclivities towards natural history were developed at a time when there were few inducements, either in the shape of popular books or general appreciation, to take up the study of the natural sciences. Having derived so much pleasure from his studies he desires to arouse in others the spirit of observation and a similar enthusiasm for a knowledge of nature.

The earlier geological chapters are devoted mainly to dissertations on rocks and fossils; identification of flowers is the chief botanical feature, and zoology is introduced with botany in the description of a ramble which occupies a third part of the book. The final chapter containing practical hints is by no means the least useful, although the manipulation of microscope and camera are better postponed to a more advanced stage. The purpose of the author is best served in those passages where he describes his own observations and experiences. There is overmuch introduction of information which, referring to natural objects not easily obtained, cannot be practically confirmed, and it is certainly inexpedient to give a string of morphological definitions (as on pp. 120 to 130), some of which are admittedly incorrect; it would be wiser in every respect to refer the student to a text-book for such details. Undoubtedly the author would be a delightful companion in the field, but conversations that are instructive on a ramble appear fragmentary when offered as a set piece.

The Oxford Geographies. Edited by A. J. Herbertson. Junior Geography. Questions. Pp. 28. By F. M. Kirk. Statistical Appendix. Pp. 36. By E. G. R. Taylor. (Oxford: Clarendon Press, 1911.) Price 1*s.*

IF these questions and summaries—prepared to accompany Prof. Herbertson's "Junior Geography"—lead teachers to make boys and girls themselves take an active part in their geography lessons, and not merely listen to what the teacher has to say, they will serve a very useful purpose. The resourceful master should find no difficulty in basing practical work upon the material here provided.

LETTERS TO THE EDITOR.

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

The Deformation of Rocks under Tidal Load.

THAT a shore-line should be depressed by the weight of a high tide and rise again when the tide retreats is an idea that has occurred to many. Sir George Darwin has on certain assumptions calculated the form and amount of deformation to be expected under given tidal conditions. In the British Association Report for 1910, p. 49, I showed what had actually been recorded by Mr. W. E. Plummer at the Bidston Observatory, which lies two miles inland from high-water mark. At that place a 10-foot tide resulted in an angular deflection of approximately 0·2″. Had the instrument been nearer to the sea a greater change in inclination might have been expected.

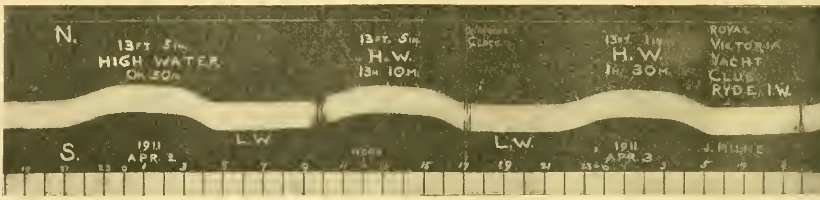


FIG. 1.—Record of Deformation of Ground by Tidal Load.

This year, between March 4 and May 24, an instrument similar to that at Bidston was, by the kind permission of the committee of the Royal Victoria Yacht Club, installed in the base of their premises at Ryde. The distance between this installation and high-water mark was 138 feet. The displacements due to a 10-foot tide were approximately 0·9″. This is more than I should expect to find at Bidston if that observatory were near to the high-water mark. If it would be really greater, then the soft Tertiaries beneath the Solent yield more than the hard sandstones which run seawards from Bidston. This may perhaps be a point of interest to geologists. The astronomer with his observatory near a seashore will realise the extent to which he is handicapped, due to tidal tilting, in relation to the man who makes similar observations twenty miles inland.

Considering the magnitude of the deflections due to tidal load, the geophysicists may wonder whether we could or could not in a country like Britain obtain satisfactory measurements of a terrain tide due to lunar influences. The definite measurements of the amount of bending which a tide produces on a floor of a shallow dish-like sea bed puts the hydrographer in a position to calculate the difference between what he observes in the rise and fall of the tide and what it would be if the bed had been absolutely rigid.

Lastly, as to the seismologist who has tried to find the relationship between earthquake frequency and tidal load. So far as I know, this has not yet been shown. The reason for this is perhaps because we have not confined our attention to earthquake regions where the effect of tidal load was marked.

The diagram (Fig. 1) is a half-sized reproduction of a "graph" at Ryde. The flat crests and sinuses of the waves indicate that the tide lingers for a considerable time at "high" and "low." The reason for this is apparently connected with the fact that Ryde is approached by tides from two directions. One enters the Solent from the east and the other from the west, but at somewhat different times.

Shide, Isle of Wight, July 5. JOHN MILNE.

Electrical Discharge—Possible Cause of Flare Spots in Photographs.

DURING a recent yachting cruise on the north-east coast, I sailed from Holy Island to St. Abbs, arriving off the harbour before the fishing fleet came out, and therefore dropped anchor off the entrance. About 5.30 p.m. some of the Scotch herring boats sailed out, and I photographed one shortly after leaving the entrance, and another when she was well outside. On having the two negatives developed and printed, I was disappointed to notice that both pictures were considerably marred by a white flare extending from the mast and yard of the sail skywards. At first I put down the flare spot to light leaking into the camera, or some sort of optical halation. On considering the matter more carefully, I was struck with the coincidence of both photographs showing the defect starting from the yard and the mast, and not at all visible on the lower dark sail. I talked the matter over with several friends, and eventually Mr. C. Faraday Proctor jokingly suggested it was evidently caused by electrical discharge. We both took the idea in a sarcastic spirit; but very soon we realised that the suggestion was not so ridiculous, and was well worthy of serious consideration, particularly as I remembered that the weather conditions had been thundery during the two previous days whilst sailing up from Blyth

Photograph of Flare Streak, possibly due to Electric Discharge.

to Holy Island. I then carefully examined other photographs taken on the following day of boats in the harbour, and several of these showed evidence of the same effect.

I enclose herewith three photographs.

No. 1 (here reproduced) shows the keel boat just sailing out of the harbour, taken Tuesday, June 20, 5.30 p.m., looking south.

No. 2 shows boat taken a few minutes later looking east.

No. 3 shows boats in the harbour looking north, taken about 1 p.m. on Wednesday, June 21. In the sky above all the masts are distinctly visible, pronounced white flares extending skywards. The photographs were taken on a Kodak film, exposure about one twenty-fifth of a second.

On the Tuesday the wind was blowing fresh from the north-west, and on the Wednesday the wind was still fresher from the south-west.

This note and photographs are being sent with the object of directing attention to the phenomenon, and with the hope of learning whether it has been noticed by others.

ARNOLD SPILLER.

Northumberland Yacht Club, Blyth, July 5.

Anhydrous Volcanoes.

THE cumulative evidence in Dr. Albert Brun's "Recherches sur l'exhalaison volcanique" leaves very little doubt but that the explosive action in volcanoes is due to decomposition of compounds of C, N, Cl, F, &c., held dissolved in the glass of the lava. All the theories about volcanic activity must be revised, as pointed out by that author; but along with the disappearance of the theory attributing the explosive action to water, there must be a disappearance also of the theory of a hot interior of the globe, as a corollary following on Dr. Brun's researches, if on no other grounds. For if a magma containing carbides, nitrides, &c., will explode with great violence if heated, then, supposing the earth's centre were hot, a single volcanic vent would allow the whole of the volcanic magma contained in the earth to swell and boil over on to the surface of the earth.

Accepting, then, Dr. Brun's conclusions, the volcanic magma below the crust must be cold, and only when heat is applied to it, through movements in the earth's crust, will the expansion take place and the volcano be formed. The gases given off from volcanoes, or expelled by heating obsidians to their melting points, are strongly reducing, and were, therefore, forced into the magma at a stage in the earth's growth (on the planetismal hypothesis) when the surface was incandescent from the infalling of meteorites, and when the atmosphere consisted of gases carried to the earth in these meteorites, principally CO, CO_2, H, N, and CH_4. The rock-silicates absorbing these gases gradually cooled down and were buried, and thus a supply of material was laid by from which the volcanoes of future ages could be formed. The absorption is more than mere occlusion, for an obsidian can be thoroughly weathered and absorb water throughout its mass, yet, when dried and then raised to fusion point, free chlorine can be given off, showing that the water cannot have had access to the storage chamber of the chlorine. Again, a granite powder may be sprayed with paraffin and heated to 1100° C. The excess of paraffin burns instantly, but a certain portion is fixed by the silicates and remains as paraffin within the rock-magma up to the explosion point, when it is expelled with explosive violence. Actual paraffin can be distilled from the pitchstone of Arran. If paraffin can be retained in a magma heated to above 1000° C., it means that it has practically entered into chemical composition with the silicates.

An obsidian retains some of the gases originally held in the magma, because it has cooled quickly; a certain time is necessary, even at fusion point, for the gases to be expelled; hence a lava will continue to give off gases as it flows down the side of the volcano, although a large proportion has escaped in the chimney, and will still be found to contain gas when it has cooled completely. The solidified lava, if left long enough, will slowly give off gases, N, Cl, CO, CO_2, CH_4, &c., but the life of a lava, before it becomes what Brun calls a "dead rock," is probably thousands of years.

There is certainly an analogy, if nothing more, between these results of Dr. Brun's researches, and the properties of radio-active substances. Helium must have existed in the earth's atmosphere when the surface was incandescent, for the same reason that it exists in the sun's atmosphere to-day, and it is possible that certain substances had the power of causing it to enter into a sort of chemical combination with them, like the paraffin in the rock silicates. Existing in the lower layers of the earth's crust near the centre, which I have given reasons to suppose is very little, if at all, above the temperature of outer space, these substances would retain the helium frozen in them, as the chlorine, paraffin, &c., are frozen in the rock silicates, and they could retain the helium for indefinite periods. When some of these substances, however, are brought by the ordinary processes of ore-formation into the warmer regions of the outer crust, they would give off their helium. The difference between the way in which the helium is held in radio-active substances, and that in which the gases are held in rock-silicates, is shown by the fact that the rate of expulsion of helium is unaffected by temperatures available in the laboratory, whereas the gases can be all driven off from a rock-silicate at one time. There may be nothing in this, but it may reassure some who are alarmed at the rate of decay of radium and see no possible sources of replenishment.

ERNEST H. L. SCHWARZ.

Rhodes University College, Grahamstown, June 12.

The End of the *Beagle*.

WITH reference to the letter in NATURE of June 1, the following particulars of what I know upon the subject may be of interest.

In the year 1863, at Hong Kong, a friend of mine purchased from the Government the dispatch gun vessel *Beagle*, which was at that time laid up, after being some years on the China Station. We had her thoroughly overhauled and repaired, and renamed her *The Stork* (a sacred bird of the Japanese). I then took her over to Japan, to the ports of Nagasaki and Yokohama, for sale. She was visited and examined by the Japanese; but no sale was effected at the time, and I took her back to Shanghai. However, she was eventually purchased by the Japanese Government, and after that I have no further knowledge of her movements.

The other *Beagle* mentioned in NATURE was an old 10-gun sailing brig, and I think there can be no doubt that she was the vessel in which Darwin made his scientific explorations. I see in the "Encyclopædia Britannica" that Darwin made his voyage in the *Beagle* in the years 1832 to 1836, several years before the *Beagle* that I commanded was built, so I presume that settles the matter.

H. C. SHOOSMITH.

54 Billing Road, Northampton, June 23.

[THE second line of the "Voyage of a Naturalist" describes the *Beagle* as a 10-gun brig. The vessel was barque-rigged, and is believed to have been about 280 tons.—ED. NATURE.]

The Osmotic Pressure of Colloidal Salts.

IN reference to the interesting letter of Dr. Hardy, published in NATURE of June 29, I should like to state that work on similar lines has been proceeding in this laboratory during the last year and a half. We have been investigating the general subject of "membrane-equilibria" and "membrane-potentials" in the case of non-dialysing electrolytes. An informal note on the principles involved in these investigations was read by me before the Physiological Society in December, 1910. Some time ago a paper dealing with the theory of these equilibria and potential-differences was sent to the *Zeitschrift für Elektrochemie*. In this paper, which is already in type, Dr. Hardy will find that I have arrived at equations expressing the membrane-potentials which are practically identical with the equation given in his letter. We propose, therefore, to continue our investigations on the subject.

F. G. DONNAN.

Muspratt Laboratory of Physical and Electro-Chemistry, University of Liverpool, July 1.

The Date of the Discovery of the Capillaries.

DR. FRASER HARRIS is quite correct in stating that Malpighi (working with Charles Fracassati) demonstrated the existence of blood capillaries with the microscope in the year 1660. The two letters to Joh. Alph. Borelli announcing the discovery were published in folio at Bononia (Bologna) in 1661. This is now a rare tract, and not usually quoted. It is, however, doubtful whether

Malpighi first saw capillaries in the frog's lung or in the frog's bladder—probably it was the latter. Although, of course, he was not the first to practise injection methods, we may note that Malpighi traced the course of the vessels by (*a*) inflating them; (*b*) injecting mercury; (*c*) injecting coloured fluids. Both Sir Michael Foster and your correspondent appear to have overlooked the fact that the expression "Magnum certum opus oculis video" is not Malpighi's, but a translation from Homer, and is intended, I imagine, to be translated after the Malpighian manner as: "I see with my eyes a truly great work."

F. J. Cole.

University College, Reading, July 4.

Arising out of the letter on the above subject in Nature of June 29, by Dr. D. Fraser Harris, is the true date of the momentous discovery of what is the oxygen carrier of the blood. This discovery is put down to Sir G. G. Stokes, and the date some years later than 1862.

I wish to direct attention to a fact hitherto overlooked, namely, that Dr. John Roberts, of Plas Eryr, Clwtybont, Carnarvonshire, was the first to say (and to publish it) that the colouring matter of the blood (hæmoglobin) was the oxygen carrier. This can be verified by perusal of his thesis (for M.D. Edin., published in 1860, and now lying in the archives of Edinburgh University) on "Pigment."

Dr. Roberts is still alive and well.

R. Cadwaladr Roberts.

Heathfield, Cardigan.

THE FUR-SEAL QUESTION.

For some time past a conference has been sitting in Washington, in which representatives from Great Britain, or rather Canada, Russia, Japan, and the United States, have taken part, for the purpose of drawing up new regulations for the conduct of the Bering Sea seal fishery, and for the protection and restoration of the herd. *The Times* of June 28 contained an account of the findings of the conference, and in the issue of July 8 its correspondent at Washington reports that the new convention was signed on July 7. The full text of the agreement has not yet come to hand, but its main provisions, which are of great international importance, and of great interest to all naturalists, are said to be as follows. Pelagic sealing will be totally prohibited to all subjects of the participating countries for fifteen years, and measures will be taken to induce other countries to prevent its being carried on under cover of their flag; the United States and Russia, which own practically all that remain of the seal herds of the North Pacific, will pledge 30 per cent. of their catches for the purpose of paying a specified yearly dole to Canada and Japan to compensate them for abstention from the fishery, and the United States (it is said) will advance 40,000*l*. to each of the latter countries for the immediate compensation of persons engaged in the industry; the contracting Powers will admit no skins to their ports the origin of which is not properly certified; and, lastly, regulations are laid down as to the method of killing seals on land, and as to the establishment of guards upon the rookeries. These resolutions are, we suppose, still subject to ratification by the several Governments, but nevertheless we have good reason to believe, and every reason to hope, that the wise and liberal proposals thus stated may soon be adopted and carried into effect. The Washington correspondent of *The Times* reports that, so far as can be gathered, the convention will be accepted by the Senate. It will come into force on December 15.

The Bering Sea Arbitration of 1893 was an affair of such international magnitude that it is far from being forgotten. It is unnecessary and impossible to enter here into a review of that great debate, of all the causes that led to it, or of the minor questions that arose for a few years after its close. We may simply remind our readers that its chief result was the delimitation of a zone of sixty miles around the Pribylov Islands, within which zone pelagic sealing was prohibited during the season when the herd were living and breeding upon the islands, while at the same time the use of firearms was entirely prohibited to the pelagic sealers. A few years later pelagic sealing was entirely prohibited, both by America and Russia, in the case of their own subjects. But while it is impossible to enter here into either diplomatic or commercial history, a few words upon the general aspect of the case, and especially upon the natural history of the fur seals, may be of interest at the present moment.

The true fur seals, forming the old genus Otaria (now broken up into subgenera), belong to the more extensive family of the Otariidæ, or eared seals, the various members of which differ considerably in their habits. For example, Steller's sea-lion (Eumetopias), a large, ungainly animal, is sparsely distributed on a multitude of coasts and islands around the North Pacific; while, on the other hand, it is characteristic of the fur seals, throughout the whole area of their distribution in the Pacific and Southern Oceans, to resort to but few local breeding-places, where, in prosperous times, they congregate in great multitudes. Naturalists are not quite agreed as to the number of species of these fur seals, but the best-known breeding-places are, or have been (besides those in the Bering Sea), Robben Island at the Cape of Good Hope, the Auckland Islands, the Falklands, South Georgia and many other islands in the Southern Ocean, Lobos Island, at the mouth of the River Plate, Guadalupe, off southern California, and the Galapagos. In the Northern Pacific by far the greatest of the rookeries are those of the Pribylov Islands, St. Paul and St. George; next in order come those of the Russian Commander Islands, Bering and Copper Islands; while in the Sea of Okhotsk there is still a small rookery on Robben Island (now ceded to Japan), and on the Kuriles a number of rookeries were formerly known but are now either extinct or very nearly so. Dr. Jordan and his American colleagues ascribe specific differences even to the seals of these comparatively neighbouring breeding-grounds, and it is highly probable, if not certain, that the Pribylov seals from the eastern part of the Bering Sea, and the Commander Island seals from its western part, form absolutely separate communities, the long southward migrations of which in winter time follow different routes, the one towards the shores of British Columbia and the other towards those of northern Japan. For an unknown period, but probably for centuries, they have been exposed to attack by expert native fishermen, spearing them at sea in the course of these winter wanderings.

During the greater part of last century the history of the seal herds, of all species and in all their various haunts, is a long record of pillage and extermination; and nowadays the extent to which they have been reduced may be measured by the simple fact that a sealskin coat is a thing we very seldom see. In a comparatively few cases, especially on the American and Russian Islands and the Uruguayan Lobos Island, the herds have long been placed under proper control while on their breeding-grounds; and, so far as we are aware, the Lobos rookery, though small (for the island is less than a mile long), and though right in the track of commerce and close to a considerable town, is still maintained in comparative prosperity. But though on the Pribylov and Commander Islands the remains of the once immense herds are still considerable, yet they represent but a small fraction of the numbers that were massed there during living and even recent memory.

The life-history of the fur seals is, very briefly, as follows. The males grow to a great age and size, wholly disproportionate to that of the small and slender females; and this difference is, as usual, accompanied by the habit of polygamy. The old males arrive upon the breeding-grounds in May, some weeks earlier than the females, and take up their quarters on the rough beaches, generally on some prominent slab of rock; here they doze and sleep until the arrival of the females, who, heavy with young, slip quietly into their places in the harems. The birth of the young follows almost immediately, and soon afterwards the comparative quiet of the rookery is exchanged for a babel of noise and incessant quarrelling. The old bulls in possession of neighbouring harems contend with one another for the females, and the younger bulls, as yet wifeless, strive continually to carry off a straying cow, or dash into a harem when its owner has wandered a few yards away. Moreover, the old bulls are now in perpetual activity, rounding up their harems, hastening after errant cows, quarrelling with their neighbours, or engaging in fierce combat with the "idle" and predatory bulls. So all day long the noise of battle rolls along the *beaches* by the wintry sea, and the growling and the snarling, the confusion and the din, are for some weeks together indescribable.

The harems vary very much in numbers, fifty cows being not uncommon, while a hundred, or even more, have been occasionally recorded; but their numbers depend upon the prosperity of the herd, and fifteen years ago the average number seemed to be rather under twenty. The young males, or bachelors, from one to three or four years old, arrive about the same time as the females, but herd apart on grounds remote from those occupied by the breeding herd. The females and these young males go down to the sea to feed, but the old males starve rather than leave their posts; they come fat and vigorous in springtime, and are gaunt, emaciated, and scarred with the scars of many battles before they leave again in autumn. This family life, and the type of rocky coast resorted to by the herds, seems to vary little in the different species, and a photograph of the herd upon Lobos Island, for instance, is scarcely, if at all, distinguishable from one taken on the Pribylovs. At Guadalupe, however, by reason of the tropical heat, the seals resort to the dark volcanic caves that surround its coast-line, and to the same cause perhaps is due the thinner and very inferior quality of the fur, as compared with that of the northern species.

The old bulls display surprising agility, in spite of their bulk and clumsy form, climbing over the rough rocks and boulders in a wonderful way; and, in general, as is well known, these eared seals can waddle on their long, flapping flippers with greater activity and over much longer distances than might be expected. It was formerly the custom on the Commander Islands to drive the bachelor seals from the "hauling grounds" to the place of slaughter a distance of at least three miles up and down a rough mountain path. But Dr. L. Stejneger was once witness of a more remarkable case. Climbing to the top of a rocky mountain on Copper Island, certainly not less, if I recollect rightly, than 2000 feet high, he heard, as he reached up to the last rocky summit, an angry growl, and there, to his amazement, was a great old bull seal, and the beast was blind!

On the polygamous habits of the species, on the segregation of the young males, and on the superfluity of the latter (for both sexes being born in approximately equal numbers, a very large proportion of the males are destined to perish in the struggle for existence)—on these characters are based the practical methods for the conservation of the herd. The Government lessees kill the young bachelors only, by preference those of three years old, leaving what they consider a reasonable proportion to replenish the stock. It is generally agreed that on the American Islands this operation has always been conducted with reasonable care and moderation, and with no more cruelty than is implied in the rapid and skilful slaughter of a large number of defenceless creatures. But the other dangers to which the herds are exposed are neither selective nor in any way conservative. The pelagic sealer when at work around the islands kills not only the young males, but in still greater numbers the females of all ages, and it is certain that many

A Rookery Courtship on the Pribylovs. (From Nature, by Bristow Adams, in the American Commission's Report, 1896–7.)

pups on shore must in consequence perish of starvation; while the raider who lands upon the rookeries kills all and sundry, young and old, in one spell of merciless destruction. Nor is the seal altogether immune from natural causes of mortality, apart from old age and from the attacks of man; but though the grampus, for instance, now and then devours him at sea, there is only one known cause of mortality that is apparently serious. In warm countries a very considerable number of puppies die owing to the attacks of a species of Ankylostoma, a tiny nematode worm, the eggs of which lie among the earth and sand, and in one way or another are swallowed by the pup; and a species of the same dangerous parasite is found abundantly in the bodies of the many dead seal-pups that towards the end of the season are found lying upon the rookeries, and apparently in greater numbers on the more sandy and less rocky of these.

But whatever part this parasite or other accidents may play as causes of mortality, it is certain that they are not such as to prevent the permanent and healthy upkeep of the herds when under proper management and control, nor even to prevent the rapid recuperation of their numbers during periods of release from persecution. On the Galapagos every seal that could be found had been killed by 1887, and the fur trade was surprised when ten years later a vessel came into San Francisco with somewhat above 200 seals from that abandoned rookery. In like manner, the seals on Robben Island were practically exterminated about the time of the Crimean war, when for a year or two 15,000 or 20,000 skins were taken in single voyages, after which the catches dwindled to trifling amounts, and, finally, the place was abandoned, and its existence as a hunting ground all but forgotten; but after fourteen or fifteen years of quiet, the rock was again covered with seals, just as it had been in the old days when first discovered.

Of the present state of the Pribylov herds we have no precise information at hand, but it is at least known that the seals are greatly diminished since the time, some fourteen or fifteen years ago, when they were last visited by British agents; while even then, some years after the arbitration, they were, of course, immensely less than in the palmy days of the fishery. We hope all the more, accordingly, that the agreement which is now said to have been arrived at will in due course be ratified, in the hope and confident belief that in a few years' time this great source of wealth, and this wonderful spectacle of crowded, teeming animal life, will be again as it was in former times. But it remains to be mentioned that the decrease of the Bering Sea herds in recent years is not to be laid at the door of the Canadian sealers, or at least not to nearly so great an extent as of their opposite neighbours, the Japanese. The once large fleet of Canadian sealing schooners has dwindled, we believe, to some four or five, while ever since the Japanese war the Japanese have taken more and more to this pelagic industry. It is said that they were first led so to do when the Russian guards were removed from the Commander Islands during the war, and when accordingly the rookeries lay at the mercy of the first comer. In recent years they have been charged with actually raiding the American rookeries, and, in any case, as Japan was no party to the Bering Sea Treaty, the Japanese captains have up to the present been free to use firearms, and to pursue their trade up to the three-mile limit of the territorial waters. In 1908, the Japanese had a fleet of thirty schooners, some with as many as sixteen boats, which formed a cordon round the Pribylov Islands. There can be no doubt at all that this has told very heavily upon the herds. Lastly, it is right to say that the terms of the new agreement, and the compensation which it is proposed to pay to Canada and Japan for the loss of their pelagic interests, appear to be both liberal and enlightened, and indicate a sincere desire on the part of the United States and of Russia to do all that lies in their power for the attainment of a great national and general benefit, and for the preservation of one of the great phenomena of the living world.

D. W. T.

THE EDUCATION AND TRAINING OF ENGINEERS.

THE Conference on the Education and Training of Engineers, held at the Institution of Civil Engineers, at the end of June, of which a report appeared in our issue of last week, marks a further advance in the development of a scheme which has engaged the attention of the council during the last fifteen years, and cannot fail to have considerable influence on the future of the engineering profession. The first step was taken under the presidency of Sir John Wolfe Barry, when a system of qualifying examinations was established. Candidates who were desirous of entering the institution as students had to give proof of a sound general education developed upon lines suited to subsequent scientific study. Every candidate for associate membership was required to give proof of a competent knowledge of those branches of science which form the basis of engineering, and to have received an adequate practical training under actual engineering conditions. The council found it necessary, from the first, to organise special examinations; these are still continued, and largely availed of by candidates for admission in both the classes mentioned. On the other hand, the council was desirous of minimising the number of examinations to which candidates were subjected, and was prepared to recognise degrees or diplomas granted by universities, university colleges, and engineering colleges, but only on condition that the standard of attainment represented by these degrees and diplomas was not inferior to that imposed by the council's own examinations.

Subsequent experience has shown that the advantages which were anticipated at the outset have been more than fulfilled. The imposition of more stringent conditions put a temporary check upon the numbers of those who entered the institution, particularly in the student class, but this check was only of short duration, and the rate of admission speedily began to grow. It may now be confidently asserted that every associate member admitted to the institution has satisfied the council that he does possess a competent knowledge of both the science and practice of his profession. In fact, British civil engineering, through the action described, has fully established its claim to rank as a learned profession, while the stringency and standard of the conditions which must be fulfilled by all successful candidates are certainly in no respect inferior to those imposed by the medical and legal professions. Another important advantage resulting from the action of the council has been the establishment, throughout the British Empire, of a practically uniform standard of attainment for engineering graduates of universities and university colleges. This excellent result has come about chiefly because the authorities of these institutions have appreciated fully the advantages attaching to the recognition of their degrees by the council of the Institution of Civil Engineers as a substitute for success in examinations held by the institution itself; and, as before stated, the policy of the council has always been to minimise examinations so far as may be possible.

On the side of practical training the council has never delegated, and probably never will delegate, to any other body the duty of deciding whether or not the training of individual candidates is satisfactory. Not merely does the council insist on the production by candidates of articles, indentures, or certificates given by trustworthy persons who have personal knowledge of the training which each candidate has undergone, but it has instituted special and stringent forms in which the details of that practical training must be recorded, and these statements have to be supplemented and verified by the testimony of members of the institution who have personal knowledge of each candidate's career and work. In other words, while recognising the value of scientific education for engineers, the claims of practical training are in no way subordinated thereto; both are essential.

In 1903 the council decided to invite the cooperation of the leading engineering institutions in the United Kingdom in setting up a special committee which should consider and report to the council on the broad principles of engineering education and training likely to yield the best results. Sir William White, who was then president of the institution, was appointed chairman of the committee; its membership embraced a considerable number of men occupying eminent positions in the practice of all branches of engineering. The inquiries of the committee included general preparatory education, as well as the scientific and practical training of those who were proposing to enter the engineering profession. The work to be done, therefore, was very extensive in its range, and occupied the committee more than two years. The report was unanimous, and was approved by the council of the Institution of Civil Engineers and by the councils of the other engineering institutions which had been represented on the committee. That report has exercised great influence since its appearance, and as the council of the institution arranged for its publication at a low price (by Messrs. Clowes and Sons) it has obtained a wide circulation, both at home and abroad. One of the most valuable features in this report was an appendix containing the analysis of replies made by a large number of eminent practising civil engineers to a series of questions framed and circulated by the committee. From this analysis it became evident that the suggestions made in the report not merely represented the views of the members of the committee, but that the recommendations of the committee were endorsed by the great majority of engineers consulted. In the main the report undoubtedly represented, and still represents, the views of the leading men in the civil engineering profession. Five years have passed since the report was issued, and the council of the institution this year reached the conclusion that many questions of detail and of method which were involved in the realisation of the principles laid down in the report might with advantage receive further consideration. It was mainly for the purpose of affording an opportunity of discussing important questions of that kind that the recent conference was held.

The broad conclusions of the members of the conference in regard to preparatory education of boys who may be intended to become engineers were confirmatory of opinions expressed in the education committee's report of 1906: a good general education, including modern languages, was considered to be essential, and early specialisation was deprecated. The advantages obtained by engineering students who are attached to a university were generally admitted, but one most interesting feature of the discussions was an outspoken declaration by professors of engineering in favour of the practical workshop training being chiefly obtained in manufacturing establishments rather than in college workshops. As to practical training, anyone who has studied the subject cannot fail to have been impressed with the enormous importance attaching to friendly relations between engineering employers and college students.

The question of the period at which practical training should be undertaken by those who intended to receive a college training has been much discussed. The report of the education committee of 1906 recommended that boys after leaving a secondary school (say, at the age of seventeen or eighteen) should serve for about a year in mechanical engineering workshops, so as to gain some knowledge of practical conditions and work. It was also recommended that at the age of about nineteen they should proceed to college and complete their scientific training, taking courses of three or four years, and availing themselves of any opportunities for practical training during the vacations. After graduation, their practical training in such branches of engineering as they might desire to follow would be completed. This clear statement of the committee's report was not grasped by some of the speakers at the recent conference, some of whom argued that the whole of the practical training should be taken between the secondary school and the college, while others maintained that all the practical training should be taken after the college course was completed, in order that there should be no break between the secondary school and the college. The balance of opinion, however, was much in favour of the committee's suggestion, and that also represents the established practice in Germany. Formerly all practical training in that country was put after the technical university or high-school education; but experience led the Germans to adopt the system which the education committee recommended. After twelve years' trial of the new arrangement, the German authorities are more than ever in favour of its beneficial effects.

No doubt whatever was expressed as to the absolute necessity of thorough scientific training for all engineers. There was equally universal acceptance of the view that no man can be considered fit to take part in the design, as well as in the control and direction, of engineering works, unless there is added to a competent scientific knowledge a thorough practical training under actual engineering conditions.

In announcing their decision to summon the conference, the council expressed the hope that it would be widely supported by those interested in solving the difficulties and uncertainties which are experienced by aspirants to membership of the engineering profession. The result of the conference has shown that this hope was well founded. No one who took part in the conference will entertain the least doubt as to the value and interest of its proceedings or of the certain and considerable benefits which will result therefrom to the engineering profession.

W. H. W.

THE PROBLEM OF PITHECANTHROPUS.[1]

NEARLY twenty years have gone since Eugene Dubois, then a young surgeon attached to the Dutch forces in Java, and now professor of geology in the University of Amsterdam, discovered that remarkable individual to which he gave the name of *Pithecanthropus erectus*. The actual discovery, it will be remembered, consisted of the roof of a skull, a thigh bone, and two teeth; they were found in a fossil-bearing stratum on the left bank of the Solo or Bengawan, a stream which, after flowing through the province of Mediun—"the hell of Java"—in the centre of the island, turns in a north-easterly direction to reach the sea. Experts agree that the bones found were parts of the same individual or at least of individuals of the same race or species. As to the nature of the individual, there has been a wide divergence of opinion; the discoverer regarded it as more anthropoid than human, hence the name, while others, looking on it as altogether human, simply name it the "fossil man of Java."

The position of Pithecanthropus amongst the higher primates is still debated; while one school of experts places it in the direct line of human evolution, another regards it as part of a side stem which ended in extinction. The age of the formation in which it was found is also still under discussion; Dubois assigned the fossil-bearing layer to late in the Pliocene period;

[1] "Die Pithecanthropus-Schichten auf Java." Geologische und Paläontologische Ergebnisse der Trinil Expedition (1907-1908). Herausgegeben von M. Lenore Selenka und Prof. Max Blanckenhorn. Pp. xlii+268+32 (Leipzig: W. Engelmann, 1911.) Price 50 marks.

the evidence and expert opinion to be found in the well-illustrated and excellent scientific memoir now under review indicate a more recent age for Pithecanthropus. It belongs, not to the Pliocene, but at the utmost to an early Pleistocene formation.

The late Prof. Emil Selenka, who did more than any man of his time to advance our knowledge of the higher primates, saw very clearly that the right way to solve the Pithecanthropoid problems was not discussion, but exploration. After his death in 1902, his widow took up the aim he had in view, and the manner in which she has carried it out commands our unstinted praise. Only those who have organised a scientific expedition know the care, labour, and expense entailed. Financial assistance was obtained from learned institutions in Berlin and Munich, but the major part of the expenditure had to be met from Fräu Selenka's private purse. Scientific investigators and overseers had to be selected and sent out; coolies had to be engaged—as many as seventy-five were employed at one time—and barracks built for them; Fräu Selenka accompanied the expedition into this remote and unhealthy part of Java. Extensive mining and digging operations were necessary for the fossil-bearing layer lies under 35 feet of a sedimentary deposit of volcanic origin. In the seasons 1907-8 10,000 cubic metres of material were removed, and forty-three large boxes filled with the fossil remains found. The contents of these boxes were sent to Europe and distributed amongst seventeen specialists. Their reports, with an introduction by Fräu Selenka and a summary of results by Prof. Max Blanckenhorn, make up the present memoir.

So far as Pithecanthropus itself is concerned, the expedition was a failure; the stone which Dubois erected to mark the spot of his discovery was found, but no further trace was seen of the much-discussed fossil primate. In the dry bed of a tributary of the Bengawan—about two miles from the scene of Dubois's discovery—the crown of a human tooth was picked up; it is a human lower molar of rather remarkable dimensions, but otherwise showing no special feature beyond its state of preservation. Dr. Walkhoff found that the dentine within the enamel cap was replaced by a fossilised organic matrix. From its condition he infers that it may be older in point of time than the remains found of Pithecanthropus, and is inclined to regard it as the earliest known trace of man.

Dr. E. Carthaus has prepared even a greater surprise for the readers of this memoir. In the same stratum as contained Pithecanthropus he has found traces of man's existence. These traces are:—(1) Certain splinters of bones and tusks; (2) hearth foundations and wood charcoal. He is quite aware of the fact that jungle fires by ignition from volcanic outbursts still occur in Java, but believes the appearances he has seen cannot be explained by any accidental conflagration.

On the slender evidence thus brought forward by Drs. Walkhoff and Carthaus, Fräu Selenka supports the theory that man was a contemporary of Pithecanthropus, and that therefore the latter is an aberrant form, taking no place in the line of human evolution. The evidence, in our opinion, is rather of the nature of suspicion than of fact; the Selenka expedition leaves the problem of Pithecanthropus so far as concerns its structure and position, unchanged, but it may be otherwise as concerns its geological age. Dr. E. Carthaus regards the Pithecanthropus stratum as belonging to a comparatively recent Pleistocene formation; Fräu H. Martin-Icke finds that 87 per cent. of the gasteropods found in it are modern forms, and concludes that the formation must be well within the Pleistocene period; the evidence and opinion of the botanist, Dr. J. Schuster, tend to the same conclusion.

The problems relating to the estimation of the age of a fauna of a tropical and distant country are many and difficult; most palæontologists will follow the example of Dubois and look to the mammalian fauna as the means of fixing, if not the age, at least the degree of evolutionary change undergone by higher vertebrates in this part of the earth since the period of Pithecanthropus. It is the mammalian fauna which is best known; Dubois found remains of nineteen genera and twenty-seven species; Dr. H. Stremme and Dr. W. Janensch, who describe the mammalian remains of the Selenka expedition, found fourteen genera and seventeen species, many of which are new. The whole of the mammalian fauna contemporaneous with Pithecanthropus has been extinguished or modified, and hence those authorities lean towards Dubois's estimate that Pithecanthropus belongs to the Pliocene period. It is at least not on a point of geological age that Pithecanthropus can be excluded from the genealogy of modern human races.

Prof. Blanckenhorn's general summary of the results of the expedition constitutes one of the best chapters of this memoir. He recognises the difficulty of drawing a line between Pliocene and Pleistocene in the formations of Europe and the even greater complexity in correlating the geological data of Europe and Java. As a tentative hypothesis he places the age of Pithecanthropus in the first interglacial period, corresponding to the formation of the Norfolk beds; the Heidelberg man—whose lower jaw only is known from the Mauer strata—he places in the second interglacial period, while the Neanderthal race he assigns to the third period. From an anatomist's point of view this provisional dating will answer very well, for these three forms are certainly progressive steps towards the modern human type. A. KEITH.

DR. G. JOHNSTONE STONEY, F.R.S.

DR. JOHNSTONE STONEY has passed away, one of the last of those who, during the latter half of the nineteenth century, contributed to the development of the modern ideas of the constitution of the atoms, which have borne such a rich harvest during the last two decades.

It is often difficult to get back to the point of view from which to estimate correctly the pioneer work of those who took the first steps; often the new ideas introduced by them have become the commonplace, so to speak, of science, but it is just these first steps breaking away from the older positions which mark the far-seeing intellect.

So early as 1871 we find Stoney endeavouring to formulate a relation for spectral lines depending upon possible simple harmonic modes of vibration in the atom, and he succeeded in finding a numerical relationship of a simple character in the case of the hydrogen spectrum, which has proved to be the forerunner of much subsequent work. Twenty years later he returned to the subject in a paper in which he considered the question more systematically, viewing the internal movements of the atom as those of a planetary system. Much work had been done by others in the meantime in following up the clue which Stoney had found in the numerical relationships of the spectral lines of hydrogen, and he was able himself to show further that double and triple lines would be produced by perturbations of elliptic orbits described under controlling forces in the atom, double lines being attributed to apsidal motions, triple lines to precessional motions. These conceptions of the constitution of the atom afterwards found satisfactory support in Preston's observations on the Zeeman effect.

He took a keen interest in the development of the kinetic theory of gases, to which he made notable contributions. In 1867 he arrived at his estimate of the size of molecular dimensions, which is substantially that made by Kelvin a year or so later, and by Loschmidt two years previously.

By utilising his value of the mass of the atom Stoney was able to give, at the Belfast meeting of the British Association in 1874, the first calculation of the atomic charge in electrolysis. To this quantity he gave the name *electron*, which is now very generally adopted, and has proved a most suitable term. It was to the orbital movements of the electrons in the atoms, to which, as we have seen, Stoney attributed in 1891 the spectral lines and their various singularities.

Stoney invariably invented a nomenclature for the quantities he was dealing with, where none already existed. Such new terms are continually to be met with in his writings. Many of them have been found by others to be most convenient, and have consequently taken root in science, as, for example, his term *wavelet*, employed advantageously in his papers on microscopic vision, in connection with his method of resolution into plane wave fronts. This facility in suggesting suitable terms proved most useful when serving on the now famous committee of the British Association which devised our present system of electrical units, and of which he was one of the early members.

Stoney was the first to see that the movements in Crooke's radiometer were not due to radiation directly, but arose from unsymmetrical gaseous impacts resulting from unequal heating of the surfaces of the rotating vanes. His original explanation, however, required modification, afterwards supplied by Maxwell and Osborne Reynolds.

He introduced into cosmical physics considerations of a limit to each planet's power of retaining a gaseous envelope, which are of the highest interest in connection with the moon and with Martian questions. He showed that helium, as well as hydrogen, must eventually escape from the earth's atmosphere, a fact with important bearings on the past history of the radio-activity of the materials of the earth's crust.

Stoney's ideas were sometimes rather ahead of the recognised requirements of the day, and consequently paid the penalty of neglect which unfortunately sometimes happens in such cases; indeed, one of his papers on a periodic scheme of the elements, predicting, among other points, the atomic weights of the "inert" group, remained unpublished on the mistaken advice of one of the greatest of his contemporaries. This very scheme is now thought by many to be the most satisfactory of any yet devised.

He was essentially of a philosophic turn of mind, and wrote several papers on ontology and kindred subjects, but at the same time he took delight in all new developments of both industry and science, rejoicing that his span of life had coincided with what he considered would probably prove in the world's history to have been the period of most rapid advance, flowing from the first systematic application of scientific method on an extended scale to industrial progress. He would describe how as a child he had witnessed the first use of illuminating gas in the streets of Paris, and would with evident pleasure recount the many achievements of man in his time.

Stoney was born in King's Co., Ireland, in 1826. His mother was a Blood of County Clare. His ancestry belongs to the Protestant settlers in Ireland of the sixteenth and seventeenth centuries, a class from which has sprung so many of our great men of science, including Hamilton, Stokes, and Kelvin, but which, through economic and political causes, is now fast disappearing. He came from strong stocks on both sides, which have provided an unusually large number who have made their mark, including four Fellows of the Royal Society.

He was educated at Trinity College, Dublin, taking high place in his examinations. He was anxious to devote his life to collegiate work, and sat for the fellowship examination, the entrance in Trinity College to this, but, as in many other cases, his brilliant intellect was lost to his university through the unfortunate working of an examination system, now happily to be abolished.

For many years he held the post of secretary to the Queen's University of Ireland, a position affording him small leisure for pursuing his scientific researches. To his official duties he gave a wholehearted service. This involved much organisation of the scattered colleges which constituted that university, and it was with unfeigned regret he saw the work of these years abandoned on its dissolution.

All who came in contact with Johnstone Stoney were impressed with his sincerity and devotion to all which makes for truth and righteousness. He was veritably a prophet as of olden time. Younger scientific men who have had the privilege of knowing him will not easily forget his kindliness and encouragement.

He died on July 1, after a prolonged illness, in his eighty-sixth year, at his residence at Notting Hill Gate, where he had lived for some years.

F. T. T.

NOTES.

A new attempt is being made to work the alluvial goldfield in Helmsdale, in eastern Sutherland. The existence of gold there has long been known, and some of the gold of the ancient ornaments found in north-eastern Scotland may have come from that district. The first modern attempt to work the field was in 1869, when gold was obtained in the Kildonan and Suisgill Burns, two tributaries of the Ullie, the main stream of Helmsdale. Royalty was paid on about 3000*l.* of gold, but the amount obtained is said to have been considerably higher. The largest nugget was found in the Kildonan Burn, and weighed two ounces. The richest alluvial deposits were in the Suisgill Burn, a higher tributary of the Ullie. This burn flows over mica schists belonging to the Moine system, which have been invaded by granite dykes. The existence of gold in this granite was recorded by Bryce in 1870. The workings were stopped at the end of 1869 owing to damage done to the fishing and the farmers. A serious effort to reopen the field is now being made by the Duke of Sutherland. Gold is being obtained, but whether it occurs in paying quantities has still to be proved.

Dr. H. N. Dickson, president of the Royal Meteorological Society, in a letter to *The Times* of Thursday, July 6, raises the question of increasing the utility of the daily forecasts of weather issued by the Meteorological Office by more effective distribution. His letter suggests the general restoration of the afternoon service of weather forecasts, which is now only operative in the summer months. "Presumably these could be issued all the year round, and they could easily reach the general public before the arrangements for the next day's work were finally completed, provided proper facilities for distribution were given." The history of the public announcement of weather forecasts in this country includes some interesting chapters, and the last of them carries the story to the present day from the re-establishment of the issue of forecasts in 1879 by the Meteorological Council, which at that time was composed of Prof. Henry Smith, Warren de la Rue, Captain Evans, Francis Galton, Prof. G. G. Stokes, and Sir R. Strachey. After the experience of thirty-two years, it is time that a new chapter was begun in which the question of the distribution of forecasts should receive its share of attention.

WITH an extraordinary regularity, all the aviators in the European Circuit—with the exception of Valentine, who came to earth at Brooklands—recrossed the Channel in the last stage but one from Hendon to Calais on July 6. The following day Paris was reached by six of the competitors, the remaining three, Tabuteau, Védrines, and Barra, coming in at intervals during July 8, owing to various minor mishaps *en route*. The winner was Naval-Lieutenant André Conneau (who flew under the pseudonym of "Beaumont"), who completed the circuit in 58h. 36m. on a Blériot monoplane fitted with a 50 horse-power "Gnome" motor and a "Normale" propeller. His time works out at an average of more than 17 miles an hour. Those who obtained the next six places were Garros (Blériot), 62h. 18m.; Vidart (Déperdussin), 73h. 32m.; Védrines (Morane), 86h. 34m.; Gibert (R.E.P.), 89h. 42m.; Kimmerling (Sommer), 93h. 10m.; and Renaux (Farman biplane), 110h. 44m. Barra (M. Farman biplane) and Tabuteau (Bristol biplane) also finished. Renaux deserves a special word of praise, as he carried a passenger, M. Senoncques, throughout the race.

A SPELL of ideal summer weather has occurred recently over England, where in places the thermometer in the shade has risen to between 85° and 90°. For the country generally it is unfortunate that the high temperature was preceded by dry weather, and rains are now greatly needed. At Greenwich the thermometer in the shade exceeded 80° on the four days from July 5 to July 8, and on July 6, 7, and 8 it exceeded 86°, the highest temperature being 88°, on July 8. In the sun's rays the thermometer was 144° both on July 7 and 9. The shade temperature has not risen so high at Greenwich since the summer of 1906, when, it will be remembered, a reading of 94·3° was recorded on August 31, and on the three following days the readings were respectively 91·9°, 93·5°, and 91·0°, the last three observations being a record for September. The temperatures recently experienced are not excessive for July; in 1900, on July 16, the reading was 94·0° at Greenwich; in 1896, on July 14, 91·1°; in 1887, on July 4, 92·2°; in 1885, on July 26, 90·2°; and in 1881, on July 15, 97·1°, the latter being the highest temperature recorded at Greenwich since 1841. In the recent hot spell the thermometer registered 90° in London at Camden Square, at Epsom, and at Cullompton. A decided change of temperature set in during the evening of July 8, and the weather became much cooler, although the conditions continued dry. On July 11 the shade reading again touched 80° in parts of London, and a return of the hot weather seemed probable. The temperature experienced in England falls considerably short of that in the United States, where in many parts the sheltered thermometer has exceeded 100°. The official records of the U.S. Weather Bureau, which are not available in this country yet for a later date than July 2, show a temperature of 104° on that day at Marquette, Mich.; 104° at Valentine and North Platte, Nebr., on June 29; and 108° at Tuma, Ariz., on June 28 and 26. The hot spell in England can in no way be associated with the excessive heat in the United States. It is not conceivable that the heated air could traverse the whole extent of the North Atlantic. The atmospheric conditions were at the time similar in England and America, the type of weather being in both cases anticyclonic and the movement of the air very sluggish.

SIR HENRY MORRIS, Bt., has been elected president of the Royal Society of Medicine for the session 1911–12.

PROF. A. E. METTAM, principal of the Royal Veterinary College, Dublin, has been elected president of the Royal College of Veterinary Surgeons for the ensuing year.

Science announces that Dr. Leonhard Stejneger has been appointed head curator of the department of biology in the U.S. National Museum to succeed Dr. F. W. True.

THE council of the Royal Society of Arts has elected Lord Sanderson, G.C.B., chairman for the year 1911–12. Lord Sanderson has been a member of the society for more than thirty years.

DR. W. J. S. LOCKYER, whose recent articles upon the British solar eclipse expedition have interested many readers of NATURE, has just returned home by the *Mauretania*, quite recovered from the attack of fever which he had in Fiji.

THE death is reported, in his fifty-third year, of Dr. Julian W. Baird, since 1886 professor of analytic and organic chemistry at the Massachusetts College of Pharmacy, and dean of that institution since 1895. He had previously been on the scientific staff of the University of Michigan and Lehigh University successively.

MR. R. H. CHANDLER, of Kearsbrook, Belvedere, Kent, desires to direct attention to an exceptionally good section of the plateau drift of the chalk downs, exposed in a pit which has been recently opened by Mr. Benjamin Harrison, of Ightham. The section is in a field behind Two Chimney House, about half a mile from Terry's Lodge, near Wrotham, and is described as showing between 2 and 3 feet of plateau flints in a sandy clay, resting in pockets in the clay-with-flints.

THE Paris correspondent of *The Morning Post* states that the inauguration of the Aërotechnic Institute, near Versailles, founded by M. Deutsch de la Meurthe, who has endowed it with a capital of 20,000*l*. and a yearly income of 600*l*., took place on July 6. The institute has been provided with all the apparatus necessary for experiments in aëronautics and aviation. Speeches were made by M. Steeg, the Minister of Public Instruction, M. Liard, Vice-Rector of the Paris Academy, and Prof. Appel, Dean of the Faculty of Sciences in the University of Paris.

WE are informed by the Royal Society that the Mackinnon studentships for the ensuing year have been awarded to Mr. T. F. Winmill, of Magdalen College, Oxford, for research in structural chemistry, and to Mr. T. Goodey, of Rothamsted Experimental Station, for research on protozoa in relation to the fertility of soil. The Joule studentship for the ensuing period of two years has been awarded to Mr. Albert Eagle, Imperial College of Science, for research on the thermal relations of spectra of gases and on cognate subjects.

AT the meeting of the Royal Society of Edinburgh on Monday, July 3, the Makdougall-Brisbane prize for the biennial period 1908–9, 1909–10, was awarded to Mr. E. M. Wedderburn for his series of papers bearing upon the temperature distribution in fresh-water lochs, and upon seiche phenomena which occur at the interface of two layers of different density, whether that difference be due to difference of temperature or difference of salinity, published in the Proceedings of the society within the prescribed period, and also in the Transactions and Proceedings before and after that period.

A STRONG earthquake was felt at San Francisco and throughout a large part of central California and Nevada on the afternoon of July 2, and was evidently the most severe of all the successors of the great shock of 1906. The total damage was comparatively slight, but many buildings were cracked, part of the cornice of the Bank of California fell, and the coping of the Hall of Justice was cracked. The latter was one of the few buildings which escaped uninjured in 1906.

ON July 9, at 2h. 2·5m. a.m., a strong earthquake occurred in Hungary, the epicentre being at or close to Kecskemet, which lies about fifty miles south-east of Budapest. In this town, of some 50,000 inhabitants, nearly every house was damaged, some so seriously that they collapsed. In the neighbourhood of Kecskemet ten persons were killed by the fall of a house, and two others at Nagy Körös, twelve miles to the north-east. The shock was felt over a large part of Hungary, and was evidently of unusual strength when compared with previous movements in the same seismic centre. In his catalogue of Hungarian earthquakes for 1865–84, Fuchs records only seven slight shocks at Kecskemet or in the surrounding district.

ARRANGEMENTS have been made to hold the autumn meeting of the Iron and Steel Institute at Turin on October 2 and 3 next. On October 2 the members of the institute will be welcomed by the civic authorities of Turin, the Chamber of Commerce, and the reception committee of the Associazione fra gli Industriali Metallurgici Italiani. After the reception, the Carnegie gold medal for research for 1910 will be presented to M. Félix Robin, of Paris, and papers will be read and discussed. At the conclusion of the meeting, beginning on October 4, a tour in Italy has been arranged to visit Genoa, Pisa, Rome, Naples, Florence, Milan, and other places. Members desirous of attending the meeting must signify their intention on reply forms, to be obtained from the secretary of the institute, not later than August 22.

FROM a circular just received from South Africa we find that the ninth annual meeting of the South African Association for the Advancement of Science was to be held last week at Bulawayo under the presidency of Prof. P. D. Hahn. The four sections, with the name of the president in each case, are as follows:—Section A, astronomy, mathematics, physics, meteorology, geodesy, surveying, engineering, architecture, and irrigation; president, the Rev. E. Goetz. Section B, chemistry, geology, metallurgy, mineralogy, and geography; president, Mr. A. J. C. Molyneux. Section C, bacteriology, botany, zoology, agriculture, forestry, physiology, hygiene, and sanitary science; president, Dr. E. A. Nobbs. Section D, anthropology, ethnology, education, history, mental science, philology, political economy, sociology, and statistics; president, Mr. G. Duthie. The South African medal and fund for 1910 has been awarded to Dr. L. Peringuey, director of the museum, Cape Town.

THE United States Weather Bureau is forming in its library, at Washington, a collection of meteorological photographs, and will welcome additions thereto from all parts of the world. The following classes of pictures are among those desired:—(1) views of meteorological offices, observatories, and stations; (2) pictures of meteorological apparatus; (3) portraits of meteorologists—views of their homes and birthplaces; (4) views showing the effects of storms, inundations, freezes, heavy snowfall, &c.; (5) cloud photographs; (6) photographs of optical phenomena (rainbows, halos, Brocken specter, mirage, &c.); (7) photographs of lightning and its effects; (8) photographs of meteorologically interesting pictures in old books, or of early prints and paintings (*e.g.* contemporary pictures of the damage wrought by the great storm of 1703 in England). Persons who are willing to present such pictures to the Weather Bureau, or will furnish them in exchange for Weather Bureau publications, are requested to address: Chief U.S. Weather Bureau (Library), Washington, D.C.

DR. W. T. SHEPHERD has contributed to the Psychological Monographs, issued in connection with *The Psychological Review*, a paper entitled "Some Mental Processes of the Rhesus Monkey." His experiments lead him to conclude that this monkey is able to discriminate colours with speed and precision when it is presented with foods (rice) variously coloured red, pink, yellow, and green; that it can be trained to discriminate between double-octave differences in pitch of musical tones; that, alike in the formation and in the inhibition of habits, it is superior to the raccoon and far superior to various other mammals that have been examined. Dr. Shepherd believes that monkeys learn only to a limited extent by imitation, and that, although they may acquire a generalised mode of action when confronted with a series of similar problems, there is no evidence that they form true general notions or can truly reason.

The Japan Magazine for last April contains an interesting article, by Mr. Mikimoto, on the culture pearl industry, describing the methods employed in the Bay of Ago. Every year during the months of July and August small pieces of stone are deposited in those parts of the sea where the pearl oyster is abundant. In the third year of the oyster's life it is removed from the sea, and into the shells are introduced small pearls or pieces of nacre to serve as nuclei for the pearls. These are allowed to develop for at least four years, when they are taken up and the pearls recovered. The success of the industry is much restricted by the great mortality among the oysters due to what is called "red currant," an accumulation of microscopic organisms in the water, and a seaweed known to the Japanese as Mirumo (*codium*), which by its growth smothers the young oysters. These artificially grown pearls are said to resemble those of natural growth in colour, lustre, and symmetry. It is interesting to note that most of the work in this industry is done by women, who are believed by the Japanese to be able to remain longer under water and to perform more and better work than men.

THE report of the Lancashire Sea-fisheries Laboratory and Fish Hatchery for 1910 contains a number of interesting papers dealing both with economic and with more purely scientific subjects. Mr. James Johnstone's memoir on internal parasites and diseased conditions of fishes contains a detailed description of a new genus and species of trematode (*Paracotyle caniculae*), and Mr. W. J. Dakin provides a note on a new sporozoan from the whelk, which he also regards as belonging to a new genus and species (*Merocystis kathae*). Prof. Herdman, in conjunction with Mr. A. Scott, contributes part iv., dealing with the year 1910, of his report on the intensive study of the marine plankton around the south end of the Isle of Man, and in conjunction with Mr. W. Riddell gives an account of some plankton observations made on the west coast of Scotland, and compares them with those made in the Irish Sea. There is, indeed, much truth in the remark of these authors that, "for a complete understanding of the plankton changes throughout the year in the Irish Sea, it is essential that we should have full information, not merely as to the larger organisms of the zoo-plankton, but as to the planktonic conditions in general in both surface and deeper water along the north coast of Ireland and off the west of Scotland."

A PAPER on the educational treatment of stammering children, by Dr. J. T. McHattie, with discussion thereon, has been issued by the Medical Officers of Schools Association, and contains much information on the causation and remedial treatment of this distressing condition.

MESSRS. GOETSCH, CUSHING, AND JACOBSON publish an important experimental and clinical study on the functions of the hypophysis cerebri, a small organ situated at the base of the brain. If either experimentally or in certain cases of brain disease an increased discharge of the secretion of the posterior lobe take place, an increased amount of sugar appears in the blood, apparently indirectly through the action of the secretion in causing an increased discharge of the glycogen stored in the tissues. Later an increased tolerance for sugars is established, often with a tendency towards general obesity (Johns Hopkins Hosp. Bull., xxii., No. 243).

WE published recently (June 29) a short article on the progress of radiography in medical diagnosis, and alluded in particular to the work of the staff at Guy's Hospital in their investigation of pathological conditions of the intestine. In this connection we note the appearance of a new paper, a reprint of which has reached us, by Dr. A. C. Jordan, medical radiographer to Guy's Hospital (*Brit. Med. Journ.*, May 20), in which he shows that it is often possible to detect duodenal obstruction by the X-ray method after giving the patient a bismuth meal. Diseases of the duodenum are often extremely obscure, and this new method of diagnosing the condition will be welcomed both by the medical profession and the sufferers from such complaints.

To the Entomological Research Committee (Africa) the Natural History Museum owes a beautiful enlarged model of the tropical rat-flea (*Xenospylla cheopis*), which appears to be the main vehicle in the conveyance of bubonic plague to the human subject. The species is believed to have been a native of North Africa, but is now practically cosmopolitan. The model is about 12 inches in length.

WE have been favoured with a copy of part xxvi. of the elaborate work in course of publication by Messrs. Friedlander, of Berlin, under the auspices of the Royal Prussian Academy of Sciences, entitled "Das Tierreich," of which Prof. F. E. Schulze is editor. The first part was issued in 1896, and from the commencement the editor has been greatly assisted by Prof. Fritz Edler von Maehrenthal, of the aforesaid academy, whose death at Berlin on August 28, 1910, is deplored in a special leaflet, with portrait, accompanying the present issue. Dr. von Maehrenthal was born at Olmütz, Moravia, on January 2, 1857, and, after spending his youth at Gratz, eventually became chief official of the Prussian Academy. In the present issue of the "Tierreich" Prof. L. G. Neumann treats of the acarines of the family Ixodidæ in the detailed manner characteristic of the work as a whole. We are likewise indebted to Messrs. Friedlander for a sale catalogue of works and papers on recent and fossil mammals.

THE June number of *The Quarterly Journal of Microscopical Science* (vol. lvi., part iv.) contains a full description, by Mr. R. Kirkpatrick, of the remarkable sponge *Merlia normani*, which the author has now obtained in quantity from a depth of 60 fathoms near Porto Santo, Madeira. The nature of this enigmatical organism seems likely to give rise to as much controversy as did that of Haliphysema or Astrosclera. Mr. Kirkpatrick has at length settled down to the view that it is a siliceous sponge of the monaxonellid family Haplosclerldæ, which, in addition to the typical skeleton of siliceous spicules, secretes a basal skeleton of calcite. This basal skeleton takes the form of a horizontal perforated lamina, and the perforations are filled with what is believed to be sponge tissue. The evidence brought forward for this view, if not quite conclusive, is certainly very strong. The upper part of the organism, which rests upon the basal lamina, is an undoubted haplosclerid sponge, characterised by a new type of microsclere, to which the name "clavidisc" is applied, a name to which exception might perhaps be taken on the ground that the spicule is characterised, not by anything resembling a key, but by something resembling a keyhole. The author considers that the canal system of the sponge belongs to a new type, to which he gives the name "hymenopylus," characterised by the fact that the very wide openings of the flagellate chambers are guarded by a delicate sphincter membrane. It is probable that the flagellate chambers of most sponges are "hymenopylous," and the condition is very well known in the Calcarea, but, of course, such a structure can only be made out in exceptionally well-preserved material. The arrangement of the prosopyles, consisting "simply of spaces between the fused rays of the stellate bases of the collar-cells," which the author is led to believe may possibly occur among other tetraxonid sponges, has, of course, been known for many years in the common British *Halichondria panicea*. In short, the canal system appears to be of the normal eurypylous type so common amongst the Monaxonellidæ, and it was hardly necessary to coin a new term for the special benefit of this sponge. The paper is admirably illustrated, and will be read with great interest by all spongologists.

EXPERIMENTS described by Dr. R. Seeger in the *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften*, Vienna (vol. cxix., part 9), indicate that hemiparasites of the tribe Rhinantheæ transpire much more freely than autotrophic plants. Thus *Euphrasia Rostkoviana* and *Odontites verna* gave off 19 milligrams of water in 10 minutes, as compared with 6 milligrams transpired by *Veronica chamaedrys*, 1·8 by *Hydrangea hortensis*, and 0·48 by *Rhododendron hybridum*.

A FULL description of the forestry court at the United Provinces Exhibition held at Allahabad in December last year appears in *The Indian Forester* (March and April). The exhibition comprised timber specimens and products, trophies of sport, and other forest products which occupied the three main buildings. In addition there were installed a turpentine distillery, a wood-pulp laboratory, wood-working machinery, a lac factory, various artisan demonstrations such as the Hoshiarpur wood carvers, and an exposition of katha extraction. The success of the section may be largely accredited to the energetic president, Mr. P. H. Clutterbuck.

A SHORT note on comparative trials with calcium cyanamide, ammonium sulphate, nitrate of lime, and nitrate of soda as artificial fertilisers, is contributed by Mr. F. J. Chittenden to the Journal of the Royal Horticultural Society (vol. xxxvi., part 3). Calcium cyanamide or nitrolim and nitrate of lime are both products manufactured at a high electrical pressure and compete individually with the other two fertilisers tested. The results obtained with turnip crops indicate that the first two are of about equal value, but are slower in their influence than the last two. Nitrate of lime suffers from hygroscopic defects, and provides weight for weight rather less nitrogen than nitrate of soda. Calcium cyanamide also presents physical difficulties which have been obviated by the production of a hydrated form.

THE account communicated by Mr. T. G. B. Osborn in *The Annals of Botany* (vol. xxv., No. 98) of the organism, *Spongospora subterranea*, producing "corky" or "powdery scab" of potatoes, is interesting not only for its economic aspect, but also for the cytological results recorded. In the earliest stage, the organism was observed as a uninucleate amœba in the meristematic potato cells. The amœbæ divide to provide units for the invasion of new cells, as also to form several individuals in each potato cell. Eventually the various amœbæ in a cell unite to form a plasmodium. Later on nuclei become very apparent in the plasmodia before fusion occurs in pairs (karyogamy); two karyokinetic divisions ensue, after which the protoplasm round each nucleus rounds off into a uninucleate spore. The author concludes that Spongospora is a member of the Plasmodiophoraceæ, which group has many points of relationship to the Mycetozoa, differing chiefly in the parasitic habit, the method of division of the vegetative nuclei, and by the less constant presence of a flagellum on spore germination.

MR. R. CORLESS contributes to *Symons's Meteorological Magazine* for June a useful article on the distribution of rain in a barometric depression. It is known that the heaviest rain usually falls on the left side of the path of the centre of a depression, irrespectively of the direction of its motion. The reason for this is shown by a diagram and a simple formula. For the sake of argument, the author considers a depression in which the wind at some altitude is blowing tangentially to the isobars, and for the immediate purpose all that is required is that when the path of the air is straight the relation vd = constant holds good between v, the wind velocity, and d, the distance between the consecutive isobars. When the path is curved cyclonically, the value of v as determined from this equation is theoretically too large; the error increases with increasing curvature, and the maximum curvature is shown to be on the left side of the path of the centre. The air has no alternative but to rise, and an ascending current of air is admittedly a cause of rain; it is in this region (the left front quadrant of the depression) that heavy falls of rain actually occur. Of course, rain falls in other parts, but its origin may be quite different from that here suggested.

UNDER the title "La Temperatura in Italia," the Italian Central Meteorological Office has published, as part i. of vol. xxxi. of its *Annales*, a very complete summary of the mean temperature of Italy. The main part of the volume is devoted to tables giving the mean temperature for decades, wherever possible, for each year of the period 1866–1906. The mean temperature is computed from observations taken at 9h. and 21h., and from daily readings of maximum and minimum thermometers, by the formula $\frac{1}{4}(9+21+\text{max.}+\text{min.})$. Data are given for about 120 stations, though only a small number of these can supply information for the whole period. The later chapters contain summaries of the information given in the main tables. We find in them values of averages and extremes for months, seasons, and years. Numerous plates showing the geographical distribution add greatly to the value of the work. The preparation of the data has been in the hands of Dr. Filippo Eredia, whose name is a guarantee for the excellent arrangement of the results.

IN 1908 a number of experiments carried out by Mr. H. E. Watson, of Trinity College, Cambridge, added about 200 new lines to the spectrum of neon, bringing the total number of lines to 321. Further research, the results of which are published in the June number of *The Astrophysical Journal* (vol. xxxiii., No. 5, p. 399), has shown that certain regularities, suggesting subdivision into "series," occur in the oscillation frequencies of these lines. The lines appear to be divided naturally into three groups, one of 252 lines extending from the extreme red to λ 4071, a second of 29 lines extending from λ 3754 to λ 3370, and a third consisting of 40 lines between λ 3167 and λ 2736. On investigating the oscillation frequencies, Mr. Watson finds that there are distinct indications of regular differences which suggest the existence of a principal and two subordinate series, in which the lines are grouped in triplets and quadruplets with constant frequency differences, the whole arrangement resembling the blue section of the red spectrum of argon investigated by Rydberg. The investigation of these brighter lines and of the numerous weak lines is being continued, and it is hoped that, by methods not purely mathematical, a further elucidation of this remarkable spectrum will result.

IN the abstract of Prof. Silvanus P. Thompson's paper on harmonic analysis, printed in NATURE of June 29 (p. 607), it was stated that the process described to find the coefficient of any term in the harmonic series set down was subject to a limitation. This limitation was expressed in the abstract issued by the Physical Society, but was omitted in the abridgment published in NATURE in order to bring the report of the society within reasonable limits of space.

OUR ASTRONOMICAL COLUMN.

A NEW COMET, 1911*b*.—A telegram from the Kiel Centralstelle announces the discovery of a new comet by Mr. Kiess at the Lick Observatory on July 6. At 15h. 23·7m. (Lick M.T.) the position was

R.A. = 4h. 51m. 51·8s., dec. = 35° 15′ 2″ N.

A later telegram gives the position on July 7, at 14h. 39·7m. (Lick M.T.), as

R.A. = 4h. 52m. 54s., dec. = 34° 52′ 17″ N.

The comet is fairly bright, magnitude 9·0, and has a tail, but its position, about $1\frac{1}{2}$° north of ι Aurigæ, makes it a difficult object to observe in these latitudes. At 1 a.m. the altitude of ι Aurigæ is about 8°, and its direction is north-east.

NOVA LACERTÆ.—No. 5, vol. xxxiii., of *The Astrophysical Journal* contains a note by Prof. Frost discussing the observations of Nova Lacertæ and its spectrum, made at the Yerkes Observatory between December 31, 1910, and May 6.

A suspected nebulosity around the star, shown on the earlier photographs, was not confirmed by later observations with the telescope readjusted. Despite its distinctly red colour, the light from the nova was found to be strongly actinic, a phenomenon accounted for by the considerable extension of the spectrum into the ultra-violet. With the 40-inch telescope, Prof. Barnard found that a sharp crimson image of the nova, due probably to Hα, was formed 9 mm. further from the object-glass than the usual image, which conformed with the ordinary stars.

Two series of spectrograms were secured, one with the Bruce spectrograph, the other with an objective-prism camera having a U.V. 15° prism; the scale of the latter is such that the distance on the plate from $H\beta$ to $H\theta$ is 3 mm. The outstanding features of the spectra are broad bright hydrogen lines, and a very strong bright band which Prof. Frost designates λ 4640. On the Bruce spectrogram (scale, 1 mm. = 26·0 A.U.) dark shadings and bright maxima are suspected within these bright lines, and dark lines are seen on the more refrangible edges, especially in the cases of $H\beta$ and $H\gamma$. The displacements of the lines, if interpreted by line-of-sight motions, would indicate velocities varying from −1300 to +760 km. per second. Spectrograms taken on May 4 and 6 indicate a strengthening of the chief nebular line at λ 500, thereby suggesting that the change to the nebular state, apparently common to all novæ, had set in.

A number of observations of position, magnitude, and colour of the nova are recorded by various observers in No. 4509 of the *Astronomische Nachrichten.*

THE TAIL OF HALLEY'S COMET.—As an extract from No. 3 of *Ciel et Terre* we have received a paper in which Prof. Eginitis summarises the discussion concerning the appearance of the tail of Halley's comet on the night of May 20, 1910. Having demonstrated that an error of observation, at Athens, is out of the question, he explains the apparent digression between his observation and some others by the suggestion that at that time the earth was situated on, or very near to, the axis of the main tail. Thus only the nucleus bounded by nebulosity would be seen, and the form observed would be one that would change rapidly as the angle under which it was seen changed. The differences are thus reduced to a question of perspective, and it is argued that this would change quickly at that critical period.

THE GREAT RED SPOT ON JUPITER.—Mr. Stanley Williams, writing to the *Astronomische Nachrichten* (No. 4507), confirms the abnormal change of longitude of the Red Spot, which was observed by the Rev. T. E. R. Phillips and others. In addition, he remarks upon the great change in the visibility of the spot itself which has recently taken place. For several years the spot has been indistinct and not of its earlier characteristic red colour, but lately it has been, to Mr. Williams, not only a comparatively conspicuous object, but also strongly coloured. It would seem that the spot is now free from the overlying material which has for some time masked its characteristic clearness and colour. Mr. Williams's transit times, taken on May 10 and 17 and June 1 and 8, confirm the change of longitude, and show that the length of the spot has not changed; the difference of longitude, −7·7°, between June 1 and 8, if real, is remarkable.

DEFINITION OF THE TERM "DOUBLE STAR."—Having for some years been desirous of establishing a definite scope for the term "double star," Prof. R. G. Aitken recently prepared a scheme for this purpose and submitted it to the chief double-star observers of the world. The majority agreed that some restriction to the use of the term is necessary, while others believe that the difficulties in establishing a rigorous system would outweigh the advantages accruing from its adoption. Prof. Aitken publishes his scheme, and the correspondence respecting it, in No. 4505 of the *Astronomische Nachrichten.* His definition of a double star includes any two stars which come within the following limits of distance:—

1″	if combined mag. of components	is fainter than	11·0
3″	,, ,,	,,	9·0 B.D.
5″	,, ,,	lies between	6·0 and 9·0 B.D.
10″	,, ,,	,,	4·0 ,, 6·0 ,,
20″	,, ,,	,,	2·0 ,, 4·0 ,,
40″	,, ,,	is brighter than	2·0 B.D.

JUBILEE MEETINGS OF THE INSTITUTION OF NAVAL ARCHITECTS.

THE jubilee meeting of the Institution of Naval Architects opened on Monday evening, July 3, with a reception by the president, the Marquis of Bristol, which was attended by members and delegates from all parts of the world. H.R.H. the Duke of Connaught took the chair at the meeting on the morning of July 4 as honorary president of the congress, and the president's address was delivered at this meeting. Reference was made to the death of the late president, Lord Cawdor, whose personality and zeal marked him out as a leader whom men would be proud to follow. The present congress had a twofold purpose—to commemorate the jubilee of the institution and to bring together from all parts of the world the great leaders in this sphere of industrial activity. The council desired to do honour to their guests from abroad, and had determined to invite the following to accept honorary membership of the institution, the highest honour in their power to confer:—H.M. the King of Norway, H.M. the King of Spain, H.M. the King of Sweden, H.I.H. Prince Henry of Prussia, H.I.H. Archduke Ferdinand, H.R.H. the Duke of Connaught, H.R.H. the Duke of Genoa, Prince Roland Bonaparte, Lord Rayleigh, Admiral Dewey, Admiral Togo, and Admiral Ijuin.

Sir William H. White gave an interesting account of the history of the Institution of Naval Architects, in which he referred to Sir Nathaniel Barnaby, the only survivor of the little group of men whose meeting on January 16, 1860, practically secured the establishment of the institution. Looking back upon work which has been done by the institution, it may be claimed that the intentions of its promoters, on the whole, have been well fulfilled; in some respects they have been surpassed. The meetings of the institution have afforded exceptional opportunities for the discussion of questions affecting the science and practice of naval architecture and marine engineering, the construction of warships and of merchant ships, the shipbuilding policy of Great Britain, the safety of life and property at sea, the introduction of new materials of construction and structural arrangements, the development of experimental methods of research, the introduction of new methods of ship calculations and design, and the discussion of new inventions of various kinds. Before the institution was founded, naval science had no home in England; its treasures lay scattered far and wide in the form of memoirs and papers contained in the Proceedings of the Royal Society or in other publications. Everything worthy of publication now naturally finds its way to the Transactions, and through them to naval architects, marine engineers, and others interested in these subjects throughout the world. Every great movement may be said to have been chronicled for fifty years.

Fifty years' architectural expression of tactical ideas formed the subject of a paper by Admiral Sir Cyprian Bridge. In the year 1860 what may be called the seventeenth-century type of man-of-war was still represented in the British Navy. The gun, as the weapon without a rival, conspicuously dominated tactics. The great change introduced in 1871, the virtual abolition of the broadside system of arming ships, occurred at a time when the contest between the gun and armour was in full progress. Tactical considerations receded into the background. In 1871 we adopted as a weapon of war the Whitehead locomotive torpedo. It is a remarkable fact that the adoption of this weapon and the limitation of a ship's gun-armament to a small number of the heaviest guns that she could carry occurred almost simultaneously. We made no tactical provision for dealing with torpedo attacks; reliance was placed on passive defence arrangements exclusively. The French were the first to break away from the position above indicated. They had a vivid perception of the great tactical principle that concentration of the effect of weapons should be the end aimed at, and that concentration of the weapons themselves is merely the means. They armed their ships in accordance with this principle, and other nations had to follow their example. The ships launched or designed for our own navy during the last dozen years of the nineteenth century and the first two or three years of the twentieth supply monumental evidence of the reviving, but far from dominant, influence of tactics.

Fifty years' changes in British warship machinery were dealt with by Engineer-Vice-Admiral Sir Henry J. Oram. In 1860 the Navy List included a total of 499 ships, having a collective indicated horse-power of 540,000. In 1910 the number of warships was 585, of approximately 5,000,000 indicated horse-power. The founding of the institution coincided with the abandonment of the paddle-wheel in favour of the screw-propeller. The warship fitted with the most powerful machinery in 1860 was the *Warrior*, which had engines of 5469 indicated horse-power. The introduction of surface condensers was referred to, as also triple-expansion engines, the evaporator, and the steam turbine. The author also dealt with the troubles experienced in finding suitable boilers.

Mr. C. E. Ellis described the advances made in the manufacture of armour for ships during the last fifty years. To resist the attacks of guns of ever-increasing power, the thickness of side armour was increased from 5½ inches in the case of the *Agincourt* (1868) to 24 inches in the *Inflexible* (1881). The introduction of compound armour effected a revolution in ship protection. Its partial adoption for the turret protection of the *Inflexible* effected a saving of 600 tons in weight. Since then the efforts of Krupp, Captain Tresidder, and Harvey have led to great reduction in the weight of armour required. In evidence of this, a 12-inch plate, tested in 1897, was attacked by three armour-piercing projectiles of high quality. In each case the projectile was completely broken up, and no cracks appeared in the plate.

Dr. S. J. P. Thearle traced the developments in mercantile ship construction. Fifty years ago some of the ships of the mercantile marine were being built of iron, some of wood, and a small proportion were of composite construction. In 1860 the length of an average cargo steamer was less than 200 feet; now it has reached to 350 and 400 feet. Much of the development has been owing to the introduction of mild steel for iron. Finality has not yet been reached, nor is it likely to be in the near future.

It is of interest to note from the Hon. C. A. Parsons' paper, on the marine steam turbine, that there are now a total of 281 war vessels, 87 mercantile vessels, and 10 yachts fitted with his well-known turbines. The total horse-power of these amounts to 5,841,000.

An account of the progress of naval construction in Japan was given by Rear-Admiral Motoki Kondo. At present there are four navy yards in Japan, and two large private shipbuilding yards, capable of turning out the heaviest warships complete with their machinery. Armour plates of trustworthy quality are now being produced in the Kure Navy Yard. The author understands that the process is a special one invented by Japanese engineers, and that the results are fully up to the best armour plate of the day. The progress of naval engineering in Japan was described by Engineer-Rear-Admiral Terugoro Fujii, and the development of merchant shipbuilding in the same country by Dr. S. Terano and Mr. M. Yukawa. These acknowledged the debt which Japan owes to engineers in this country for advice and help.

A paper on the design and service performance of the Transpacific liners *Tenyo Maru* and *Chiago Maru* was presented by Prof. S. Terano and Prof. Baron C. Shiba. These vessels were built in Japan; they are the largest vessels yet produced in the East, and are the first turbine steamers in Pacific waters. During the last year, and owing to the uncertainty of oil-fuel supply in Japan and China, the owners decided to burn coal. Six of the boilers were converted to use coal, and the remaining seven still burn oil. It is found that the consumption of coal is 20 to 22 tons as against 14 tons of fuel oil.

Among the many other papers presented is one by Prof. A. C. E. Rateau, on the rational application of turbines to the propulsion of warships. Owing to the low efficiency at ordinary speeds, turbine machinery reduces by one half the radius of action. This does not have much importance to Great Britain, as she has naval bases in all the seas of the world; but other nations are not in the same position as regards turbines; indeed, one of the most powerful of these is about to replace turbines by reciprocating engines for her new battleships. The author describes a combination of reciprocating engines and turbines, introduced into the French Navy in 1906, which appears to meet the case. The destroyer *Voltigeur*, fitted with this system, shows consumptions, at speeds below 20 knots, slightly above those obtained in destroyers fitted with reciprocating engines. Above 20 knots the consumptions remain fewer than those of all other destroyers, even with turbines only.

On Wednesday, July 5, a large company proceeded to the National Physical Laboratory for the opening of the experimental tank. An account of the opening is given in another article in this issue.

THE OPENING OF THE NATIONAL EXPERIMENTAL TANK AT THE NATIONAL PHYSICAL LABORATORY.

THE National Experimental Tank for experiments on models of ships, recently completed at Teddington, was formally opened on Wednesday, July 5, and the great public interest taken in the work was evidenced by the number of distinguished guests who travelled to Teddington to be present at the ceremony. The chair was taken by Sir Archibald Geikie, who, as president of the Royal Society, is chairman of the general board of the laboratory, and he was supported by Lord Rayleigh, the chairman of the executive committee, with Lady Rayleigh, the Marquis of Bristol, president of the Institution of Naval Architects, and Lady Bristol; while among those occupying seats on the platform were Mr. A. F. Yarrow, Dr. Glazebrook, the director of the laboratory, and Mrs. Glazebrook, Sir Wm. and Lady White, Mr. G. S. Baker, the superintendent of the tank, and Mrs. Baker, H. E. Senor Edwards, Sir Wm. Crookes, Mr. R. W. Dana, Rear Admiral Capps, Herr Hüllmann, M. Bertin, Sir Norman Lockyer, Mr. Alex. Siemens, Sir J. W. Swan, Rear Admiral Moore, Mr. A. B. Kempe, Sir J. Rose Bradford, Sir J. Larmor, Sir Chas. Parsons, Prof. Unwin, Sir J. Wolfe Barry, Sir David Gill, and Mr. F. W. Black.

Sir Archibald Geikie, in opening the proceedings, referred to the efforts which had been made since 1901 by the Institution of Naval Architects to secure the funds necessary for the construction at the National Physical Laboratory of a tank for ship-model experiments of a national character, where facilities could be provided for experimental work necessary to shipbuilders to enable them to improve and perfect the principal features in the design of their vessels. The project has now been realised owing to the generosity and enthusiasm of Mr. A. F. Yarrow, who has provided the sum of 20,000*l.* for the construction and equipment of the tank, while the Institution of Naval Architects has secured guarantees amounting to 1340*l.* per annum towards the sum of 2000*l.* per annum for ten years considered necessary to ensure the successful working of the tank.

Lord Rayleigh, to whom fell the task of declaring the tank open, spoke of the pioneer work accomplished by the late Mr. William Froude, who in 1871 started a tank at Torquay, and by his investigations established the fundamental principles to be followed in the application of this method of research to the science of shipbuilding. The Torquay tank was followed by the Admiralty tank at Haslar, where the work so well begun by the father is now ably continued by his son, Mr. R. E. Froude. Other tanks are now in existence in shipbuilding yards in this country, as well as on the Continent and in the United States of America. At the request of the Institution of Naval Architects, Dr. Glazebrook has visited a number of these tanks, and every assistance has been cordially rendered him, in particular by M. Bertin in Paris and by Prof. Busley and Herr Gebers in Germany, in the effort to ensure that the new national tank, for which the laboratory and the nation are indebted to Mr. Yarrow, shall be thoroughly well equipped for its work. To the realisation of the scheme the architect, Mr. Mott, and the contractors, Messrs. Dick Kerr and Co., have also largely contributed, while the superintendent of the tank, Mr. Baker, and his assistants have worked hard to ensure that the details of the equipment should be in every way satisfactory.

In his further remarks Lord Rayleigh made reference to some of the more important of the principles established by Mr. Froude, and especially to the principle of dynamical similarity, which laid down the conditions and relations governing the application of "model" methods to problems of naval architecture, as well as to similar problems in aëronautics and other subjects. In illustration of this principle, instances were adduced of its application in the domain of general physics, among which may be mentioned Lord Kelvin's proof of the "gravitational rigidity" of the earth.

In response to an invitation from Lord Rayleigh and a general demand from the assembled guests, Mr. A. F. Yarrow spoke of the needs, national and individual, which it is hoped the tank will help to fill. He was glad to have the opportunity of thanking those who have cooperated in furthering the scheme for the construction of a national tank, and especially the Institution of Naval Architects and Sir Wm. White. As in other branches of engineering practice, scientifically organised experiment is necessary to enable the shipbuilder to take advantage of every possible improvement in design. In the stress of competition with other nations it is imperative that no means of advance should be neglected. Shipbuilders must cooperate in furthering the development of their profession, on which the safety of the nation largely depends. The Admiralty has in the past led the way to progress, and it is important that in the future it should continue to encourage firms who show keenness to initiate improvements.

Lady Bristol was then invited to start the carriage by which the models are towed along the tank, and an experimental run was made and a record obtained of the resistance of a model specially prepared for the experiment. This record, in the opinion of the experts who examined it later, was of an extremely satisfactory character.

In replying on behalf of the Institution of Naval Architects, Lord Bristol spoke of the assistance given by the institution in the work of establishing the tank, and of the important practical results which it is hoped may be the outcome of the work to be undertaken.

At the conclusion of the proceedings connected with the opening ceremony, the visitors were entertained at tea in the grounds of Bushy House, and had the opportunity of visiting other departments of the laboratory.

A description of the tank and its equipment were given in NATURE in the number for June 15 of the current year.

ASSOCIATION OF TECHNICAL INSTITUTIONS.

SUMMER MEETING AT CAMBRIDGE.

THE Association of Technical Institutions holds two public meetings every year, the annual meeting in London in the winter, at which the important business of the year is discussed, and the summer meeting, held in different places throughout the country, which the members regard as much a friendly gathering for the informal interchange of information as a serious conference to listen to learned papers. Nevertheless, at the summer meeting, which was held at Cambridge on Thursday and Friday last, very important questions formed the subject of the papers.

Training of Technical Teachers.

On the first day the association discussed the qualifications and the training of teachers of technological and commercial subjects, papers being submitted by Mr. C. T. Millis, principal of the Borough Polytechnic, S.E., Mr. A. Nixon, principal of the Municipal Evening School of Commerce, Manchester, and Dr. T. Percy Nunn. In view of the extension of the provision in both day and evening schools of instruction in technological and commercial subjects, and of the still further extension which could be brought about by the raising of the school-leaving age, the council of the association felt that a discussion of the qualifications and the training of teachers would serve a useful purpose, and it must be said that if nothing very definite was produced by the papers, or by the subsequent discussion, the subject is a very thorny and difficult one, and any light thrown upon it is helpful. Mr. Millis and Mr. Dixon dwelt most strongly on the need for practical or workshop experience in the teacher, while Dr. Nunn represented more the pedagogic aspect of the case, and insisted on his qualities as a teacher rather than as a skilled workman. All three papers, of course, regarded the combination of the two qualities as ideal.

Mr. Millis summed up the essential and requisite qualifications in the training of a good technical teacher as follows:—(1) a fairly good education; (2) a liking for teaching others; (3) a sound practical knowledge of the trade or industry which he has to teach—this must be gained from actual experience; (4) a knowledge of the growing trade literature and of the improvements and changes in the methods and processes of manufacture; (5) attendance at classes in the trade subject he has to teach; (6) a sound knowledge of the science or art subjects cognate to the trade or industry; (7) ability to teach both theoretical and practical work; and (8) ability to teach with energy and enthusiasm.

Dr. Nunn admitted at the outset that on one hand the belief was held that all teachers would be the better for training, but that on the other some people regarded the idea of training the highest class of technological teachers as almost an absurdity. The latter view, he contended, was not based upon their universal efficiency. "Some of these teachers have been and are among the most brilliant masters of the craft of exposition. Others have been so amazingly bad that, like ancient heroes, they have become centres of legend. Their reputation for boring and bewildering their students has grown into the cherished mythology of the institution which their genius as investigators illuminated." Yet it was the training of the teachers at the other end of the technological hierarchy —the teachers of workshop arithmetic, science, &c., preparatory to technical instruction proper—which carried us to the heart of one of the most thorny educational problems. School teaching, especially on the scientific and mathematical side, Dr. Nunn remarked, should aim at illuminating the practical value of knowledge in relation to adult activities in which the boy can imaginatively enter. The following quotation from Dr. Nunn's paper sums up his view of the training of the preparatory teacher:—

"If there is to be no break between 'general' and technical education; if the technical ideal is to rule throughout, then there must also be continuity in the training of the teachers. There should be no teachers of mathematics and science who have not come into real touch with the technical spirit in its new and liberal form, and have not added to their academic equipment the practical outlook and sympathy which it generally lacks so woefully. Side by side with them, for the greater part of their training, should be the teachers whose stronger technical bias marks them out for charge of the preparatory technical work of the central elementary and continuation schools. Some actual workshop experience should be an essential constituent of their course of preparation. Finally, we should have the technical teacher proper, the man who comes to his class daily from the workshop or the mill. The ideal would be reached where there was the closest association in training between the man who has real technical knowledge, but is ultimately drawn to teaching, and the man who, having received some training as a teacher, spends the greater part of his life in the actual practice of the trade which he teaches in the technical institute."

The general opinion of the members who took part in the discussion is well represented by Dr. Walmsley, of the Northampton Polytechnic, who declared that the training of the technical teacher was to be sought, not in the classroom, but in the workshop.

The School Attendance Bill.

On Friday morning the members listened to a most able exposition of the Government's Education (School and Continuation Class Attendance) Bill by Mr. P. Sharp, secretary to the St. Helen's Education Committee. Sir H. F. Hibbert, president of the association, occupied the chair, and pointed out that the carrying of the Bill into practice would mean large additions to elementary day schools, large additions to the staff, and considerable increases in the number of evening continuation schools. The Bill would involve the abolition of half-time, and its consideration would therefore bristle with difficult points so far as Lancashire and Yorkshire were concerned. The views of the association are represented in a resolution, passed at the suggestion of Mr. Hewitt (Liverpool), seconded by Principal Reynolds (Manchester), to the effect that, "while cordially approving of the general principles of the Bill in the effort to secure continuous education of all scholars under suitable conditions to sixteen years of age, this association is of opinion that the provisions of the Bill as introduced require considerable amendment, especially in the direction of fixing more definitely the age of fourteen as the normal age for leaving the day school and in the incidence of compulsion upon employers to afford facilities for the attendance of young people at continuation schools by the reasonable limitation of their hours of labour."

At the close of the business of the meeting the president presented, on behalf of the association, a handsome silver rose bowl and four candlesticks to Dr. R. S. Clay, principal of the Northern Polytechnic Institute, Holloway, "in recognition of his valuable services as honorary secretary from 1907 to 1911."

The master of Caius presided at a dinner on Thursday night at Caius College, and the president of Queen's College received the members on Friday night.

Ralph S. Hyams.

THE OPENING OF THE NEW BUILDINGS OF THE ROYAL COLLEGE OF SCIENCE FOR IRELAND.

THE scientific work of the Department of Agriculture and Technical Instruction for Ireland received welcome recognition through the opening of the new buildings of the Royal College of Science for Ireland by the King, accompanied by the Queen, as the first act of the royal visit to Dublin on Saturday last, July 8. The ceremony was under the control of the Commissioners of the Board of Public Works, and a picturesque temporary hall had been constructed in the Great Quadrangle, through the open side of which the front of the new college was visible. The vice-president of the Department of Agriculture and Technical Instruction (the Rt. Hon. T. W. Russell, P.C.), the higher officials of the Department, and the professors of the college, had the honour of being presented to their Majesties. The King was pleased to announce that he had conferred a knighthood on Prof. W. Noel Hartley, F.R.S., dean of faculty of the college, whose absence through temporary illness was greatly regretted. The architects, Sir Aston Webb, R.A., and Mr. T. Manley Deane, and the builder, Mr. W. H. McLaughlin, were presented to his Majesty, who knighted Mr. Deane upon the spot. A pleasing feature was the introduction to their Majesties of a deputation of the foremen engaged upon the works.

The Minister in Attendance (the Rt. Hon. Augustine Birrell, P.C.) then asked the King to open the college, and their Majesties, conducted by the officers of the Board of Works, visited the building. Though the ceremony had little of an academic character, the large number of visitors honoured with an invitation must have realised the place taken by science in the educational system now being built up in Ireland, and the honour conferred on Prof. Hartley will be warmly appreciated. When the classes begin work in October in the handsome building now provided, it is hoped that a scheme of correlation may be introduced by which the Irish universities will take advantage of the courses of instruction in applied science in the college. It is important to remember that the maintenance of such courses, from the days of the Science and Art Department onward, has been recognised as a part of the system of public education, and that the new building of the Royal College of Science for Ireland represents visibly the stimulus given to scientific observation and research by Sir Horace Plunkett and his colleagues when they reorganised the agricultural and technical instruction of the country.

THE EUGENICS EDUCATION SOCIETY.

THE annual report of the Eugenics Education Society shows how much progress has been made by the society during the three years of its existence. Besides quick growth of the parent stem, branches have spread from Liverpool to New Zealand; indeed, in New Zealand eugenic ideas seem to be making their way into legislation.

The main feature of the report, however, is the address of the new president, Major Leonard Darwin. Major Darwin emphasises the view that the study of heredity and its application to sociology is the main function of eugenics. He says:—

"Although the science of heredity is now young, yet certain not hitherto widely recognised conclusions can already be preached with absolute confidence:

"(1) That men are very differently endowed by nature in inherent mental and bodily qualities. . . .

"(2) That in normal conditions, although [individual] children differ widely from their parents, yet each generation closely resembles its predecessors in average inherent qualities; a truth which applies to every nation, and every separable section of a nation.

"(3) That it follows from these premises that, if one nation is more highly endowed than another in inherent qualities, that superiority will remain with it generation after generaton in the absence of disturbing causes. . . .

"(4) That if the least naturally gifted sections of a nation are reproducing their kind more rapidly than are those more highly endowed in mental and physical qualities, then the higher are being swamped by the lower, and the nation is decadent. . . .

"(5) Lastly, that whilst every effort to improve the environment of the nation should be made, modern science indicates that the beneficial results on the race of possible changes in external conditions are, in nearly all cases, likely to be far less than was formerly believed to be the case, the advantages being, moreover, probably dependent on the maintenance of the reforms in question; whereas no assignable limit can be placed to the amount of the improvement in the condition of the nation which might in time result from reforms affecting its inherent qualities, the results thus attainable being also of a vastly more permanent character."

In the necessary application of these principles in practice, Major Darwin places in the forefront the need of legislative power to segregate the feeble-minded. He says:—"Here the difficulties encountered ought not to be great, since public opinion is already largely on our side." Doubtless, instructed public opinion is almost or quite unanimous. But, unfortunately, instructed public opinion has little voting power in present political conditions, and the long delay in carrying out the recommendation of the Royal Commission on Mental Defect is impressing on us the unwelcome fact that the Government and Legislature will take no action, even in a case which is urgent and patent to every thinking man, unless there are votes behind it. All the more need exists, therefore, for the efforts of such associations as the Eugenics Education Society to awake the nation to the evils of further inaction.

On the other side, Major Darwin rightly points out that much might be done by the adjustment of taxation to give really effective economic relief to households consisting of large families of sound stock. He also revives the suggestion that the Government as an employer should pay salaries to include an allowance for every living child. As Government employees are usually picked men, this proposal has definite eugenic value.

Major Darwin concludes with a striking passage on the moral question. He says:—

"With regard to the moral aspects of eugenics, what is it which has hitherto been the chief aim of the moral teacher? Has it not been to enforce the necessity of self-sacrifice for the sake of our fellow creatures? The eugenic reformer now demands an enlargement of this code in the light of facts unknown to our ancestors, and pleads for the self-sacrifice of this generation for the sake of the moral and physical welfare of the countless millions of the unborn of the future. May not this be the greatest moral question of all?"

W. C. D. W.

PERUVIAN ANTHROPOLOGY.

UP to the present, the dearth of knowledge regarding the people of Peru has been due to the almost complete lack of anthropological examination of the living subject and to the nature of the material available, consisting largely of skulls accidentally or artificially deformed, normal specimens from this region being rare in our existing collections. We knew in a general way that Peru, shortly before the conquest, was peopled by at least three or four Indian races: the Aymara and Quichua in the central and southern highlands; the Huancas in the north; the Yungas or Chinchas along the coast, besides several still unclassified tribes in the north-eastern and northern territories. From recent accessions of material collected by the American museum, we are now able to differentiate the Aymara, representing a dolicocephalic type, from the middle coast people, who are brachycephalic. Further information has now been collected by Dr. Ales Hrdlicka, curator of physical anthropology in the United States National Museum, who has recently made a hasty tour through the coastal region and a more careful examination of two important sites, Pachacamac and Chan-chan or Gran Chimu. The results of his investigations are published in vol. lvi., No. 16, of the Smithsonian Miscellaneous Collections.

It now appears to be certain that the whole, or the greater part, of the Peruvian coast was originally peopled by a race of a single type, brachycephalic Indians of moderate stature. The remains of the earliest people are found in the huacas and some cemeteries associated with pottery of simple but interesting forms. Metal is scarce, and when found is gold. These people were followed by others of the same fundamental type, but of different habits, as is shown by the fact that their skulls have been subjected to occipital flattening and fronto-occipital deformations. In their graves are found copper and brass, with a little gold and some simple pottery. Upon this brachycephalic people a dolichocephalic race, probably from the north, intruded, and were the makers of the more highly ornamented pottery, some specimens of which are illustrated in this memoir.

The material collected by Dr. Hrdlicka contributes some other interesting facts. No case of rachitis was observed, and in only one vertebra was there indications of tuberculosis; but the evidence is not quite conclusive, and the age of the grave is uncertain. The specimens indicating syphilis were recent. Fractures were rare, the setting defective, and there were no indications of surgical skill. The evidence for trephining is confined to a single case. Finally, it is clear that the ordinary collections of Peruvian pottery possess no scientific value, as it is usually a heterogeneous mixture of specimens of different races and epochs. The work of exploration must begin *de novo*, and the new race of archæologists must adapt those methods of scientific excavation of which the work of Dr. Arthur Evans in Crete and Prof. Flinders Petrie in Egypt are such excellent examples.

AËRONAUTIC INVESTIGATIONS.[1]

THE Advisory Committee for Aëronautics was appointed in April, 1909. The first report of the committee was prepared in April, 1910, and presented to Parliament in July of that year. At the date of the preparation of that report no very large amount of experimental work had been completed: the first year's work was necessarily largely devoted to an examination of the ground to be covered, with a view to the determination of the questions upon which experimental information was most urgently required, and to the design and construction of the necessary apparatus.

The aim of the present report is to give a general account of the work of the committee during the year 1910–11. The technical papers giving the detailed results of the various investigations which have been carried out by the experimental department, with other reports and memoranda of general interest which have been laid before the committee, are no longer included with this report, but will be collected together in a volume to be issued separately. This will be referred to as the Technical Report of the Committee for the year 1910–11.

During the past year the committee has had under consideration a large number of questions which have arisen in connection with the constructional work in progress at Farnborough and at Barrow. At the National Physical Laboratory, also, a considerable proportion of the experimental work has been directed towards the solution of specific problems of airship design and the determination of the necessary experimental data. In addition, research of a somewhat more general character has been carried out, and some results of fundamental importance with reference to the future work to be undertaken have been arrived at.

Equipment for Experimental Work.—The principal apparatus which has been installed at the National Physical Laboratory for the purpose of the researches in aëronautics now in progress was described in the report of the committee for 1909–10. The most interesting and novel addition to the equipment during the past year is a circular rotating water channel, to be used for determining the forces acting on plates and small models in a circular stream of water. It is hoped that, with the aid of this, certain data of fundamental importance in connection with the motion of an airship may be determined, and, in general, that the forces acting on aircraft when executing turning movements in the air may be investigated. In addition, a special water tank has been provided for the study, by visual and photographic methods, of the eddying motion in the rear of plane and curved surfaces, balloon bodies, &c.

Air and Water Channels.—The laboratory has now at its disposal for resistance experiments two air channels—the larger air channel of 4 foot square section, specially constructed for the aëronautical work, and the circular channel of 2 foot diameter, previously employed by Dr. Stanton in his researches on the resistance of models in a current of air—and a water channel which continues to be of much value for obtaining results from which the corresponding data for air can be immediately deduced.

With these various means a large amount of experimental work has been carried out throughout the year. This work has included the determination of the resistance of a number of airship bodies of different forms, and the measurement for these forms of the "lift" and "drift" at various angles to the wind; the investigation of the relative stability of different airship models, and of the stabilising action of fins of different area and in different positions; the determination of the efficiency of various types of rudders and lifting surfaces, plane and curved; the air resistance of wires, stationary and vibrating, of stays and ropes, of model gondolas, model radiators, &c.; the investigation of the forces due to the wind acting on models of dirigible sheds of different forms; and of the forces acting under various conditions on a model of a girder of the type employed in the new Paulhan aëroplane.

Resistance and Directional Stability of Airship Models.—Perhaps the most interesting investigation among those enumerated above is that on airship models. The investigation has comprised a large series of observations on models of different forms, carried out at intervals throughout the year. The work has been directed to the determination of the head resistance for motion parallel to the axis, the "lift" and "drift" for motion oblique to the axis, the magnitude of the moment tending to increase the obliquity—called hereafter the negative righting moment—when the ship is at different angles to the relative wind, and the amount of fin area necessary to give a positive, in place of a negative, righting moment.

The work has been carried out in cooperation with the superintendent of the Army Aircraft Factory, who provided the models for the tests, the head and tail curves for which were systematically varied according to a plan devised by him. The object of the tests for head resistance was to determine the amount of change in resistance due to specific alterations of the curvature in head or tail, and ultimately to determine the forms of minimum resistance for a given gross lifting power and for a given net lift. The experiments led to the adoption of certain curves for head and tail, with a ratio of total length to maximum diameter of about 6 : 1.

The experiments on models inclined to the current determined the amount of dynamic lift obtainable owing to the inclination of the airship to the horizontal, as distinct from that directly due to the elevating planes, and at the same time the increase in head resistance owing to the obliquity.

The complete investigation of the conditions affecting the stability of path of an airship will no doubt take a

[1] From the Report of the Advisory Committee for Aëronautics for the Year 1910–11. [Cd. 5706.] (London: Wyman and Sons, Ltd., 1911.) Price 1½d.

considerable time to complete, but results of practical importance have been obtained in the determination of the negative or positive righting moments acting on models of airships of different forms. If an elongated model of the customary fish-shaped form be supported in a current so that it can turn about an axis through its centre of gravity, it tends to set itself at right angles to the current; when it is oblique to the current a moment acts on it tending to increase the obliquity. The amount of this moment has been investigated for different angles of obliquity in the case of several models; combined with the measurements of "lift" and "drift," this enables the magnitude and line of action of the resultant force on the model at any obliquity to be determined.

The next step was to find the amount of fin area necessary, and the best position for the fins, to give a positive in place of a negative righting moment. Experiments for this purpose have been carried out, and have led to interesting results. It was found, even with a considerably elongated tail, that if the fin were placed towards the rear of the tail and close to the body, the portion of the fin nearest the body was comparatively inactive, owing to the slow movement of the stream in this region. This slow motion of the stream near the tail was confirmed by photographs taken to investigate the nature of the flow past fish-shaped models.

These experiments have enabled the amount of fin area necessary to give a positive righting moment to be determined. Other questions which have to be investigated in connection with the general problem of stability are the effect of the instability of the wake, which does not leave the tail symmetrically when an airship body is moving parallel to its axis, and the "damping" action of the air as regards any motion which involves rotation, as when oscillations are set up, or in turning. Apparatus has been constructed with the aid of which it is hoped that the damping coefficient may be determined, and the effect of wake instability examined.

Air Resistance of Wires and Ropes.—The experiments which have been carried out on wires and ropes have also furnished results which will probably be of general interest. The tests were made on a large number of wires and ropes, including smooth wires of diameters ranging from 0·04 to 0·25 inch, with wire ropes of five or six strands and hemp ropes of three strands of diameters ranging from 0·1 to 0·6 inch.

The air resistance of the stranded ropes, per unit of the sectional area exposed to the wind, is found to be of approximately the same amount as that for small square plates. No great difference was found between wire ropes and hemp ropes at the same velocity. In the case of smooth wires, the resistance per unit of sectional area is appreciably less, the difference being of the order of 20 per cent.

Experiments were also made on the air resistance of vibrating wires; no appreciable effect on the air resistance was found at the vibration velocities reached, whether the wires were made to vibrate in a plane parallel to the direction of motion or perpendicular to it. It may be inferred, therefore, that in practice the air resistance of wires can be calculated on the basis of the values given for stationary wires in the table printed in the account of these experiments given in the technical report.

It is of interest to note that the values found at the National Physical Laboratory are in close agreement with the results obtained, also during the past year, for the resistance of stationary wires and ropes at the well-known aërodynamical laboratory at Göttingen under the direction of Prof. Prandtl. The work on airship models, and the results for the resistance of inclined plates, are also in general accordance with the observations of a similar character which have been made at Göttingen.

Wind Resistance of a Radiator of Honeycomb Type.—Experiments have also been made on the wind resistance of the honeycomb form of radiator. For the purpose of these tests, a scale model was made and its resistance compared in the wind channel with that of a solid block of the same external dimensions. The conclusion was that the wind resistance of such a radiator, in which the net area is about 25 per cent. of the total area, is approximately one half that of a flat board of the same dimensions.

It was considered of some interest to determine also the velocity of the air flow through the tubes of the honeycomb, and its variation with the length of the tube. In these experiments the tubes of the actual radiator were employed, and with a tube length of about 4 inches the wind velocity in the tube was found to be about three-fourths of the mean wind velocity outside. Reducing the length of the tube by one half produced an increase of only about 15 per cent. in the air velocity through the tube.

The general conclusion was that the honeycomb form of radiator is fairly efficient, and it does not appear that any considerable increase in efficiency can be obtained by diminishing the length of the tubes or by increasing the ratio of diameter to length beyond the value, viz. 1 : 12, which obtained in the type tested.

Other Tests in the Air Channel.—Among the other investigations which have been made in the air channel may be mentioned a series of tests on models of dirigible sheds of different design to determine the resultant force on each due to the wind; tests to determine the wind resistance of a model gondola; and a number of experiments on a model of the girder designed by Fabre and used in the new type of Paulhan aëroplane. The experiments on this girder were directed to the determination of its head resistance at various angles to the relative wind and also of the lift obtained from it when inclined about an axis parallel to its length. It was found that the efficiency of the girder, regarded as a small biplane, was about 50 per cent.

Small Water Channel for Visual and Photographic Work.—A small water channel has been constructed with a view to the investigation of the nature of the flow round an obstacle in a fluid medium. In this a steady stream of water is kept in motion, into which small models of plates, aërofoils, airship bodies, &c., can be introduced, and the nature of the flow can be studied with the aid of colouring matter added locally to the water.

With this apparatus interesting photographs have been obtained of the flow past plates and balloon models. These have shown that even for an elongated fish-shaped airship model the relative velocity of flow near the tail is considerably less than in the main stream, thus explaining the relative inefficiency, as regards the production of a righting moment, of the portion of a stabilising plane close to the body in this region.

Some valuable information has also been obtained with this apparatus as to the eddy formation in the rear of plane and curved plates, and the experiments on these will be continued.

Wind Pressure on Square Plates.—In connection with questions arising out of the model tests and the determination of the correction factor, if any, to be applied in passing from the results obtained in small model experiments to the corresponding full-scale values, an examination has been made by Messrs. Bairstow and Booth, of the National Physical Laboratory, into the experimental results obtained by different observers for the air pressure on square plates. Both Eiffel and Stanton in their experiments on square plates have found that the wind resistance per square foot of a small plate is less than that of a large plate, the difference, according to Stanton, as between plates 2 inches square tested in the wind channel and plates 10 feet square exposed in the open being about 20 per cent.

In the report of the committee for the year 1909–10 (p. 38) Lord Rayleigh pointed out the general form which, according to dimensional theory, the law of variation of resistance with dimensions must assume, and showed that such a variation as found by Stanton for square plates involved also a departure from the law according to which the resistance of a plate in a current of air is taken to be proportional to the square of the velocity. Messrs. Bairstow and Booth have shown that a formula can be found, falling under the general type indicated by Lord Rayleigh, which accurately represents the results both of Eiffel and Stanton over the whole range to which their experiments extended when both the dimensions of the plate used and the air velocity at which the results were obtained are taken into account.

The question is one which is at present mainly of theoretical interest, and the importance of which lies in the light it may throw on the comparison of water and air resistances. Lord Rayleigh in a second note, also printed in the technical report, has discussed the matter further, and has pointed out some difficulties in reconciling the general formula with certain conclusions from experiment. Some evidence is furnished by results recently obtained by Dr. Stanton in experiments on the flow of air in pipes and by the study, by visual methods, of the flow past obstacles in a water channel, but the matter demands further investigation before a final conclusion can be arrived at.

Friction of Air in Pipes.—Among the reports included in the technical report is a preliminary communication by Dr. Stanton of some results obtained for air friction by means of experiments on the flow in pipes, in which the effect of changes in the dimensions and roughness of the pipes is discussed. Some of the pipes tested were artificially roughened by cutting right- and left-handed screws along the inner surface of the pipes of pitch and depth proportional to the diameters. It is interesting to note that the dimensional relation for these artificially roughened pipes is precisely similar to that found by Messrs. Bairstow and Booth in their examination of the experiments on the normal resistance of flat plates of different sizes, referred to above.

Whirling Table and Propeller Tests.—A description of the whirling table and of the design of the dynamometer was given in the report of the committee for the year 1909–10. A number of tests on propellers of different types have been carried out with the apparatus there described, and particulars of some of these tests are given below. Recently, with a view to obtain increased propeller speeds, up to 3500 revolutions per minute, and a greater range and sensitiveness in the measurements, a motor of greater horsepower has been provided to drive the propeller, and a new dynamometer has been designed and constructed. A brake has also been added, since at high propeller speeds the propeller alone in some cases drives the whirling arm faster than is desired.

With the view of reaching as high an accuracy as possible in the future tests, especially at the higher speeds of translation, a careful study has been made of the motion set up in the air of the whirling table shed by the rotation of the whirling arm. As a result of the experiments, it was found that when the end of the arm was travelling at a speed of 35 miles per hour the mean velocity of the air in the shed at the boundary of the circle described by the arm was about 2 miles per hour, while the velocity of the air into which the arm was entering was 1·6 miles per hour. The air velocity was also found to be approximately proportional to the arm speed. The second figure gives the air swirl correction to the arm speed at 35 miles per hour required for the purpose of the propeller tests. In all future tests a direct determination of the swirl velocity will be made and the necessary correction applied.

Effect of Blade Area on Propeller Efficiency.—At the request of Captain Sueter, a series of tests was made to determine the effect on propeller efficiency of varying the width of blade. The tests were made on model propellers designed and supplied by Messrs. Vickers, Ltd., whose representative visited the National Physical Laboratory for a few days in order to take part in the work. Messrs. Vickers were also good enough to furnish the results of tests made at Barrow on a full-sized propeller, in order that these might be compared with the results of the small model experiments made at the laboratory.

For comparison with the full scale results, a test was first made on the corresponding model propeller at a speed of translation having a ratio to the test speed of the full-sized propeller equal to the ratio of the square roots of their linear dimensions. It was found that, for the same slip, the thrust and efficiency given by the model experiments differed only by a small amount from the values they should have as deduced by calculation from the full scale tests. The experiment is important from the point of view of the prediction of full scale results from small model tests, but the work so far done is not sufficient to justify any general conclusion as to the validity of the "model" law, which proved in this instance to be correct. It is hoped that further comparisons may be carried out shortly.

The further tests on the series of models were made at the speed of translation suggested by this preliminary work, and by reducing the width of blade from that used in the above experiment an increased efficiency was obtained. It was found that the maximum efficiency was reached at a disc area ratio of approximately 0·19.

Other Propeller Tests.—A series of tests has been made for the superintendent of the Army Aircraft Factory on some Ratmanoff propellers, to the design of M. Drzewiecki, who also paid a visit to the laboratory. These tests are not yet entirely completed, the intention being to carry them up to speeds of the propeller tip in the model equal to those occurring in practice with the full-sized propeller. For this work the new apparatus recently installed is required.

The particulars given in the detailed account of the propeller tests of the work so far done will, however, be found of interest. As is well known, the aim in the design of this propeller is that each element of the blade should strike the air at the same angle of maximum efficiency, the propeller being run at a definite ratio of translational speed to speed of rotation. The maximum efficiency reached with any of the propellers tested, at the propeller speeds attainable at the time when the tests were made, was 67 per cent., at a speed of translation of about 30 miles per hour.

In addition to the above, other experimental tests have been made, and some propellers have been tested for private firms or individuals.

Balloon and Aëroplane Fabrics.—A considerable amount of work has now been carried out at the National Physical Laboratory in connection with the testing of fabrics. The materials tested have included rubbered fabrics by various makers, oilskin, varnished silk, and other fabrics with special proofing, goldbeaters' skin, &c.

Strength Tests.—The apparatus employed for tensile tests has been supplemented by a testing machine by Messrs. Avery. This has been modified to enable wide variations in the rate of loading to be obtained. The dimensions of the test specimen now regularly employed are 20 cm. between the jaws of the testing machine by 5 cm. wide, and the usual rate of loading is such as to fracture the specimen in not less than two minutes.

Experiments to determine the effect of varying the rate of loading have been made, and it was found, for a particular fabric, that the ultimate strength found by rapid loading was about 14 per cent. higher than that found by slow loading. The rate indicated above as that now employed is practically equivalent to a dead-slow rate.

The existence of the speed effect just mentioned suggested the probability of a fatigue effect, and this question was also investigated. Some difficulty was experienced in devising a satisfactory method of test, as owing to the large and unavoidable variations between one sample and another, the usual methods of making fatigue tests are not applicable. With the method finally employed it was found that the strength of the particular fabric tested to withstand repeated applications of stress was about 11 per cent. lower than the strength taken on a single specimen loaded to rupture.

Bursting Tests.—Difficulties were originally found in making bursting tests owing to the fact that most of the earlier cylinders tested broke at the join. Finally, a cylinder of diagonally doubled material was obtained which did not burst at the join, and which broke at very high stresses. Damage done in this test led to the redesigning of the apparatus, and in the new apparatus arrangements have been made to enable the cylinder to be subjected to longitudinal tension in addition to internal pressure.

An account is given in the technical report of an interesting series of tests carried out with this apparatus. In these tests the ratio of the circumferential to the longitudinal stress varied from 2 : 1, corresponding to pure bursting test, to 0 : 1, corresponding to a pure tension. The tests appeared to indicate that the strength in warp or weft is approximately independent of stress applied in the direction at right angles. The behaviour of fabrics under various ratios of compound stress is being further examined by a graduated series of tests on a number of bags of a specially selected fabric.

In the above tests it was found that bags of parallel doubled material and of the same material diagonally doubled appear to be of nearly the same strength for a 1 : 1 ratio of stresses, while the tensile strength of the latter determined in the usual way is only half that of the former.

An account is also given by Mr. O'Gorman in the technical report of a large number of bursting tests carried out at the Army Aircraft Factory on a variety of fabrics. The object of these tests was to obtain a comparison with the ordinary tensile tests. The results showed that, on the average, the bursting tests on parallel doubled rubbered cotton gave results a little higher than the tension test, while for diagonally doubled fabrics the mean of the bursting tests was about 1½ times as great as the tension test. For single oilskin the bursting test gave a slightly lower figure than the tensile.

Tearing Tests.—Some tests have been made to determine the effect of a small wound in the fabric on its strength, with the view of indicating, if possible, the factor of safety necessary to ensure that such a wound or tear shall not immediately spread. The disturbance of stress distribution caused by such a wound is accommodated within a large but finite area of the fabric, which may be called the "danger rectangle." It was expected that the applied stress causing rupture of a specimen containing a relatively small cut of fixed magnitude would be independent of the dimensions of the specimen provided it were at least as large as the "danger rectangle," and the results obtained were in agreement with this theory. The necessary factor of safety for wounds of different sizes was given, for the particular fabric tested, as the result of these experiments. The work was limited to wounds of small size, which would, however, include ordinary bullet holes; apparatus is under construction to enable the work to be extended to wounds of larger dimensions.

Permeability Tests.—A large number of rubbered and other fabrics have now been tested for permeability by hydrogen. The apparatus employed continues to give satisfactory results, which can be relied upon to a high degree of accuracy. The practical conclusions to be drawn from these tests, especially when considered in conjunction with the weathering tests, would appear to be of considerable importance.

In the case of rubbered fabrics, the permeability is found to be more or less directly dependent on the quantity of rubber employed; the lighter rubbered materials show a higher permeability, a number of samples tested exceeding the maximum of 10 litres per square metre per twenty-four hours usually allowed in French specifications. This is especially the case with the parallel doubled cloths examined, and the work done points to the superiority of diagonal doubling from this point of view. The permeability of rubbered fabrics increases rapidly with rise of temperature, the increase being as much as 9 per cent. per degree centigrade in the samples tested.

Samples of oilskin, varnished silk, and of other fabrics proofed in various ways have also been tested for permeability. The exact nature of the proofing is not in all cases known. Some of these have shown excellent qualities as regards their hydrogen-holding capacity, the permeability in many of the samples being less than 1 litre per square metre per twenty-four hours, and in some instances not exceeding a quarter of this amount, with a less weight than that of the lighter rubbered fabrics above referred to. In some of these fabrics the hydrogen-holding capacity appeared to improve with rise of temperature.

Tests have also been made on a number of samples with joins. In the rubbered fabrics tested, and in some of the others, the permeability of the join was no higher than that of the rest of the fabric, but with proofing other than rubber the join has sometimes been found to have a much higher permeability. This is a point, therefore, to which attention must be paid. The joins have also sometimes shown a deficiency in tensile strength.

Weathering Tests.—The weathering tests of fabrics have been directed to the determination of the rate of loss of tensile strength and the rate of increase of permeability due to exposure in the open. The rate of diminution in tensile strength does not show any very important difference between the rubbered fabrics tested and those proofed in other ways. It is of interest, however, to note that the rate of deterioration was usually found to be most marked during the second month of exposure. Thus for one fabric the losses in strength in the first three months of exposure were approximately 9, 28, and 10 per cent., and similar figures have been obtained for other fabrics.

As regards the effect of exposure on permeability, the difference between the rubbered fabrics tested and some of the fabrics proofed in other ways has been very marked. In unprotected rubbered fabrics the deterioration in hydrogen-containing capacity has usually been comparatively rapid. The effect of the usual yellow protective colouring is, however, considerable. In several uncoloured samples, after fifty days' exposure in the open, the hydrogen leakage has been found to exceed 100 litres per square metre per twenty-four hours. A number of yellow fabrics, however, which have been exposed for some five or six months, are still moderately gas-tight, and, further, as regards tensile strength, are only a little weaker than the unexposed samples. From the more recent tests it appears that sunlight is the most important factor in producing deterioration.

On the other hand, the oilskins, varnished silk, &c., tested have not, in general, shown any appreciable increase in permeability with exposure. If taken down for test on a warm day, their hydrogen-holding capacity has often been found to have improved. In some cases where a sample has shown deterioration, it has again improved after further exposure, the temporary increase in permeability being probably due to crumpling when cold.

A very complete scheme of tests on rubbered and other fabrics is now in progress to examine more closely the rate of deterioration with exposure, and to distinguish between the relative effects of sun and moisture. Tests of various proofing materials are also being carried out at the laboratory, and some satisfactory results have been obtained.

Light Alloys.—A considerable amount of experimental work has been carried out on light alloys intended for structural work on airships and aëroplanes. Samples of the alloy known as "duralumin" have been supplied by Messrs. Vickers, Ltd., and the mechanical tests made on these were in general agreement with the results found at Barrow. Samples of channel bar tested at the National Physical Laboratory gave a tensile strength of 25·7 tons per square inch, and samples of wire 30 tons. Further investigation of this alloy will be undertaken, including ageing, fatigue, and corrosion tests, special attention being paid to the question of the permanence of the material. Tests of this kind are being made by the metallurgy department in conjunction with similar work on light alloys prepared in the laboratory. Some of these, at present being studied in connection with the work for the Alloys Research Committee of the Institution of Mechanical Engineers, are showing very promising results, tensile strengths up to 34 tons per square inch having been obtained, together with reasonable ductility and without recourse to special thermal treatment. When these new alloys have been more fully studied it is hoped that some of them will prove of service for aëronautical construction.

Meteorological Work.—The preliminary programme of experimental work adopted by the committee upon their appointment included the following items:—

(32) General information relating to the variation of wind velocity and phenomena connected with gusts of wind.

(33) Relative variation in speed and direction of the wind at different heights above the earth's surface.

(34) Vertical movements in the air.

(35) Rotary movements in the air.

(36) Electrical phenomena.

(37) Formation of clouds, snow, hail, &c.

The items numbered (32) to (35) were dealt with provisionally in a memorandum on details of wind structure, &c., by Dr. Shaw, presented with the report of the committee for last year. This has been followed up by further experimental work on vertical motion and rotary motion in the atmosphere at Pyrton Hill, by Mr. J. S. Dines, under the direction of the Meteorological Office. The results of the investigation are presented by three memoranda included in the technical report.

Electrical phenomena in connection with ballooning have been the subject of various communications to the committee.

Vertical Motion in the Air.—With reference to the first of the three memoranda above mentioned, the method which has up to the present been employed for the study of vertical motion in the air consists in observing, by means of self-recording theodolites, the variations in azimuth and altitude of a pilot balloon. With two such theodolites the path of the balloon can be determined both as regards its horizontal and its vertical motion, and the changes in vertical velocity due to air currents can be identified.

For the purpose of this work special self-recording gear was designed for attachment to an existing theodolite; two theodolites fitted with this self-recording gear, and specially constructed for the work, are now being provided. The apparatus is one which may be useful for many purposes besides that which has immediately led to its construction. The azimuth and altitude at any instant can be read off from the record with an accuracy of about one-tenth of a degree; this is sufficient for the purpose. The process of observing is thus simplified; with the self-recording instrument a balloon can be followed continuously without moving the eye from the instrument, and, further, the record can be taken by one observer only, whereas two are necessary in working with the eye-observing instrument.

A considerable number of records with this apparatus have already been obtained, and the results are in every way satisfactory. The records furnish definite evidence of the existence of vertical currents, but it is not yet possible to give any general discussion as to the conditions affecting vertical motion in the air as deduced from these observations.

Rotary Motion in the Air.—For the study of rotary motion in the atmosphere a special anemometer head has been designed to indicate both velocity and direction, with an apparatus to record automatically vector diagrams of the wind, from which the velocity and direction at any instant can be read. Full details of the construction are given in Mr. Dines's description.

In the earlier observations the head was mounted at a height of 36 feet above the ground; more recently a steel windmill tower has been erected for the purpose of these observations, and the head is now mounted on this at a height of 98 feet above the ground. There is no noticeable difference in the character of the diagrams taken at the two levels. The observations do not support the idea that eddy motion is the cause of the gustiness of the wind.

Some interesting particulars are given in Mr. Dines's report of comparisons between simultaneous records of velocity obtained from this anemometer and from a standard anemometer mounted on a house at a distance of 150 yards. As was anticipated from the work of previous experimenters, the individual gusts were not, as a rule, in agreement on the two records, but it is surprising to find that in certain cases squalls of five minutes' duration recorded by the anemometer on the house did not appear at all on the 98-foot record. A possible explanation of these differences is that an increase of wind velocity of as long as five minutes' duration may be confined to quite a narrow belt.

Gustiness of the Wind.—To aid in the study of gustiness, apparatus has been designed to register simultaneously the pull of a kite wire and the length of wire paid out. The tension record shows the fluctuations due to gusts, while, from the length of wire, with a knowledge of the vertical angle, the height of the kite can be approximately determined. A number of records have been obtained with this apparatus, and the discussion of these records by Mr. Dines will, it is thought, be found of great interest.

The mean gustiness found at altitudes from 500 to 1000 feet was 60 per cent. of the gustiness from 0 to 500 feet. Above 1000 feet no certain rule can be deduced from the observations. Easterly winds gave uniformly high gustiness factors; the anemometer at Pyrton Hill, where these records were obtained, is situated at the foot of the western slope of the Chiltern Hills, so that the gustiness of this easterly group of winds may be due to the previous passage of the air over the range. The decrease of gustiness with height does not appear to be dependent upon direction to any noticeable extent.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—At the Degree Congregation held on July 8 the honorary degree of Doctor of Laws was conferred on the Rt. Hon. Sir Joseph Ward, Bart., K.C.B., Premier of New Zealand. The following were admitted to the degree of D.Sc.:—William Ernest Fisher, David Frazer Harris, and Frederick Steward.

The Worcestershire County Education Committee has made a grant of 300*l.* to the University.

Mr. R. R. Cormack, lecturer in economic mineralogy, has resigned.

Mr. F. Lawrence Talbot has been appointed external examiner in the biology and chemistry of fermentation.

The following gentlemen have been appointed honorary assistant curators of the pathological museum for three years:—Dr. Stanley Barnes (medicine), Mr. A. W. Nuthall (surgery), Mr. J. T. Hewetson (diseases of women), and Mr. L. S. Sedgwick (comparative pathology).

Mr. J. Furneaux Jordan has been appointed Ingleby lecturer for 1912.

Prof. R. Beazley is to represent the University at the laying of the foundation-stone of the National Library of Wales, at Aberystwyth, by the King on July 15.

The tenure of the Walter Myers travelling studentship by Dr. John Dale has been extended for a further period of six months.

PRINCETON UNIVERSITY, it is announced in *Science*, has received gifts amounting to more than 20,000*l.*, of which 8000*l.* is for a lectureship in public affairs.

MISS STANCOMBE WILLS, an adopted daughter of the late Lord Winterstoke, has presented 10,000*l.* to Bristol Grammar School in memory of Lord Winterstoke.

DR. R. A. HARPER, since 1898 professor of botany in the University of Wisconsin, has accepted the offer of the Torrey chair of the same subject at Columbia University. Prof. Harper has had a somewhat unusual record, having begun his academic career as professor of the Greek and Latin languages at Gates College. From 1891 to 1898 he was professor of botany and geology at Lake Forest University.

THE Toronto correspondent of *The Times* states that Sir William Macdonald has completed a large purchase of land on the slope of the mountain adjoining Mountroyal Park, and will give the property to McGill University for a new campus and residential buildings. The purchase price was more than 200,000*l.* Including the cost of Macdonald College and its endowment, this brings Sir William Macdonald's total gifts to McGill University to about 2,000,000*l.*

IT was announced at the prize distribution at University College, London, last week, that Mr. R. C. Forster has made a further gift of 30,000*l.* to the fund for providing new chemical laboratories at University College. As Prince Arthur of Connaught, president of the appeal committee, wrote in acknowledging Mr. Forster's generous gift, this method "of commemorating Coronation year by promoting scientific study and research is a most happy one," and it may well be hoped that other wealthy men may adopt it so that the remainder of the sum required for the new laboratories may be subscribed at an early date. Early in the year, as was announced in NATURE (vol. lxxxv., p. 448), Mr. Forster gave 4500*l.* to complete the purchase of the site for the new laboratories. We trust that his generosity may inspire others to contribute, as further sums are still needed to complete the fund to supply a pressing need at University College.

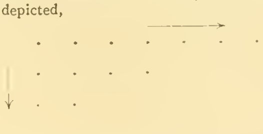
A RURAL SCHOOLS' EXHIBITION was one of the features of the Royal Agricultural Society's Show held recently at Norwich, and in connection with it the County Councils Association arranged on July 1 a conference on rural education. After a paper by Mr. Cloudesley Brereton on education in relation to agriculture, Sir George White, M.P., gave an address, in which he referred to the further education of school children. A leaving age of even fifteen years, he said, may be of little real value unless the great object of the teacher is to make the child think. "People," he remarked, "see a number of boys working in a manual class, say a carpenter's shop, and the first question they ask is, Are you going to make them all carpenters? They do not see that it is not the wood or the tools that are of consequence, but the play of intelligent thought that brings them together to produce a certain object which has been already formed in the brain. Those who assist in production should know something of the processes—such as a knowledge of mechanics—the principles upon which an industry depends, and the nature and property of the material they are using; then the work becomes more interesting, and the proficiency of the worker a matter of concern to himself as well as to his employer, and it is this conviction which has produced our technical schools. The time has surely come when manual training should be available and free to every scholar in our schools, and domestic economy in all its branches to every girl."

THE will of the late Dr. Harry Bolus, of Kenilworth, near Cape Town, contains a munificent provision for scientific and educational objects. Dr. Bolus's herbarium and library, the collection of which had been one of the principal works of his life, are left to the South African College, Cape Town, an institution in which he had previously shown his interest by a large contribution to the foundation of the chair of botany, which is called by his name. He leaves a sum of 20,000*l.*, invested in Government Stock at 4 per cent., on trust for the upkeep and extension of the herbarium and library. This amount will later be increased by an additional sum of 7000*l.* A further amount of 21,000*l.* is also left to the same college for the foundation of scholarships. It is directed that in the selection of scholars to benefit under this fund regard shall be paid to necessitous circumstances and proof of industry, and not exclusively to ability. Eventually Dr. Bolus's landed property, on which is situated the house in which he lived and in which he did the greater part of his botanical work, becomes the property of the college, the proceeds to be applied to the purposes previously indicated. This is the largest bequest ever made to an educational institution in South Africa.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 29.—Sir Archibald Geikie, K.C.B., president, in the chair.—Francis **Darwin** and Miss D. F. M. **Pertz**: A new method of estimating the aperture of stomata. The apparatus here described under the name of *porometer* is similar in principle to that devised in 1873 by N. J. C. Müller, but differs from it completely in construction. By a simple arrangement a current of air is drawn through the stomata of a living leaf, its velocity being measured by the fall of a water-column. At a constant pressure the rate of air-flow is necessarily dependent on the size of the stomatal pores, and it is accordingly found that agencies such as darkness or loss of water supply, which are known to diminish stomatal aperture, cause a striking drop in the rate of air-flow as recorded by the porometer. In studying the effect of severing the leaf stalk, and thus cutting off the water supply, it has been proved that the first effect of withering is a wide opening of the stomatal pore, confirming F. Darwin in Phil. Trans., B, vol. cxc., 1898, p. 548. The porometer has been found of value in attacking the question of the causal relation between stomatal aperture and transpiration. This subject, on which a large number of observations have been made, will be fully treated elsewhere. In the present paper a single experiment is given illustrating the parallelism between the transpiration rate and the condition of the stomata as revealed by the porometer.—S. **Chapman**: The kinetic theory of a gas constituted of spherically symmetrical molecules. This paper may be regarded as a sequel to Maxwell's kinetic theory of a gas the molecules of which repel one another according to the famous fifth-power law (Phil. Trans., 1867). Maxwell's deductions from his hypothesis were found not to agree with fact, but the theory was valuable, because it was the only mathematically rigorous kinetic theory in existence. When he wrote a later paper on the same subject (Phil. Trans., 1879) he was aware of the defects of his assumption, but was prevented by certain analytical difficulties from generalising his theory by adopting a wider hypothesis. In this paper these difficulties have been very largely overcome. With the same rigour as in Maxwell's theory, formulæ are deduced for the coefficients of viscosity, diffusion, and thermal conductivity in a simple or compound gas. The molecules are assumed to be spherically symmetrical, but no particular kind of interaction is postulated. The latter, however, is involved in the formulæ by the occurrence, as factors, of two definite integrals. Certain relations may be deduced without the evaluation of these factors. The most interesting of these is $\delta = \frac{5}{2}\mu C_v$, where δ is the thermal conductivity, μ the viscosity, and C_v the specific heat at constant volume. This formula, which was also obtained by Maxwell, has always been regarded as a special consequence of his hypothesis, whereas it only depends on the spherical symmetry of the molecules, and is true for rigid-elastic spheres, among other cases. In general, the formulæ can be completed only by the evaluation of the before-mentioned factors. In the paper this is done for the case of rigid-elastic spherical molecules, for centres of force repelling according to the inverse *n*th power law of distance, and for the case of rigid-elastic spheres surrounded by fields of attractive force. The last case furnishes a rigorous proof of Sutherland's formula for viscosity, and some important corrections to his theory are made. Finally, the formulæ obtained are compared with experimental results to test the accuracy of the various laws considered, and to obtain improved data concerning the molecules and other physical constants of gases.—Major P. A. **MacMahon**: Memoir on the theory of the partitions of numbers. Part vi.—Partitions in space of two dimensions, to which is added an adumbration of the theory of partitions in space of three dimensions. In this part the author considers the partitions of a number, the parts being placed at the nodes of an incomplete lattice in two dimensions. Thus, the lattice being of the nature depicted,



the parts are in descending order of magnitude in each row and in each column. The enumerating generating function is required. It is found that for a lattice of given specification and a given restriction upon the part magnitude the generating function satisfies a functional equation. From this the functional equation satisfied by the corresponding inner-lattice function, as is defined in part v., is deduced. This investigation then turns upon the determination of the fundamental solutions of this equation and the expression of the generating function by means of them. The complete solution of the problems in hand is thence obtained, and the inner-lattice function is shown to be expressible in an elegant determinant form. At the end of the paper the subject of three-dimensional partitions is broached. It is shown that the method of lattice functions is again available, and the particular case of partition at the summits of a cube is worked out in detail from this point of view. The further investigation of this interesting question is reserved for a future communication.—W. T. **David**: Radiation in explosions of coal gas and air.—Dr. T. E. **Stanton**: The mechanical viscosity of fluids. The paper deals with the experimental determination of the ratio of the shearing stress to the rate of change of distortion in fluids which are in sinuous or eddying motion. Thus in a fluid in eddying motion flowing through a parallel pipe of circular cross-section, if F is the mean shearing stress on any cylindrical surface of radius r concentric with the pipe, and v the average velocity in the axial direction of the fluid in this surface, then writing $F = \mu' \frac{dv}{dr}$ the object of the experiments was the determination of μ' as a function of the dimensions of the pipe and the velocity of flow. This ratio has been called by Osborne Reynolds "mechanical viscosity," to distinguish it from the corresponding ratio when the field is in steady or laminar motion, which is the ordinary coefficient of viscosity. The fluid chosen for the purpose of the experiments was air flowing at speeds up to 2200 cm. per second through pipes 5·08 and 7·35 cm. diameter. A small Pitot tube of width 0·25 mm., connected to a very sensitive gauge reading to 0·005 mm. of water, has been used for measuring the distribution of velocity, and a second sensitive gauge has been used for measuring the shearing forces. The results of the experiments are as follows:—(1) In pipes artificially roughened so that air friction varied as square of velocity of flow, the value of μ' was found to be proportional to the product of speed of flow v_c, and linear dimension of pipe l, *i.e.* $F=kv_c l \frac{dv}{dr}$ where k is a constant depending on the roughness. (2) In ordinary smooth pipes the corresponding relation was given by $F=Cv_c l f\left(\frac{V}{v_c l}\right)\frac{dv}{dr}$ where C is a constant and $f\left(\frac{V}{v_c l}\right)$ a function of the kinematical coefficient of viscosity V and the above product $v_c l$. (3) In ordinary smooth pipes of different diameters, owing to the existence of a region of viscous flow at the boundaries, exact similarity between the distributions of axial velocity from centre to walls only obtains when the two viscosities (μ and μ') are the same for each pipe.—Dr. G. W. C. **Kaye**: A silica standard of length. The general properties of fused silica, and in particular its remarkably low coefficient of expansion, render this substance specially suitable for the construction of permanent length-standards of the highest class. The coefficient of expansion of platinum-iridium, which has hitherto been the material almost exclusively employed in the best work, is about 9×10^{-6} per degree C., while that of silica over the ordinary range is about $0{\cdot}4 \times 10^{-6}$, *i.e.* one-twentieth of this amount. It is true that the best qualities of invar—M. Guillaume's nickel-steel containing 36 per cent. Ni—have expansion coefficients comparable with that of silica, but experience has shown that while invar is eminently useful for working standards, it is quite unsuitable for primary standards, owing to its large thermal hysteresis. Fused silica, on the contrary, has been found to be practically entirely free from this defect; it enjoys, in the matter of cost, an enormous advantage over platinum-iridium; furthermore, in view of the fact that primary standards are always handled by trained and skilled observers, its comparative fragility is of small consequence. Modern methods of manufacturing and working silica have rendered it possible to construct a silica line-standard metre. The present model, the first of its kind, consists of a silica tube into which are fused at its ends optically worked plane parallel slabs of silica. These carry the graduations, and their undersides are platinised. The graduations, defining the metre length, are made by cutting through the platinum film with a ruling diamond. The platinum deposit permits the ruling of very beautiful clean-edged lines. The bar is supported at the Airy points so that the slabs are horizontal. The lines are viewed from above through the slabs, and are thus seen to advantage. The apparent length of the standard is independent of any change of tilt of the cover-slips which are used to protect the platinum films. The thickness and position of the end slabs are so arranged that the image of each reference line lies in the "neutral plane" when the bar is immersed in water. The silica metre was annealed at about 450° C., and shrunk a little more than half a micron in the process. It is anticipated that its future secular variation will be negligible so far as practice is concerned.—Ridsdale **Ellis**: The properties of oil emulsions. Part i.—Electrical charge. The electrical charge on the globules and the contact potential at the oil-water interface were obtained from measurements of the migration velocity in an electric field. The apparatus used by Whitney and Blake and by Burton for determining velocity of migration were found not to be accurate, since they did not take into consideration the electrical circulation which takes place, and other factors. To avoid these errors a microscopic method was employed, and corrections for electrical circulation and other effects were introduced into the method of calculating migration velocity. For determining contact potential in presence of electrolytes it was found necessary to modify the apparatus in order to enable the evolution of gas at the electrodes to be avoided, which would otherwise prevent readings being taken. It was found that the magnitude of the contact potential at the oil-water interface is of the same order of magnitude for oils of various kinds, whether very pure or containing large amounts of impurities. Further, the contact potential at the oil-water interface is of the same order of magnitude as that at the glass-water interface and at the interface between the suspended particles of colloidal metals, lycopodium, quartz, and other substances. From these and other considerations it would appear that the contact potential in neutral solution depends almost wholly on the dielectric constants of the suspended particle and of the medium in which it is suspended. The contact potential at the oil-water and glass-water interface is a maximum in neutral or slightly alkaline solutions. Thus the addition of caustic soda at first increases the contact potential at the oil-water interface, but when the concentration exceeds 0·001 N the contact potential is diminished, rapidly at first, and then slowly. In the glass-water interface the maximum potential appears to be in neutral solution. If hydrochloric acid is added the contact potential is reduced very rapidly for small concentrations, but only slowly for comparatively high concentrations.—Dr. W. H. **Young**: A class of parametric integrals and their application in the theory of Fourier series. In this paper the following theorem, *inter alia*, is proved:—If $f(x)$ and $g(x)$ are two functions the $(1+p)^{th}$ power and $\left(1+\frac{1}{p}\right)^{th}$ power of which respectively are summable, and if (a_n, b_n), (α_n, β_n), be their Fourier constants, then the series the general term of which is $(a_n\alpha_n+b_n\beta_n)\cos n\theta$ is the Fourier series of a continuous function, a simple expression for which is given. From this theorem follows as a corollary that if the series

$$\frac{1}{2}a_0\,\alpha_0+\Sigma_{n-1}\,(a_n\,\alpha_n+b_n\,\beta_n)$$

converges it has $\frac{1}{\pi}\int_{-\pi}^{\pi} f(x)g(x)dn$ for its sum, and more generally it always has this expression for sum when the summation is performed in the Cesaro manner. The method employed is shown also to lead to results of analogous nature, previously known. It involves the study of certain parametric integrals, and of a theorem in the theory of sets of points stated and proved in the paper, to the effect that if a set of points of positive content be shifted bodily a sufficiently small distance along the straight line on which it is situated, it necessarily coincides with its original position as to a sub-set of points the content of which may be made as near as we please to the content of the set.—Dr. W. H. **Young**: A mode of generating Fourier series.—H. R. A. **Mallock**: Pendulum clocks and their errors. The errors to which pendulum clocks are liable may be divided into three classes, viz.:—(1) those which may affect free pendulums oscillating *in vacuo*; (2) errors depending on the action of the air or gas in which the oscillation takes place; (3) errors due to the escapement and maintaining mechanism. In good clocks unexplained variations of rate are not uncommon, and may be as large as half a second a day, or even more. At any rate, a clock the rate of which continues constant within 1/200,000 for a year or more is exceptional, and anything which succeeds in securing a constancy of rate better than five parts in a million may be considered an improvement. In discussing the various sources of change of rate, all matters (so far as the author knows) which can alter the period by as much as 10^{-8} are taken into account. It appears that most of the anomalous changes of rate are due to variation of friction in the escapement and maintaining mechanism, which acts chiefly, but not exclusively, by altering the arc of vibration. A graphic method is given for determining in detail the action of escapements on the period.—Prof. Sydney J. **Hickson**: Ceratopora, the type of a new family of

Alcyonaria. A specimen of a compound tubular coral was obtained by the naturalists of the *Blake* off Cuba in 100 fathoms of water. This specimen was figured by Agassiz in his account of the expedition, and referred to as "a supposed Favosites is probably a bryozoan genus allied to Heteropora." A more detailed examination of the dried corallum shows the presence of long tuberculate spicules, in addition to the crystalline calcareous tubular skeleton, which is formed in a horny matrix. There are no tubulæ, and the tubular walls are not perforated. The evidence suggests that this coral is an alcyonarian belonging to the order Cænothecalia, and it is proposed to give it the name *Ceratopora nicholsonii*.—Dr. W. **Watson**: Note on the sensibility of the eye to variations of wave-length. The author has compared the width of Edridge-Green's monochromatic patch with the minimum change in wave-length perceptible as a change in hue in the yellow under exactly similar conditions, and finds there is a marked difference. It is also shown that an admixture of white light would not account for the increased sensitiveness when two monochromatic patches are compared.—E. N. de C. **Andrade**: The distribution of slide in a right six-face subject to pure shear.—Major C. L. **Williams**: The viability of human carcinoma in animals.—Prof. W. B. **Bottomley**: The structure and physiological significance of the root-nodules of *Myrica gale*.—H. W. **Harvey** and W. B. **Hardy**: Note on the surface electric charges of living cells.—Prof. C. S. **Sherrington** and Miss S. C. M. **Sowton**: Reflex inhibition of the knee flexor.—Prof. H. E. **Armstrong** and Dr. E. F. **Armstrong**: The origin of osmotic effects. IV.—Note on the differential septa in plants with reference to the translocation of nutritive materials.

Zoological Society, June 27.—Mr. Frederick Gillett, vice-president, in the chair.—Dr. R. **Broom**: Some new South African Permian reptiles.—F. E. **Beddard**: Two new genera of cestodes from mammals.—Miss Ruth **Harrison**: Some madreporaria from the Persian Gulf; with a note on the memoir and some further notes on *Pyrophyllia inflata* by Prof. S. J. **Hickson.** This memoir dealt with a collection of corals made by Mr. F. W. Townsend, the most interesting species obtained being *P. inflata* and *Tremototrochus zelandiae*, the latter of which was identical with the specimens from Cook's Straits, New Zealand, described as *Conocyathus zelandiae* by Prof. Martin Duncan. A new species of Heterocyathus was described, and Prof. Hickson appended a note on the affinities of Pyrophyllia.—C. L. **Boulenger**: Variation in the medusa of *Moerisia lyonsi*. This paper was based on an examination of 400 specimens. Nearly 14 per cent. of these were found to be abnormal, and to fall naturally into two well-marked groups containing completely distinct phenomena. The author discussed these separately and in detail, and stated that he knew of no form in which such a variety of abnormalities occurred as in Mœrisia.—Cyril **Crossland**: (1) The marginal processes of lamellibranch shells; (2) warning coloration in a nudibranch mollusc and in a chameleon. As a pendent to the second of these papers, Sir Charles **Eliot** contributed a paper on chromodorids from the Red Sea collected and figured by Mr. Crossland, containing an account of three species of Chromodoris, which were noteworthy as being varieties of known species or forms hitherto imperfectly described.

Royal Microscopical Society, June 28.—Mr. H. L. Plimmer, F.R.S., president, in the chair.—Mr. **Strachan**: The structure of scales from *Thermobia domestica* (Packard). The author showed that the longitudinal striæ which appeared to project at the free margin of the scale were in reality the walls of a set of longitudinal tubes, and when pressure was applied to the scales the tubes might be made to collapse and disappear, and in some instances, when heat was applied, both fluid and air bubbles were observed to traverse the tubes. These tubes were on the convex side of the scales. Radial striæ also crossed the longitudinal striæ at various angles, and the author illustrated his paper by an ingenious model composed of two sets of parallel thin glass tubes in close contact, almost filled with fluid and sealed at the ends, one set containing oil of turpentine, the other ethyl alcohol. One set of tubes was fixed, the other set, placed in contact with them, could be rotated over a considerable angle. By illuminating this model obliquely and varying the angle at which the tubes crossed, all the appearances of beaded, exclamation, and cuneate markings observed in the natural scales could be reproduced exactly.—Mr. **Murray**: Further report on the rotifera collected by the Shackleton Antarctic Expedition of 1909. *Rotifera of New Zealand.* There were collected forty-one species of Bdelloids, and twenty-six species of other orders. Three new species were described—*Callidina microcornis, Rotifer curtipes*, and *R. montanus.* A species of Pedalion (not identified) occurred as a plankton animal in a great lake (Wakatipu). These Bdelloid fauna of New Zealand appeared to be poor, considering the variety of conditions found in different regions. *Rotifera of S. Africa.* During a short stay at Cape Town nine Bdelloids were collected on the lower part of Table Mountain. There was one new species, *Dissotrocha pectinata*, related to *D. spinosa.* This small collection was noticeable for the absence of any of the species characteristic of tropical and subtropical Africa, many of which occurred in other parts of Cape Colony.—Conrad **Beck**: Use of an interferometer for measuring small distances.

EDINBURGH.

Royal Society, June 5.—Dr. James Burgess, vice-president, in the chair.—The absorption of light by inorganic salts. No. 1, Dr. R. A. **Houstoun**: Aqueous solutions of cobalt salts in the infra-red. No. 2, Dr. R. A. **Houstoun** and Alex. R. **Brown**: Aqueous solutions of cobalt salts in the visible spectrum. No. 3, Dr. R. A. **Houstoun**: Aqueous solutions of nickel salts in the visible spectrum and the infra-red. No. 4, Dr. R. A. **Houstoun** and John S. **Anderson**: Aqueous solutions of cobalt and nickel salts in the ultra-violet. The four papers describe the first of a series of researches in which it is proposed to determine the absorbing power for light of aqueous solutions of inorganic salts under different conditions of concentration and temperature throughout the ultra-violet and infra-red, as well as in the visible spectrum. The absorbing power of a solution is specified by A, the molecular extinction coefficient, which fulfils the equation $I = I_0 10^{-Acd}$, I and I_0 being the intensity of the light before and after passing through the solution, *c* the concentration of the solution in gm. mols./litre, and *d* the thickness in cm. of the layer traversed. A varies with the wave-length, but is independent of *c* except for wide ranges and at particular points in some spectra. The salts investigated were the fluorides, chlorides, bromides, iodides, nitrates, and sulphates of cobalt and nickel. The apparatus used in the visible spectrum was a spectrophotometer, in the infra-red a linear thermopile with highly sensitive galvanometer, and in the ultra-violet a quartz spectrograph in combination with a photographic photometer of an entirely new type. A was fully determined for the twelve salts from $\lambda = 0{\cdot}22\ \mu$ to $\lambda = 1{\cdot}27\ \mu$, and the results were shown in the form of curves of a highly striking nature, A being approximately for these salts an additive property of the acid and base even at high concentrations. Cobalt has bands at 0·510 μ and 1·3 μ, nickel at 0·405 μ, 0·690 μ, and 1·21 μ. The sulphate radical exercises no absorption whatever; in the nitrates there is a band at 0·302 μ. The fluorides and chlorides have evidently a band just below 0·22 μ. The bromides have a band at 0·285 μ, and the iodides have two very intense bands in the ultra-violet which agree with those shown by an aqueous solution of iodine itself. Quantitative measurements were also obtained on the colour changes produced by concentration and heating. It was discovered that there are changes in nickel chloride and bromide in the violet analogous to but not so great as in the case of the cobalt salts, and so similar that any explanation of the cobalt colour changes must take account of them also.—Profs. Alex. **Smith** and A. W. C. **Menzies**: The vapour pressure of dry calomel. In a previous paper the authors showed that calomel vapour contained no measurable amount of Hg_2Cl_2 or of $HgCl$, and consisted wholly of the dissociation products mercury and mercuric chloride. According to chemical theory, therefore, when, by removal of all moisture, dissociation is prevented, the vapour pressure of the dry substance should be negligibly small. Brereton Baker obtained results which indicated that dry calomel had a vapour pressure of about one atmosphere. Experiments were made to test this point directly. The final result was in accord with the theory, but only after a prolonged drying for five and a half months in an oven at 115° C.

PARIS.

Academy of Sciences, July 3.—M. Armand Gautier in the chair.—H. **Deslandres**: Ionisation of the gases of the sun. Relations between the radiation and rotation of the heavenly bodies.—J. **Boussinesq**: Calculation of the absorption, in translucent crystals, of a pencil of parallel rays.—A. **Haller** and Edouard **Bauer**: Some ketones of the type of benzyl-dimethyl-acetophenone. Trialkyl-acetic acids and the alcohols related to them. Ortho-, meta-, and para-xylene-dimethyl-acetophenones were prepared by the action of the corresponding bromo-xylenes on the sodium derivative of isopropyl-phenyl ketone. These ketones were converted into the xylyl-dimethyl-acetamides, and these latter into the xylyl-dimethyl-acetic acids. The amides were reduced to the corresponding alcohols by sodium and absolute alcohol. The analogous para-methoxybenzyl compounds were also made.—L. **Mangin**: The existence of right- and left-handed specimens of certain Peridinia.—Ch. **Deperét**: The discovery of a large anthropoid ape of the genus Dryopithecus in the Miocene of La Grive-Saint-Alban (Isère).—A. **Perot**: Solar spectroscopy.—Alphonse **Berget**: A new apparatus for taking soundings:—J. **Clairin**: Bäcklund's transformations of the first kind.—E. **Delassus**: The linear integrals of the equations of Lagrange.—Marcel **Brillouin**: Surfaces of slip. Generalisation of the theory of Helmholtz.—D. **Montesano**: The linear congruences of conics.—J. **Pionchon**: Effect produced by the relative displacement of a metal and electrolyte in contact. The E.M.F. between two electrodes alters if one of them be moved or set in vibration. For example, if two zinc plates are placed in a solution of zinc sulphate, the E.M.F. between them is zero, whereas if one of them is shaken it becomes positive to the other. Analogous effects are produced with other electrodes and electrolytes. The E.M.F. of a Daniell's cell was 1·0944 volt. When the copper was shaken it became 1·0990, and when the zinc was shaken the value changed to 1·0754 volt.—Gustave **Le Bon**: The variations in transparence of quartz for ultra-violet light, and on the dissociation of matter.—A. **Leduc**: The expansion of vapours and the variation, with temperature and pressure, of γ, the ratio of their specific heats.—A. **Blondel** and J. **Rey**: The perception of light signals of short duration at the limit of their reach.—H. **Malosse**: Specific rotatory power of camphor dissolved in acetone. Tables showing the specific rotatory power of camphor in acetone solution at various concentrations, and at different temperatures.—J. H. **Russenberger**: Extension of the laws of capillarity to the case in which the elements of the capillary system are movable in regard to one another.—Marcel **Delépine**: Some supposed chlorides of iridium; condensed chlorides. The hexahydrate of chloroiridic acid, H_2IrCl_6, analogous to chloroplatinic acid, may be obtained by drying the product of the action of chlorine on chloroiridate of ammonium with sulphuric acid of not more than 70 per cent. strength. This crystalline substance, on being heated at temperatures between 100° and 250° C. in a current of air, slowly loses water, chlorine, and hydrochloric acid, leaving black amorphous residues, of which the compositions are not expressible by simple formulæ. The supposed lower hydrated chloride, $IrCl_3,4H_2O$, could not be obtained, nor could the author prepare the anhydrous chloride, $IrCl_4$, of Claus, by the action of sulphuric acid on chloroiridites.—Œschner **de Coninck** and M. **Raynaud**: The dihydrate of uranium trioxide. The substance $UO_3,2H_2O$, when gently heated, produces the monohydrate; the second molecule of water is only lost at a higher temperature with a slight loss of oxygen. The molecular weight of UO_2 was found to be 270·46 (mean of five determinations) by heating the dihydrate in hydrogen.—M. **Portevin**: Chromium steels.—Ed. **Chauvenet**: The carbonates of thorium. Hydrated thorium dioxide, $Th(OH)_4$, absorbs carbon dioxide at the ordinary pressure until it has the composition $CO_2,2ThO_2,4H_2O$. If the pressure be increased to 30 or 40 ats., the substance $CO_2,ThO_2,2H_2O$ is formed. The anhydrous oxide, ThO_2, if prepared by strong ignition, will not combine directly with carbon dioxide, but if it has not been heated above 430° C., the substance $CO_2,7ThO_2$ is produced. In the wet way, by the action of an alkaline carbonate upon a salt of thorium, $CO_2,ThO_2,8H_2O$ is precipitated; this easily loses water, producing the above-mentioned hydrated carbonate, $CO_2,ThO_2,2H_2O$.—G. **Vavon**: The hydrogenation of carvone. Carvone, in presence of platinum black, takes up two, four, or six atoms of hydrogen to form carvotanacetone, tetrahydrocarvone, and carvomenthol respectively.—E. E. **Blaise**: The keto-glutaric acids and the aldehyde acids of the succinic series.—Maurice **Lanfry**: The oxythiophenes.—H. **Colin** and A. **Senechal**: Catalytic oxidation of phenols in presence of iron salts.—Jules **Amar**: The law of output after work. Correction of a former note.—Louis **Roule**: Some peculiarities of the Antarctic fauna, from the collection of fish recently obtained by the expedition in the *Pourquoi-Pas?*—C. **Delezenne** and Mlle. **Ledebt**: Formation of hæmolytic and toxic substances by the action of cobra venom on yolk of eggs.

CONTENTS.

THURSDAY, JULY 20, 1911.

A DETECTIVE'S VADE MECUM.

Science and the Criminal. By C. Ainsworth Mitchell. Pp. xiv+240. (London: Sir Isaac Pitman and Sons, Ltd., 1911.) Price 6*s.* net.

IN the introduction to this fascinating book is suggested a special State department of criminal investigation. Police routine work, walking beats, directing traffic, quelling drunken street rows, is not, the author thinks, an effective school of deductive reasoning or scientific investigation. He would allow his investigators to enter the State service by another door; he would train them in applied science, and he would enable them to meet the clever criminal, as Sherlock Holmes loved to do, on the same intellectual plane. It would be unreasonable, however, to expect even from investigators so trained the same unerring instincts that surprise and delight us in the popular detective of fiction. The detective story is, we must remember, written backwards, and the author, having carefully laid his clues along the track of the crime, it is an easy matter for the detective, who is in the secret, to pick them up as he goes along.

Yet it is not impossible that the same faculty which enables one to devise ingenious detective stories would help in the actual detection of crime. Edgar Allan Poe, the first and greatest of detective story-writers, could not merely devise but detect. The wonderful inductive reasoning in the story of the murder of Marie Roger, in which, as in the popular puzzle game, each clue, even to the most tiny, is fitted into its place to complete the picture, was founded on the facts of a real murder, which was perplexing the police at the time, and the storyteller succeeded in unravelling the mystery when the detectives had failed. In Sir A. Conan Doyle the new department of criminal investigation might find a distinguished first president; than Mr. Mitchell's volume there could be no better handbook for its schools.

The book admirably indicates how, with ever-increasing advantage and success, the weapons forged by scientific research and discovery can be availed of in society's interminable war against the criminal. Of those agencies, electricity is one of the most effective, if not for detecting, for capturing the criminal. The man in the street is not quick at grasping the possibilities of a novel invention. At first it is popularly regarded as a new toy, a matter of amazement and amusement, but of no moment in the practical affairs of men; so it was in our own day with the telephone, the phonograph, and the biograph, with the miracles of the X-rays, radium, and wireless telegraphy. A great invention must prove itself and so live. Still, we find it hard to believe that the utility of the telegraph was less in doubt, and that it was as a criminal catcher it first established its reputation with the public.

"It is strange to reflect," writes Mr. Mitchell, "that it was not until it had been employed in the capture of a criminal that it was recognised in how many directions the electric telegraph might be of service to mankind."

Prior to that time the invention had been little better than a failure, from a commercial point of view, for though the railway companies had some time before this realised the advantages of the new system the Government had refused to have anything to say to it. It was thus little short of a revelation to the public when in 1845 the news was made known that a suspected murderer had been arrested through the agency of the telegraph.

But the telegraph has learned a lot about detective work since that time. It has even dabbled in photography, and is now able not merely to describe but to depict the fugitive criminal. The last word (so far at any rate) on this subject appears to be the telectograph invented by Mr. Thorne Baker, which, we learn from Mr. Mitchell, "may also be used with wireless installations for the transmission of simple pictures or diagrams, and by whose means it would be easy for a ship at sea to send or receive portraits." A picture of King Edward VII., transmitted in this fashion, and reproduced from the *Daily Mirror,* is one of the most striking of the many illustrations of the book.

In every department of crime science seems to have lent a hand to make easy the work of the detective and to harass the criminal, who, with his own finger-tips, is now compelled to print off an infallible means of identification. The book is full of fairy tales of science, more startling than the wonders of the "Arabian Nights." The retort and microscope of the analyst are the special bugbears of adepts in the higher and more scientific walks of crime.

In the old days the murderer caught red-handed could safely deny the bloodstain was human, and the microscope was unable to contradict him. It is not so now. By a method recently discovered the analyst examining the minutest stain of blood, dry, and scarcely discernible to the naked eye on the garment of a suspect, can tell to a certainty the species of animal in the veins of which it originally flowed. There is but one exception to the rule; the blood of the anthropoid ape gives the same reaction as human blood. One might fancy the spirit of Darwin rejoicing in this singular confirmation of his theories.

Mr. Mitchell possesses in a rare degree the gift of interpreting between the man of science and the public. The complicated process by which the blood of different animals is differentiated in the test-tube is described in clear and popular language easily understood even by the least scientific. The ultimate result is summed up in a few sentences, which make the matter plain to the humblest intelligence.

"A simple method of applying the serum test has recently been discovered. A small quantity of human serum is placed into a series of tubes, and into each of these is next introduced one drop of the fresh blood of different animals diluted with salt solution, or of the dried blood dissolved in that liquid. The tubes are now allowed to stand from thirty to forty-five minutes, and then examined. If, in the case of the blood of unknown origin there is a faint red precipitate (of coagulated blood), leaving the upper liquid clear, the blood is of human origin. On the other hand, the blood of other species of animals will have dissolved in the human serum, colouring it red. If the tubes are charged in the first place with the serum of the horse, ox, or other animal, the corresponding blood is coagulated, while that of any other animal dissolves."

Perhaps it is as well to explain to uninitiated readers that the "serum" is the liquid or watery substance of the blood.

The more cautious murderer, who resorts to the subtle agency of poison, has even more reason to dread the analyst, with his test-tube and microscope, than his brother in crime, who adopts the cruder methods of bone-breaking and blood-letting.

There has been a deal of romantic nonsense written about Cæsar Borgia and his more famous sister and their subtle and deadly poisons, "of which the secret is now fortunately lost to mankind." The modern poisoner has fluid, powder and perfume far more subtle and dangerous at his disposal, but amongst them are none that can elude the scrutiny of modern science. It is generally thought that arsenic was a constituent part of the mysterious Borgia poisons. Mr. Mitchell tells us, "with the more refined methods of analyses now available the tests are capable of detecting arsenic even in the minute proportion of one part in sixty million"—a minuteness which the imagination can scarcely conceive.

Under the pitiless eye of the microscope the most skilful and delicate handiwork of the forger is of no avail. We have in the book a hundred interesting illustrations of how his efforts are brought to nought. Does he trace the forgery over pencil writing, the microscope shows the pencil marks along the edges. Does he erase and write over, the most delicate lines are broad smudges, under the microscope the most skilful erasures are rough as unplaned wood. When the writer begins and leaves off, every joining, every doubt, every hesitation is plainly revealed, as if the eye at the microscope was watching the penman.

But it is not in scientific explanation and demonstration alone that this book excels; it is not to the scientific student alone that it appeals. By that vast and miscellaneous public vaguely classified under the head of "the general reader," it will be thankfully received and eagerly devoured. Mr. Mitchell illustrates his scientific disquisitions by vivid illustrations and judicious extracts from the most famous and exciting trials of ancient and modern times. We have many quaint pictures of the peculiar administration of justice in the good old days, when Lord Chief Justice Hale exerted himself to secure the conviction of Anne Turner, because he was afraid "lest by an acquittal countenance should be given to a disbelief in witchcraft, which he considered tantamount to a disbelief in Christianity."

We read, too, that in the trial of Anne Turner for the murder of Thomas Overbury (1615) evidence was given that she was in possession of parchments, some of which contained the names of the Blessed Trinity, others, on which were written +B+C+D+E, and another with a figure in which was inscribed the word Corpus, and to which was fastened a little piece of the skin of a man. In some of these parchments were the names of devils, who were conjured to torment the Lord Somerset and Sir A. Mainwaring if their loves should not continue, the one to the countess and the other to Mrs. Turner.

On evidence like this poor Mrs. Turner was convicted and sentenced to death. The form of the sentence was perhaps the strangest thing of all. The learned Lord Chief Justice Hale gravely informed the trembling woman that

"she had been guilty of the seven deadly sins, and that as she was the inventor of that horrid garb, the yellow tiffany ruffs and cuffs, he hoped she would be the last by whom they would be worn. To this end he ordered that she should be hanged in that garb. This was duly done, while, as a further condemnation of the fashion to which the judge had taken exception, the hangman wore yellow bands and cuffs."

We are not surprised to learn that the fashion died with its author, but we can scarcely imagine a Lord Chief Justice of our own day solemnly deciding that a lady should be hanged in a hobble or a harem skirt by a hangman similarly attired.

We have new trials as well as old in the book. The exciting question of the guilt or innocence of Mrs. Maybrick, on which Lord Chief Justice Russell entertained such strong convictions, is elaborately and intelligently discussed. We have a brief but very vivid *résumé* of the trial of Robert Wood, whose careless and callous behaviour in the dock excited such a strange fervour of sympathy and admiration, and of whom Mr. Hall Caine wrote after watching the case throughout, "Robert Wood, innocent of the murder of Emily Dimmock, is yet the most remarkable man alive." There is no space to enumerate the hundred and odd other trials not less interesting or remarkable which are summarised in the book.

There is a singular fascination in the detective story in fiction or real life. Any editor can tell how a sensational trial inflates the circulation of his newspaper. The magazines and the publishers and the public alike are clamouring for detective stories. Of all the characters in modern fiction, Sherlock Holmes is the best-known and most admired. A man who writes one passable detective story must write nothing else, for the public will accept nothing else from his pen.

In the book under review there is the material for a hundred detective stories. Every half a dozen pages contains the suggestion of a plot which needs only a little imagination and elaboration for its completion.

It is impossible within the limits of a review to do justice to the wealth of material in the book or to the attractive form in which it is presented to the public. Hypnotism, handwriting, dog training, food adulteration and its detection, and a score of other interesting topics are elaborately discussed, and illustrated by extracts from appropriate trials. The author exhausts his subject without in the least degree exhausting the interest and delight of his reader. His book possesses the two essential qualities of a good book: it is readable and it is worth reading. It serves up scientific facts and theories in a most palatable form, and we have high authority for the dictum, "Omne tulit punctum qui miscuit utile dulci." The illustrations, of which there is a vast variety, are scarcely less interesting than the letterpress. Once published the book becomes an essential *vade mecum* of the detective and the writer of detective stories. To the detective it supplies innumerable facts and suggestions which cannot fail to be useful in the practical work of his profession. To the writer it is a veritable mine of valuable material. The general public, who read mainly for amusement, but do not object to a little instruction unostentatiously slipped in as they go along, will find the book as fascinating as a new volume of Sherlock Holmes's adventures, and a great deal more instructive.

THE GENESIS OF CIVILISATION.

(1) *Marriage, Totemism, and Religion. An Answer to Critics.* By the Rt. Hon. Lord Avebury. Pp. xi+243. (London: Longmans, Green, and Co., 1911.) Price 4*s*. 6*d*. net.

(2) *The Golden Bough: a Study in Magic and Religion.* By Prof. J. G. Frazer. Third edition. Part ii., Taboo and the Perils of the Soul. Pp. xv+446. (London: Macmillan and Co., Ltd., 1911.) Price 10*s*. net.

(1) LORD AVEBURY opens his "answer to critics" with the following just remark:—

"In spite of the profound study which has been devoted by many learned and able philosophers to the origin and evolution of civilisation, there are still great differences of opinion on the subject."

His book, "The Origin of Civilisation and the Primitive Condition of Man," published forty-one years ago, was, as Mr. Lang rightly described it, "a pioneer work of great value and importance." But the best of theories would be expected to grow or change with the accumulation of new evidence and a closer analysis of the old, and both these conditions have been satisfied in the interval.

Among the author's original theories, that which showed most insight was the demonstration of the antagonism between idolatry and fetichism, in later terms, between religion and magic. Later research, however, has not so decidedly corroborated his views on the origins of marriage, exogamy, and totemism. A good deal of misconception that has existed, owing to the use of the same terms with different meanings, is now being removed, as in the case of "religion" itself. The one term for which there is no use is "superstition." But the modern distinction between "magic" and "religion," which Lord Avebury laid down long ago, while distinguishing between man's control of nature and "supernature's" control of man, between coercion and prayer, and so forth, rather ignores that vital component of both tendencies, which is known as animism, the belief in "spirit." The antagonism, on which Tylor has laid such stress, between animistic and non-animistic thinking, and the origin of animism itself, are certainly of profound importance in the evolution of culture.

In the case of marriage, however, there is as yet little agreement as to the meaning of the term in reference to origins. Lord Avebury himself, "for want of a better term," spoke of the "primitive" condition as "communal marriage," both words connoting legalism. "Promiscuity" erred in the opposite direction; its modern substitute is "group-marriage." Lord Avebury's view that exogamy and individual "marriage" arose from "marriage by capture" was largely based on customs which were cases not of capture but of elopement, a very different thing. He does not seem yet to have realised the difference; for instance, he brings forward the Kurnai custom, reported as capture by Fison and Howitt. But their actual words prove it to have been elopement. Speaking of "marriageability" between exogamous sections of a tribe, I once ventured to say that no "rights" were exercised in virtue of it. I meant rights as against the actual husband. In reply to this Lord Avebury (p. 20) quotes a case of "capture" where the captor has a right to the captive. He concludes, "Mr. Crawley is mistaken in questioning the right of the conqueror to his captive," a statement I did not make. But, further, the case he quotes is merely a case of elopement!

The defloration of the bride among the Central Australians by other men than the bridegroom was explained by Spencer and Gillen as a rudimentary (*sic*) right of marriage deriving from a previous promiscuity, by Lord Avebury as an "expiation" (to the tribe) for individual marriage, a vestigial right of communal marriage. Here, as in the analogous custom of "symbolic capture," the whole question is the psychological question of the nature of "survivals." Can, for instance, such a custom as that of a mock capture of the *bridegroom* (a not uncommon custom) be explained as a survival, in "play" or ceremony, from a previous real and serious practice of kidnapping? All cases of symbolic capture can be explained as quasi-magical or symbolic expressions of the idea of connubial possession. Similarly with the other custom. We may explain it as a quasi-magical or symbolic expression of the idea of consummation. Spencer and Gillen themselves note that the participators wear magical decorations. Similar acts of physical preparation with or without a magical irradiation are found everywhere; they are often performed by the parents of the bride. A case is just to hand (*Journal of the Royal Anthropological Institute*, xl (1910), 298) from the tribes near Lake Nyasa, where a man (it may be any man) is "called in to oblige." I have enlarged on this point because it is crucial in the question of marriage-origins, and largely made use of by the supporters of the hypothesis of primitive promiscuity. On the face of it the custom has nothing to do with group-marriage of to-day, and all analogy is against its being a survival from the "horde"-rights of the past. Lord Avebury approves the conclusion of Spencer and Gillen that "individual marriage does not exist either in name or in practice in the Urabunna tribe." But they themselves admit that every woman is the special *nupa* of one man, that those men who have the right of "access" (not the same thing as marriage) must obtain his consent, and that this is asked only in such circumstances as the "husband's" absence ("Native Tribes of Central Australia," p. 63).

No one denies that the earliest marital relations were in a fluid state, or that even with individual marriage the husband may have had to fight for the continued possession of the wife. Of the two extremes of animal analogies, the baboon and the gorilla type, Lord Avebury favours the former. In the evolution of social organisation it is quite probable that, given the latter type as the normal, the pendulum might at times swing to the former. In the ages before custom a tendency to individual marriage would have to struggle for existence, just as the tendency to individual property had to struggle. Customs like "avoidance" seem to be expressions of a fear of "trespass." The rise of the idea of fatherhood is closely connected with the property-instinct, and the evolution of marriage, generally, will receive its most probable demonstration when adequate account is taken of the psychological and historical relations between the ideas of ownership and marital possession.

The book suffers from the lack of an index. There are some misprints, *e.g.* M'Lennan for McLennan, Ling Roth for W. E. Roth, Reinack for Reinach.

(2) The second part of "The Golden Bough" is an enlargement of the original chapter on "Taboo and the Perils of the Soul." It fulfils the promise of the first part in the way of multiplication combined with continuity. In view of the fact that the two chief subjects of the volume bring us so very near to the origins of spiritual religion on one hand, and of the immense, complex, and changing body of human morality and law on the other, one regrets that neither subject is treated as a whole. Prof. Frazer points out that such a treatise would far exceed the limits he has prescribed for himself in "The Golden Bough." Nor can we fairly ask him for more than is necessary to place in the clearest light the central figure, the supreme subject, of the book, the idea of the god-man. When first propounded, twenty-one years ago, this idea, as a world-force, savoured of the improbable, but to-day we know it as an axiomatic principle of social evolution. The idea of a man who is "a pledge and guarantee of the continuance and orderly succession of those physical phenomena upon which mankind depends for subsistence" is, in its many forms, one of the most powerful factors in human history. It is a mistake to confine its operation to royal priests and divine kings; it is embodied in all who are vicars of nature, aristocrats of science and of commerce, no less than aristocrats of politics and religion. At one end we have the savage medicine-man, in his way a depositary of knowledge and a controller of supplies; at the other we have the inventor and the capitalist. But its most spectacular form is in religion, and of all great national religions, with few exceptions, it is the living nucleus. To have proved this so convincingly is the chief social service of "The Golden Bough."

Among new sidelights are the study of confession, showing the remarkable sensitiveness of the individual brain to the social judgment; the Eskimo theory of taboo (that brilliant discovery of Dr. F. Boas), a really fascinating chapter in human ethical thought, which we will not spoil by a *précis*.

In his preface and conclusion the author has some suggestive observations on the continuity of human nature and the fluidity of moral ideas.

"When all is said and done, our resemblances to the savage are still far more numerous than our differences from him; and what we have in common with him and deliberately retain as true and useful we owe to our savage forefathers, who slowly acquired by experience and transmitted to us by inheritance those seemingly fundamental ideas which we are apt to regard as original and intuitive."

"The old view that the principles of right and wrong are immutable and eternal is no longer tenable." The ethical theory and the moral practice of an enlightened future will owe much to the pages of "The Golden Bough," veritable leaves of a tree of knowledge. A. E. CRAWLEY.

CAMBRIDGESHIRE AND THE ISLE.

Highways and Byways in Cambridge and Ely. By the Rev. E. Conybeare. Illustrated. Pp. xviii+439. (London: Macmillan and Co., Ltd., 1910.) Price 6*s*.

THE Rev. Edward Conybeare has written a fascinating book about Cambridge and the Isle of Ely. He has taken as his theme a county and an isle the natural features of which to many seem dull, flat and unprofitable. Yet all England is beautiful and all England is interesting, and owing to the skill of his pen and to his wide knowledge, Mr. Conybeare has succeeded in telling us something interesting even of the meanest of Cambridge country villages. The fascination of the fens to those who like far-off horizons and gorgeous sunsets does not escape him.

To any member of the University of Cambridge Mr. Conybeare on his bicycle is as familiar a figure as the White Knight. It is on this bicycle that he has visited and inspected innumerable churches, remote villages, out of the way farmhouses, ruins, and antiquities. He has a most intimate acquaintance with the roads, lanes, and bypaths of this part of East Anglia, and his book adds a new joy to life to those inhabitants of these districts who are interested in the history of their forefathers.

Mr. Conybeare deals fully with the early history of the country, the Devil's Dyke, Fleam Dyke, tumuli and other prehistoric works, but he is equally at home with what, in comparison with these mounds, is modern history, and as this appeals rather more immediately to us, we venture to give as an example of his style two quotations, one of which is to the infamous Dowsing:—

"In 1863, Hardwick Church, which is so conspicuous an object from the roof of King's College Chapel, was purified by Dowsing, who notes with disgust that for dealing with 'ten superstitious pictures and a cross' he was here paid only 3*s*. 2*d*. instead of the 6*s*. 8*d*., which was his regular fee. The great iconoclast had the same grievance in the adjoining village of Toft, where he got 'only 6*s*. 8*d*.' for a specially heavy 'purification' of the church, involving the destruction of 'twenty-seven superstitious pictures in the windows, ten others in stone, three inscriptions, *Pray for the souls*, divers *Orate pro animabuses* (*sic*) in the windows, and a bell *Ora pro anima Sancta Katharina*.' The 'pictures in stone' were doubtless the alabaster images of the reredos, fragments of which are still preserved in the church, exquisite in modelling and colour."

Thus was the beauty of rural England destroyed by a fanatic and at a carefully calculated price.

The second quotation deals with national history and tells us that:—

"Near Hardwick is Childerley Hall, now a farm-house, and hither King Charles the First was brought by his captors, when carried off by Cornet Joyce from Holmby House, in Northamptonshire. He was not altogether an unwilling captive, for both he and the Army hoped to arrive at some mutual accommodation which would make both independent of that Parliamentary control of which both were heartily wearied. He was treated accordingly with the utmost respect, and during his stay at Childerley Hall (from Saturday, June 5, to Tuesday, June 8), the students of Cambridge 'flocked apace' to pay their homage to him. 'He is exceedingly cheerful,' writes a contemporary scribe, 'shows himself to all, and commands that no scholler be debarred from kissing his hand, for which honour they return humble thanks and *Vivat Rex*: and there the Sophs are in their gowns and caps as if no further than Barnwell.' Nay, even the great chiefs of the army, the men who at Marston and Naseby had faced and conquered him, Fairfax, Ireton, and Whalley, and Cromwell himself, came hither to join in this hand-kissing."

The book is by no means free from small, but to a resident stimulating, errors (like the minute gas-bubbles in soda-water), but in spite of these it will do much to popularise a countryside which has been too long neglected.

THE SUGAR CANE AND CANE SUGAR.

Cane Sugar: a Text-book on the Agriculture of the Sugar Cane, the Manufacture of Cane Sugar, and the Analysis of Sugar House Products; together with a Chapter on the Fermentation of Molasses. By Noël Deerr. Pp. xv+592. (Altrincham, Manchester: N. Rodger, 1911.) Price 20*s*. net.

IN this work the author has brought together very nearly all the information, both scientific and practical, which an enthusiastic planter, manager, or chemist would be likely to require in dealing with the production of cane sugar.

The first ten chapters—about one-third of the whole space—are devoted to description of the cane and its methods of culture. They include a section on the pests and diseases to which the plant is subject, with notes on the various devices which have been found most useful in combating them. In case anyone should question whether it was advisable for the author, a chemist, to devote a considerable amount of space to the botany, agriculture, and pathology of the sugar cane, as well as to its chemistry, an explanation is offered which enlists our sympathy at once. "I found it impossible," the author says, "to live on plantations without taking a keen interest in . . . all phases of the production of cane sugar."

We may hope that there are many others afflicted with the same kind of inquisitiveness. If so, Mr. Deerr's suggestion that his work may serve to fill a gap in English technical literature will no doubt be justified. On plants and insects he may not write with the authority of the professional botanist or entomologist; but that is not the whole story. To point out the road, one need not have helped to make it. A useful purpose is served in stimulating the reader's interest, and putting him in the way of getting further information when his curiosity is aroused. From this point of view the outlines given of the botany of the sugar cane, and especially the summary of the insect and fungoid pests that infest it, are by no means lost labour.

The factory operations connected with the production of sugar and molasses from the harvested cane are dealt with in the next ten chapters, and the remainder of the volume is chiefly concerned with the chemical control of the manufacture and with questions of sugar analysis. There is also a chapter on fermentation and distillation, with special reference to the requirements of the sugar house in respect of the production of rum.

Several years ago V. H. and L. Y. Veley ascribed the phenomenon of "faulty" rum to a micro-organism which they isolated and studied, but their conclusions were subsequently challenged by Scard and Harrison. The author has found in weak rum a fungus which, he says, is "similar" to that described by the Veleys. He does not, however, think it can be called the cause of faulty rum, inasmuch as it did not develop when placed in strong alcohol (75 per cent.). It was not killed, but no change could be traced in sound, clear rum when this was inoculated with a drop of the weak spirit containing the fungus. Apart from the question of micro-organisms as a cause, the turbidity shown by faulty rum on dilution is attributed to the presence of certain kinds of caramel, higher fatty acids, and terpenes.

The book represents a great amount of reading. It is not the author's first work on the subject, and his experience as chemist, manager, and sugar technologist is a guarantee that his own statements are likely to be practical and trustworthy, whilst for the views of authorities quoted copious references are given. Tested here and there on points within the present writer's knowledge, the information has proved to be accurate. The illustrations, which are numerous, include some excellent photographs and coloured plates.

C. S.

LABORATORY METHODS IN ZOOLOGY.

Zoologisches Praktikum. By Prof. A. Schuberg. Band i., Einführung in die Technik des zoologischen Laboratoriums. Pp. xii+478. (Leipzig: W. Engelmann, 1910.) Price 11 marks.

DR. SCHUBERG has set out to write a laboratory manual of methods for dealing with different groups of animals, but found that there was a good deal of general descriptive matter as to methods, apparatus, and reagents to be dealt with before the systematic treatment of the groups could be reached. It is this general part that occupies the whole of the present volume. A good deal of it resembles an instrument dealer's catalogue, and almost every piece of apparatus used for zoological technique is described and figured. Then the choice of instruments and their use and abuse are considered, with many experienced remarks. The routine of zoological procedure, fixing, staining, mounting, the use of the microscope, and so on, are dealt with. There are many useful references to books or papers that advocate special methods.

The volume is intended for "Hochschulen" and universities, but there are one or two points in which its usefulness might have been increased. There are, for example, no instructions as to how to collect and observe animals. A few remarks on nets and boxes do not constitute instruction, and general directions would be a most useful addition, if they were devoted to skinning and preserving; how to work different kinds of ground, sea, lake, moor, &c.; how to obtain material for observing life-histories. Another point omitted is the insertion of directions for collecting in other countries, especially in the tropics, where difficulties of unusual order have to be overcome. Again, the author does not appear to describe how any of the apparatus may be made. It is, of course, nearly always possible to buy what you require ready-made, but there are many advantages in knowing how to make the simpler pieces of apparatus, since not only the manipulation is learnt, but the physics of the working are mastered in a way that no ready-made machine permits. For physiological work particularly such training is simply invaluable.

The only other point that has occurred to us is the incomplete nature of the instruction on certain modes of procedure, a drawback common to so many "practical" text-books. Thus in reconstructing embryos or animals from sections, the author does not state exactly what to do or what precautions to take to ensure a satisfactory result. Perhaps, however, the subject will recur in his later volume. In fact, any judgment on this section of the work is premature until the second part has appeared, as we trust it soon will. We must say, however, that only the beginner will learn much from the present instalment. The methods are, so far as we have been able to test them, well known and ably advocated already. But to anyone who is fitting up a laboratory or starting out upon a course of practical study, the work may be heartily recommended.

CONSTRUCTION IN EARTHQUAKE COUNTRIES.

Le Case Nelle Regioni Sismiche e la Scienza delle Costruzioni. By A. Montel. Pp. iv+116. (Torino: S. Lattes and Co., 1910.)

THIS book, dealing with construction in earthquake-shaken countries, opens with a few words on the nature of earthquake motion, particularly acceleration. Then follows two scales of seismic intensity. After this a little is said about the nature of foundations, as, for example, whether they are upon soft or hard ground, on a slope, or on a plain. The materials used for construction are given considerable consideration, particularly the advantages that may be obtained by the use of ferro-concrete. The pictures, like those showing the framework of buildings, and various formulæ are old acquaintances, whilst the text which accompanies them in many places closely follows a translation from English into Italian. Its author, Mr. Montel, particularly refers to two books from which he has obtained his information; one is No. 4 of the publications of the Earthquake Investigation Committee of Japan, written almost entirely by Dr. F. Omori, and the other is "La Science Séismologique," by Comte de Montessus de Ballore. The other contributors to some eighty volumes issued by the Earthquake Investigation Committee have been omitted, and no reference made to the Transactions of the Seismological Society of Japan, in which we find accounts of almost everything that has been elaborated by Dr. Omori, and written about by Count Montessus and Mr. Montel.

Some thirty years ago, when Europeans were invited to Japan, their attention was naturally directed to earthquakes. These they measured, and earthquake motion was for the first time reduced to mechanical units. The result was that engineers and constructors learned for the first time something about the forces with which they had to contend. The visitors even went a little further, and tested their suggested formulæ by placing columns of masonry and other articles on a truck which could be moved back and forth at an increasing rate. The quickness or suddenness of motion required to produce the shattering or overturning of these objects was recorded, and theory brought into closer relationship with practice. For many years past new forms of buildings have been rising in Japan, and these are found to withstand earthquake movement better than their predecessors. The formula of C. D. West, formerly professor of engineering in the University of Tokyo, which is the foundation of all other formulæ, relating to the more important principles guiding constructors occupies a prominent position in Mr. Montel's work, but the name of C. D. West is not mentioned. About this we need not be surprised, because it is only found with difficulty in those works from which he quotes. But practical seismology has grown and it must not be supposed that the guests who visited Japan some thirty years ago did everything. Their work also had foundations.

So far as we know, Robt. Mallet was practically the first man who treated earthquake movement scientifically, and attempted to reduce it to practical units. Notwithstanding his work, engineers continued to regard an earthquake as something strong, and to resist its effects structures should be strong and heavy. Although M. Montel has not done all the justice he might have done by more extensive references, still he has produced a useful book, and if the principles it sets forth are adopted in the earthquake-shaken parts of Italy, they should do much to ameliorate the lot of inhabitants of those regions.

J. Milne.

OUR BOOK SHELF.

Notes on the Use of the Portable Reversible Transit Instrument and the Method of Calculation of the Observations. By Captain C. E. Monro. Pp. 60. (London: J. D. Potter, 1911.) Price 3s.

THIS excellent little handbook is written to serve as a practical guide for the use of beginners with the transit instrument. After a very slight amount of personal instruction, the learner will find a sufficient aid in this book, which gives ample directions for securing the best possible determinations of time. The notes are written in a thoroughly practical manner; the whole procedure to be adopted in setting up the instrument and in making and reducing the observations is explicitly set forth.

Captain Monro is well qualified by experience for compiling such a handbook, having taken the principal part in the important longitude determination Greenwich-Ascension-Cape in 1907; but beyond his own observations, he has drawn largely on the accumulated experience of Greenwich observers during the series of fundamental longitude determinations made by the Royal Observatory. These notes may, in fact, be regarded as embodying in the main the practice actually employed at Greenwich. In one respect, however, a deficiency is apparent, namely, with regard to the observations which depend on the use of the Right Ascension micrometer. This is presumably owing to the author having gained his experience near the equator, where slow-moving polar stars are almost unobservable; in consequence, he himself would have little occasion for using the micrometer screw. To this we attribute the fact that there is no explanation of how to determine the value of the screw, a very important instrumental constant in time determinations under ordinary conditions. Further, the example given of the reduction of a slow-moving polar involves an extravagant amount of arithmetic, and an excessive number of decimal places are employed. It may also be remarked that the wire intervals are better determined from special observations of two or three polar stars than by the laborious process of reducing some hundreds of equatorial transits.

Apart from this the book contains all that is necessary for the most refined work with the type of instrument described. The appendix, containing specimens of computing forms for the reduction of the observations, is a useful feature. Another appendix contains an elementary account of the theory of the corrections for azimuth and level. A. S. E.

Elements of Zoology; to accompany the Field and Laboratory Study of Animals. By Dr. Charles B. Davenport and Gertrude C. Davenport. Revised edition. Pp. x+508. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1911.) Price 5s. 6d. net.

THIS attractive work was issued ten years ago by Dr. and Mrs. Davenport, and it has now passed into a revised edition. In the interval the author has taken charge of the Carnegie Institute for Experimental Evolution and of the Brooklyn Institute Laboratory at Long Island, and he is consequently well qualified to introduce changes in the work that reflect to some extent the advance of zoological knowledge so far as it affects an elementary text-book. The chief feature of the work is the abundance and excellence of the illustrations. Scarcely less striking than the figures are the suggestive and interesting remarks on the habits and behaviour of the examples selected. There is little plan or sequence in the chapters. Each of them consists of an isolated study of some particular topic associated with a given form of animal life. By some curious oversight only one-half of the selected forms are figured, though illustrations of related forms occur in abundance, and there are, in addition, photographs of the localities in which the chosen animals may be found. The work is so attractive and will be so useful to teachers who wish to organise nature-study courses that we are loth to point out the few blemishes that we have noticed. Darwin, however, would object to be quoted as saying (p. 171), or rather writing "mold" for mould, and "plow" for plough. The Ranidæ occur over Africa, and are not limited, as suggested on p. 348, to the northern hemisphere and East Indies. The spotted salamander figured on p. 335 is called "A urode," a name which is certain to cause trouble and misunderstanding, as are many other curious vernacular names, such as "sow-bug" for Oniscus, "basket-fish" for branched Ophiuroids, "tumble-bugs" for the large dung-beetles, the "underwing" for Catocala, "spring azure" for blue Lycænas, and many others. Probably in the States these difficulties will not occur. We can heartily recommend this book.

Modern Industrial Chemistry, from the German of H. Blucher. Translated by J. P. Millington. Pp. xvi+779. (London: Gresham Publishing Co., 1911.) Price 30s. net.

THIS work is an attempt to survey the field of chemical technology and to bring the results within the compass of about 800 pages of well-leaded type. It is, lexicographically arranged, fairly well illustrated by "process" cuts, and plentifully interspersed with advertisements, or with references to the many advertisements between which the book itself is sandwiched. As might be anticipated from its origin, it deals mainly with German technology, and is especially rich in references to German patent literature. Another feature in which it differs from the ordinary run of such works is the prominence it gives to the nostrums and drugs with which modern chemical manufacturers, more especially in Germany, have flooded the markets of the world. Many of these are only of the most ephemeral interest, and certain of them are no longer in use, either because they have been found to be baneful, or because they have been superseded by others more convenient in use. As their names are to be found in modern pharmacological literature, and are presumably of interest to medical men, a catalogue of them, arranged alphabetically, may possibly be of some service. It must be admitted, however, that the information vouchsafed in the case of many of them is very meagre and not always authentic. Indeed, many of the titles in the book seem to be introduced for no other purpose than to direct attention to a trade advertisement.

The book may be of use in the counting-house of a manufacturer, but would be of very limited value to the specialist or the student of chemical technology.

Practical Plant Physiology. By Prof. F. Keeble, assisted by M. C. Rayner. Pp. xvi+250. (London: G. Bell and Sons, Ltd., 1911.) Price 3s. 6d.

BOTANICAL physiology is one of the most instructive branches of science, because it provides an excellent test of a student's capabilities and is particularly suitable for inculcating the spirit of original research. Both these objects are kept in view by the author of this practical text-book, where they supply the main undercurrent flowing below the more obvious stream of information conveyed in the text. The course outlined is also thorough and complete, as the student is led systematically by argument and experiment through the sequence of problems connected with plant nutrition.

Indeed, it will be speedily ascertained by those who start the course that the experiments indicated require considerably more time than is ordinarily devoted to this branch of botany; however, in this case there is no great objection to superfluity, as it is a simple matter to leave out those experiments considered to be less important. In the circumstances the author was well advised to touch only lightly upon the sensitivity of plants, which is discussed in the last chapter.

The general method of exposition is original, and a certain number of experiments, such as that devised by Dr. F. Blackman for illustrating the dependance of germination upon oxygen supply are additions to the courses generally followed in botanical laboratories. There is overmuch insistence on the correlation of guessing, reasoning, and trying, and perhaps a superabundance of chemical and physical tests. But these are minor matters of opinion, whereas there can be no question that the book is original, vigorous, and stimulating.

The Statesman's Year-Book. Statistical and Historical Annual of the States of the World for the Year 1911. Edited by Dr. J. Scott Keltie. Pp. lxxii+1412. (London: Macmillan and Co., Ltd., 1911.) Price 10*s*. 6*d*. net.

This is the forty-eighth annual issue of a work of reference which has become indispensable to administrators, statesmen, and students of economics and geography. The volume has been thoroughly revised and brought up to date—a preliminary section of additions and corrections including the results of the 1911 census of the United Kingdom. A series of new maps is provided, and these include maps of the new projected railway routes to India; railways, navigable waters, and steamship routes; the new Liberian Boundary, 1909; the northern territory of Australia; and of the Panama Canal from the latest reports of the Isthmian Canal Commission.

Several sections of the book have been greatly improved—those dealing with Turkey, Spain, and China may be mentioned. Altogether this issue of the "Year-Book" will preserve the high reputation the work has secured, and the editor may well be congratulated upon his efforts to maintain the accuracy and usefulness of the volume.

Catalogue of the Serial Publications in the Library of the Manchester Literary and Philosophical Society. Compiled, under the direction of the honorary librarian, C. L. Barnes, by A. P. Hunt. Pp. vi+177. (Manchester: Published by the Society, 1911.) Price 2*s*. 6*d*.

The object of this catalogue is to make known the wealth of periodical scientific literature in the library of the Manchester Literary and Philosophical Society. The total number of current publications at present received by the society is 810, and they come from all parts of the world and cover every branch of science. The catalogue is excellently arranged, and is provided with an exhaustive index. It should be of great service to members of the society and to others engaged in scientific research.

The Lore of the Honey-Bee. By Tickner Edwardes. Pp. xx+196. (London: Methuen and Co., Ltd., 1911.) Price 1*s*. net.

The first edition of Mr. Edwardes's book on the bee was reviewed in the issue of Nature for November 5, 1908 (vol. lxxix., p. 6). This fourth edition is a cheap re-issue of what has already proved a popular work; and, at its present price, such an interesting history of the folk-lore of the bee and account of its activities should become known to a wider circle of readers.

LETTERS TO THE EDITOR.

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

The Deformation of Rocks under Tidal Load.

I have read with interest Prof. Milne's letter under the above title in Nature of July 13, and congratulate him on the promising character of the results. As he himself remarks, the subject theoretically is not a new one. Its geophysical interest lies largely in the possibility of deriving information from the observed phenomena as to the elastic character of the earth's crust. Several difficulties, however, stand in the way of this information. The earliest mathematical treatment of the problem, so far as I am aware, is that by Sir G. H. Darwin, to which Prof. Milne refers. The problem which he actually solved relates to the effect of load on the surface of an elastic solid material which is *homogeneous, isotropic,* and *incompressible.* In ignorance of this solution, I obtained another[1] in 1896—a simple deduction from the important solution by Prof. Boussinesq for material bounded by an infinite plane—which is somewhat more general, in so far as it does not assume incompressibility in the material, but otherwise is subject to the same limitations. In practice, the most important of these limitations are probably the assumptions of homogeneity and isotropy. Very possibly, an expert mathematician familiar with recent developments of the mathematical theory of elasticity might have no serious difficulty in removing these restrictions in part or in whole. For instance, if a solution were obtained for the case where there is a relatively thin superficial layer differing in elastic quality from the remainder, it would immediately throw light on what is to be expected from differences in the surface strata.

The solution derived from Boussinesq's for the homogeneous solid is simple, the formula for the vertical component w of the elastic displacement at a point in the plane of the loaded surface being[2]

$$w=\{(1-\eta)/2\pi n\}\iint (p/r)d\sigma,$$

where p is the normal pressure over the element $d\sigma$ of surface, situated at a distance r from the point where w is being measured, n denotes the rigidity, and η Poisson's ratio for the material, dw/dx gives the slope measured in the direction of the axis of x, supposed horizontal. We see at once that however complex the distribution of load may be, the slope varies directly as $1-\eta$, and inversely as n. For a given value of n it is 50 per cent. greater when Poisson's ratio is $\frac{1}{4}$—as it approximately is in steel—than when the material is incompressible.

There is, however, another aspect of the case that has to be taken into account. The influence of the tide does not consist solely of the pressure effect. At high-tide we have a large additional quantity of gravitating material, the attraction of which modifies the direction of gravity at the land station. If we compare the readings of a delicate spirit level at mid-tide and at high-water, there is an apparent change of level $\psi_1+\psi_2$, made up of ψ_1 due to the actual slope of the surface carrying the level, and ψ_2 due to the alteration in the direction of local gravity. Under the conditions postulated in my solution of the problem

$$\psi_1/\psi_2=2(1-\eta)g\rho a/3n,$$

where g is gravity, a the earth's radius, and ρ its mean density. The ratio varies enormously for values of η and n that exist in known materials. Thus we have, measuring n in grammes weight per sq. cm.,

$$\eta=0{\cdot}25,\quad n=80\times10^7,\quad \psi_1/\psi_2=2 \text{ approximately},$$
$$=0{\cdot}5,\quad n=11\times10^7,\quad =11 \quad ,,$$

The first thing to be considered is what does the instrument used actually record? Is it ψ_1 or $\psi_1+\psi_2$? In the latter event, unless ψ_2 is relatively negligible, we must

[1] See *Phil. Mag.*, March, 1897, p. 173.
[2] Proc. Physical Society, vol. xv., p. 36, and *Phil. Mag.*, *l.c.*, p. 177.

calculate it before we can arrive at the true bending effect. If the material is homogeneous and elastic, the vertical plane of steepest slope at any place contains the direction of the resultant gravitational force. But while the gravitational effect must be as instantaneous as gravity itself, the bending effect will show a lag unless the material is perfectly elastic, so far, at least, as tidal load is concerned. It is manifestly a case in which measurement of the apparent slope in two perpendicular planes is likely to add materially to knowledge. An estimate which I made in 1896 for the effect of tides in the Thames at Kew Observatory, assigning the low value of 11×10^7 grammes weight per sq. cm. to the rigidity, and assuming the material incompressible, made the difference of the slope between extreme high- and low-water only of the order $0''\cdot05$, and so too small to be measured satisfactorily by the Milne seismograph at the observatory. CHARLES CHREE.

July 15.

Hamilton and Tait.

IT may at first sight seem a little ungracious to take exception to a statement in the extremely gratifying review of the "Life and Scientific Work of P. G. Tait," which "A. G." contributed to NATURE of July 13. But the point is one which brings out in a remarkable degree the great modesty of Tait in regard to his own achievements. Your reviewer says that Tait "was introduced by Andrews to Rowan Hamilton, at that time in the full tide of his quaternion work, and busy with the preparation of the 'Elements' for publication."

Now it is, I think, clearly established in the "Life," by means of quotations from Hamilton himself, that when the correspondence with Tait began Hamilton had stopped working at quaternions, that the correspondence drew Hamilton back to the study of his calculus, and that, as I put it in the "Life," p. 132, it was Tait "who fired Hamilton with the ambition to write his second great 'Treatise on Quaternions.'" This is proved by Hamilton's own words, quoted on p. 131 of the "Life." Since possibly many readers may not be interested in the quaternion side of Tait's activities, I take the liberty of reproducing this quotation here. Writing on January 21, 1859, Hamilton remarked:—

"As to myself I cheerfully confess that I consider myself to have, in several respects, derived advantage, as well as pleasure, from the correspondence. It was useful to me, for example, to have had my attention *recalled* to the whole *subject* of the *quaternions*, which I had been almost trying to *forget*; partly under the impression that nobody cared, or would soon care, about them. The result seems likely to be that I shall *go on* to write some such 'Manual,' not necessarily a very *short* one—as that alluded to in a recent paragraph."

It seems clear that without the Tait correspondence, Hamilton would never have undertaken the second treatise. This was one of the discoveries which I was privileged to make when the correspondence was committed to my care. To me it was a very surprising discovery. I had often conversed with Tait about his relations with Hamilton—and he was critical as well as appreciative in these reminiscences—but I never heard him say anything as to the part he played in the first beginnings of the "Elements." In his own writings, such as the prefaces to the successive editions of his treatise, or the biographical notices he wrote of the great Dublin mathematician, Tait had ample opportunities of telling the story of his intimate connection with Hamilton's second treatise. But not the least hint was ever given. It may be that Tait felt his hands tied because of the absence of any reference in the "Elements" to the correspondence. But we must remember that Hamilton did not live to complete his work or to write more than the merest fragment of a preface. Now that we know the truth from Hamilton's own letters, the whole episode is a fine example of Tait's modesty, and even self-effacement, in regard to his influence in shaping scientific development. The story throws such a beautiful light upon the character of Tait that I am sure your reviewer will thank me pointing out the one slight inaccuracy in an otherwise perfect review. C. G. KNOTT.

Edinburgh University, July 17.

The Fruiting of the Tamarisk.

THIS exceptional season is having strange effects on many of our native plants and animals, and naturalists would do well to note these before it is too late.

For many years I have tried without success to find *Tamarix anglica* in fruit in Britain. The absence of fruit, and the rarity of the tamarisk except where obviously planted, seemed to support the idea that it was of fairly modern introduction.

A few years ago, however, fragments of rope, found in Roman Pevensey and sent to Kew, were pronounced to be formed in part from the inner bark of tamarisk. This seemed to favour the inclusion of the tamarisk in the British flora, though rope found in a Roman seaport may quite well have been manufactured abroad.

This season the negative evidence yielded by the absence of seed has also broken down; and if a plant seeds once in its lifetime, it may hold its own and establish its right to a place in our flora—as the Cornish elm has done.

I planted last spring some young tamarisks on a steep bank of loose sand in my garden at Milford. During the long drought they received no water; they are now seeding freely, and the winged seeds are being dispersed by the wind. If the plant reproduces itself from these seeds, sown under natural conditions, the cycle will be complete; but the garden is a quarter of a mile from the sea, and the test may be too severe a one.

Tamarisk is essentially a desert and sea-coast plant, and it would be worth while to examine any tamarisks growing on sand-dunes, to see whether they also are seeding, and to see whether seedlings come up. Possibly the tamarisk may be a survivor from times when desert or "loess" conditions extended over western Europe. We have found the fossil remains of many of the desert animals, but plants decay in porous deposits of dust, and desert plants are seldom washed into ordinary alluvial deposits. CLEMENT REID.

Milford-on-Sea, Hampshire.

Sunshine and Fleas.

ARISTOTLE (H.A. viii. 605*b*) makes the following curious and perplexing statement:—*πάντα δὲ τὰ ἔντομα ἀποθνήσκει ἐλαιούμενα· τάχιστα δ', ἄν τις τὴν κεφαλὴν ἀλείψας ἐν τῷ ἡλίῳ θῇ.* That is to say: "All insects die if they be smeared over with oil; and they die all the more rapidly if you smear their head with the oil and lay them out in the sun." So Pliny, Albertus Magnus, and recent commentators read and interpret the passage. But in the former half of the sentence, for *ἐλαιούμενα*, several MSS. read *ἡλιούμενα*: *i.e.* not "if they be smeared with oil," but simply "if they be exposed to the sun"; while in the latter half there is an obvious ambiguity, which inclines me to think that *τὰ ἔντομα* is used *sensu restricto,* and that *τὴν κεφαλὴν* refers, not to the insect's head, but to the experimenter's.

I take it, in short, that the heat of the sun was the main agent recommended for the destruction of the insects, and it is interesting to find this agency again coming into practical use for a very similar purpose. One of the latest of the Indian Medical Department's "Scientific Memoirs," by Capt. J. Cunningham, is entitled "On the Destruction of Fleas by Exposure to the Sun." The writer recommends the wholesale disinfection of clothing and baggage, for the special purpose of destroying plague-carrying fleas, by the simple process of laying out the garments or bedding on a sandy floor, exposed to the full rays of the sun. The author has made many careful and elaborate experiments, and has succeeded in showing that in less than an hour's time, under an Indian sun, the fleas are all dead.

D'ARCY W. THOMPSON.

The Oban Pennatulida Again.

MARINE biologists may be interested to hear that the bed, near Oban, of the largest British pennatulid *Funiculina quadrangularis*, and the smaller *Virgularia mirabilis* described by Mr. W. P. Marshall and the late Prof. Milnes Marshall in 1881 or 1882 (I have no books of reference with me) is still apparently in very flourishing condition. In a couple of hauls of the small Agassiz trawl, from this yacht yesterday, between the islands of Kerrera and Lismore, at depths of eighteen to twenty fathoms, I got about a dozen fine specimens of Funiculina, the largest of which measured nearly four feet in length. The bed must be of considerable extent, as the hauls were not on the same spot, and both brought up equally good specimens of these magnificent pennatulids. Most of the large specimens of Funiculina, by the way, were not caught in the trawl-net, but were balanced across the front of the frame, at each end, in such a precarious position as to make one wonder how many others had been lost in hauling in. The bottom deposit was evidently fine mud. W. A. Herdman.

S.Y. *Runa*,
Sound of Iona, July 11.

On the Non-simultaneity of Suddenly Beginning Magnetic Storms.

In his paper "On the Supposed Propagation of 'Equatorial' Magnetic Disturbances with Velocities of the Order of a Hundred Miles per Second," read before the Physical Society of London, November 11, 1910, and published in the Proceedings of that society, vol. xxiii, pp. 49–57, Dr. Chree, in reviewing my paper published in the *Journal of Terrestrial Magnetism* (vol. 15, pp. 93–105), expressed some doubts as to my views on the subject of the non-simultaneity of suddenly beginning magnetic storms.

It seems to me that there should not be any doubt as to my position on this point when I stated in my above-mentioned paper (*loc. cit.* p. 103) that the evidence there presented confirmed what Dr. Bauer had stated, namely, that magnetic storms do not begin at the same instant all over the world, and added a little further on that a new view-point in the discussion and analysis of magnetic storms is thus introduced, meaning that a new view-point must now be had on account of this non-simultaneity of the occurrence of the beginning of the storms which, I believe, the data shows to exist.

I agree with Dr. Bauer in his conclusion that the abruptly beginning magnetic storms are not simultaneous all over the world, and this conclusion, it seems to me, is supported, not only by the data in my paper, but by that in his paper which appeared prior, and in that which has appeared subsequent, to mine. R. L. Faris.

U.S. Coast and Geodetic Survey,
Washington, D. C.

The Number of Possible Elements and Mendeléeff's "Cubic" Periodic System.

According to Rutherford's theory of "single scattering" ("On the Scattering of α and β Particles by Matter and the Structure of the Atom," *Phil. Mag.*, May, 1911), and to Barkla's "Note on the Energy of Scattered X-Radiation" (*ibid.*), the numbers of electrons per atom is half the atomic weight; thus, for U, about 120. Now, a reconstruction of Mendeléeff's "cubic" periodic system, as suggested in his famous paper "Die Beziehungen zwischen den Eigenschaften der Elemente und ihren Atomgewichten" (*Ostw. Klass.*, No. 68, pp. 32, 36, 37, and 74), gives a constant mean difference between consecutive atomic weights $=2$, and thus, from H to U, 120 as the number of possible elements (van den Broek, "Das Mendelejeff'sche 'Kubische' Periodische System der Elemente und die Einordnung der Radioelemente in dieses System," *Physik. Zeitschr.* 12, p. 490). Hence, if this cubic periodic system should prove to be correct, then the number of possible elements is equal to the number of possible permanent charges of each sign per atom, or to each possible permanent charge (of both signs) per atom belongs a possible element. A. van den Broek.

Noordwijk-Zee, June 23.

Phases of Evolution and Heredity.

I should like your reviewer of the above book in Nature for May 25 to consider the following points:—

1. In a tall-dwarf crossing where the results are read in plants, the ultimate ratios considered as due to a probability combination of the egg-cells and pollen grains the influence of which necessarily ends within a generation, explain why we do not get the ratio in the plants coming out in F^1.

2. To my query, "How is the recessive element expressed in F^1? It has not disappeared as it reappears in F^2 unaltered. It is not expressed in the 'soma' of the plant: where is it?" your reviewer answers "In the germ-cells."

If, however, the determinants of the recessives are expressed in the germ-cells, *i.e.*, in the propagative part of the plant, so must those for the impure dominant and dominant plants. These plants segregate in a 1 : 2 : 1 ratio, and therefore the determinants for the contrasted unit-characters must be in that ratio in the propagative part of the oospores. Does the reviewer not admit the accuracy of my view after all? D. Berry Hart.

5 Randolph Cliff, Edinburgh.

I find it very difficult to follow Dr. Berry Hart. If he means, by the question which concludes his letter, to ask whether I accept his theory as truly representing, once and for all, the causes which determine the Mendelian ratio 1 : 2 : 1, my answer is an unqualified negative; not because I think I know what the true theory is, but because I do not think the time is yet ripe to formulate it. Dr. Hart's theory is evidently different from the accepted Mendelian theory; and it may be nearer the truth. Whether it is or not, further experiment alone can show. The Reviewer.

Available Laboratory Attendants.

The London County Council has for some time been referring to us a certain number of boys who have been trained as laboratory attendants in their higher grade and secondary schools, and whose services they are unable to retain after they have attained seventeen years of age. We are anxious to find suitable vacancies either in chemical works or laboratories for these boys, who are of a distinctly superior type and some of whom have profited by their experience to pass the Board of Education examinations in inorganic chemistry.

Some of these boys who were placed by us, thanks to a letter published by you last year, are doing well and giving satisfaction to their respective employers.

Should any of your readers, now or at any future time, have a vacancy for such a lad, I should be glad to hear from him.

G. E. Reiss, *Hon. Sec.*

Apprenticeship and Skilled Employment Association,
36 Denison House, 296, Vauxhall Bridge Road,
London, S.W. July 6.

Mersenne's Numbers.

I desire to announce the discovery which I have made that $(2^{181}-1)$ is divisible by 43441. This leaves only 16 of the numbers (2_q-1) originally reported composite by Mersenne, still unverified. I have submitted my determination to Lt.-Col. Allan Cunningham, R.E., who has kindly verified it.

It is interesting to know that while $(2^{181}-1)$ is divisible by 43441, the quotient when divided by this number (43441) leaves a remainder 21839. This latter result has been verified by two divisions.

Herbert J. Woodall.

Market Place, Stockport, June 12.

The Fox and the Fleas.

Some readers of Nature may be interested in seeing the following passage from one of Liebig's letters to Wöhler, dated Giessen, June 24, 1849, as showing that the story has long been familiar, at least in Germany:—

"Das freiheitsmörderische Gesindel ist nun, wie beim Fuchs die Flöhe in dem Bündel Heu, in einer Schlinge gefangen . . .," &c. William A. Tilden.

The Oaks, Northwood, Middlesex, July 10.

Cabbage White Butterfly.

Would some entomologist state if he knows of any reference to the fact that the larvæ of the Large Cabbage White seek to arrange themselves in pairs—male and female—when they pupate?

Can the sexes be distinguished externally in the larval and in the pupal stages? E. W. Read.

Sutherland Technical School, Golspie.

NOTES ON THE HISTORY OF THE SCIENCE MUSEUM.[1]

II.

IN the former notes I referred to the early history of the Patent Museum.

By 1874, in consequence of the acts of the Commissioners of the 1851 Exhibition, land for the proper display, on the one hand, of objects chiefly illustrating art and its application to industry, and, on the other, of objects illustrating natural history, had been provided, and buildings for these purposes, as well as a School of Science, had been commenced. But for the Patent or Science Museum, no building had been erected on the five acres assigned to it by Lord Palmerston on the land bought in 1863.

In this year the question of museums was considered by the Duke of Devonshire's Commission, and the collections at South Kensington were inquired into. The question of the Patent Museum was specially considered, and it was pointed out that objects illustrating patents should find their true place among those dealing with the advance and applications of the physical and mechanical sciences.

As a result of this inquiry, the Duke of Devonshire's Commissioners recommended to the Government the establishment of what they were the first to call a Science Museum, in which was to be included not only patented objects, but those necessary to illustrate the advances of both pure and applied science. I give the following extract from their fourth Report :—

"81. While it is a matter of congratulation that the British Museum contains one of the finest and largest collections in existence illustrative of Biological Science, it is to be regretted that there is at present no National Collection of the Instruments used in the investigation of Mechanical, Chemical or Physical Laws, although such collections are of great importance to persons interested in the Experimental Sciences."

"82. We consider that the recent progress in these Sciences and the daily increasing demand for knowledge concerning them make it desirable that the National Collections should be extended in this direction, so as to meet a great scientific requirement which cannot be provided for in any other way."

"83. The defect in our collections to which we have referred is indeed already keenly felt by teachers of Science. If a teacher of any branch of Experimental Science wishes to inspect any physical instrument not in his possession, as a teacher of Literature would a book, or a teacher of Biology would a specimen, there is no place in the country where he can do it."

"93. We accordingly recommend the formation of a Collection of Physical and Mechanical Instruments; and we submit for consideration whether it may not be expedient that this Collection, the Collection of the Patent Museum, and that of the Scientific and Educational Department of the South Kensington Museum, should be united and placed under the authority of a Minister of State."

Here then we find the definition of a "Science Museum" as resulting from all the inquiries made by the Duke of Devonshire's Commission. Their statement regarding its organisation under a Minister of State was evidently inserted, because in another Report they pointed out the importance of the whole National Museum system being under a Minister of State, instead of being in two water-tight compartments, one of them controlled by a body of Trustees without Government responsibility.

This is too large a question to be entered upon in these notes, but it may be pointed out that if this recommendation had been acted upon the recent discussions would never have arisen.

A step was at once taken by the Government to facilitate the carrying out of these recommendations, and a loan collection of scientific apparatus was brought together in 1876, as an object-lesson of what such a Science Museum might be in relation to the "Patent Museum," arranged for by Lord Palmerston in 1863, which would form part of the new museum. Still no steps were taken to commence the building.

The building of the new Natural History Museum, however, was proceeding; it was finished in 1880. It has been shown that the land allotted for natural history purposes by Lord Palmerston was five acres. The completed museum building covered nearly four acres, and was erected in the centre of a space of about eleven and a half acres, fenced off from the remainder of the sixteen and a half acres purchased in 1863, in such a manner as to make it difficult to apply the eight acres not built over to any other service, or even to expand largely the museum itself without injury to its architectural features. As to how this state of things, so different from that to be gathered from Lord Palmerston's speech, came about I have no information.

The recommendations of the Duke of Devonshire's Commission touching a Science Museum had much influence in leading the Commissioners of the 1851 Exhibition to adopt proposals for the future appropriation of their estate.

Even while the loan collection of scientific apparatus in 1876 was indicating the national importance of such a museum as the Duke of Devonshire's Commission had suggested, the 1851 Commissioners began their proposals to bring it into being by offering to endow a Science Museum with money and land.

I quote from the sixth Report (p. 41) the action taken in 1876 :—

"Influenced by these considerations, and by the regrets expressed by the Royal Commission on Scientific Instruction, in their Report already quoted, we concluded that there could be no more appropriate employment of a portion of our resources than to expend them on a building on our own Estate, for the advancement of scientific study and research, and, in connection with the South Kensington Museum, to receive the important contributions of instruments which we understood would be made to the nation at the close of the Loan Exhibition already alluded to.

"We, therefore, proposed to Her Majesty's Government that 100,000*l.* of the amount we might realise, or might be enabled to raise on ground-rents, should be devoted to the furtherance of the recommendations of the Royal Commission on Scientific Instruction by erecting, on a site opposite the Government Science Schools, a building suitable for a Museum of Scientific Instruments, or for a Library of Scientific Works, and for laboratories of scientific research and instruction. And we made this offer on condition that the Government would undertake to maintain the building, when erected, in the manner proposed. The site referred to is partly our property and partly the property of the Government, and we suggested that, in exchange for a conveyance of the part belonging to us, the Government should return to us two small portions of the site of the Exhibition of 1862, which project into our main square."

The proposal then was very similar to the present one, utilising the land to the north of the Natural History Museum building.

Events, however, indicated that the Commission's land to the north of the plot first proposed would be a more convenient site for the Science Museum, and a second letter was addressed to the Govern-

[1] Continued from p. 16.

ment in 1878, in which the Commission again offered to convey land and to provide 100,000*l*. for a Science Museum to be built on a plan to be approved by the Government.

The view of the Commission is thus expressed in their sixth Report (p. 44):—

"*The proposed new building would complete the group of buildings already erected by the Commission, and these . . . would alone satisfactorily realise the first conception of the illustrious Prince who conceived the idea of purchasing the estate.* Should the Government eventually acquire also the ante-garden for the extension of the Science building now proposed, or for other public buildings, and thus connect our direct work with the Natural History and the South Kensington Museums, *the success of the plans of the Prince Consort would be complete.* The national collections of Mediæval and Recent Art would have their home on the portion of the Estate purchased with the funds derived from the Exhibition of 1851 which lies on the east of Exhibition Road; the Science collections on the portion of the Estate which lies on the west of that road."

This offer was declined by the Government in 1879 on the ground of the depression of trade, and that the establishment of such a museum was not sufficiently urgent!

After this the Commissioners took no further action with regard to the Government until 1888. In the meantime, however, they had granted land for the erection of the City and Guilds Institute and the Imperial Institute.

In a letter of 1888 the land to the south of the Imperial Institute Road, reaching to the land conveyed to the Government in 1864, was offered under the old conditions, namely, "that the land shall be permanently used for purposes connected with Science and the Arts." This plot consisted of 4½ acres, valued at 200,000*l*. It was offered to the Government for 70,000*l*., and the contained southern gallery (already leased to the Government) for 30,000*l*. This offer was accepted.

In the year 1907, in spite of the Commissioners' repeated efforts, we had no Science Museum, and the Commissioners had no more land to offer.

All that remained in 1906 was given to the governing body of the Imperial College of Science and Technology, the new institution which is to bring together all the colleges already built, and to be built, on land presented, or sold at reduced value, by the Commission for scientific purposes.

The existing buildings are the College of Science, the site of which was given gratis; the City Guilds' College, the site of which is rented at one shilling per annum; and the new Chemical and Physical Laboratories of the Imperial College, on a site sold by the Commission at less than half its value.

It may be said that, adding the value of these old plots to that of the three given in 1906, the Commission has really endowed the new institution to the extent of some 400,000*l*.

But if a Science Museum was desirable before such a bringing together and extension of science teaching and research as the new institution affords, it is vastly more important now, when advanced research in the applications of science to the national industries is to be fostered along new lines. The opinions of those most competent to judge of the national importance of a Science Museum thirty years ago can be gathered from an appendix to the Commissioners' sixth Report (p. 130), in which is printed the memorial addressed to the Lord President of the Council in 1876.

Such a museum is vastly more important now, but its location at South Kensington, in close contiguity to the Imperial College, has become imperative.

In 1907, mindful of what the Commission of the 1851 Exhibition had attempted to do during the whole time of its existence up to that time in furtherance of the completion of the National Museum organisation, I considered it my duty to call the attention of the Commissioners to the fact that practically the whole of the land belonging to them had been allocated, and that, so far, no proper provision had been made for a Museum doing for the Physical, Chemical, and Mechanical Sciences what the British Museum Library does for books, the Galleries for Antiquities, the National Gallery does for pictures, and the Natural History Museum does for the Biological Sciences.

In a memorandum to the Commissioners urging the early erection of such a museum I wrote:—

"How, then, can its early erection be brought about? I submit by holding out a special inducement to the Government to utilise in this direction some part of the land sold to the Government in 1888 still waste between the old and new buildings of the College of Science and adjacent thereto.

"The importance of the eastern part of this site for the purpose I have indicated has long been recognised. In 1891 it was ignorantly offered by the Government to Mr. Tate for an art gallery, but when the facts had been inquired into, the offer was withdrawn by the then Chancellor of the Exchequer, Mr. Goschen. Both in a memorial presented to Lord Salisbury and by a deputation to the Lord President of the Council and the Chancellor of the Exchequer it was pointed out that were the corner site in question not occupied by the science collections the teaching in the Royal College of Science would be cut in two when the new laboratories were erected (they have been erected since). On this ground the Government withdrew the offer to Mr. Tate, and reserved the site for future science buildings.[1]

"The frontage of this plot, which indeed is the last important and considerable *frontage* remaining, is in Exhibition Road, stretching from the Natural History Museum grounds to the Imperial Institute Road. It lies exactly between the old and new Royal College of Science buildings.

"I may add that the frontage available in Exhibition Road is over 360 feet; that is, 60 feet longer than the west frontage of the Victoria and Albert Museum, and only 17 feet shorter than the frontage of the new buildings of the British Museum. . . .

"Were this building erected, all the ground once possessed by the Commissioners along Cromwell Road and to the south end of Exhibition Road would have been utilised for the purposes of Science and Art, Art on the east side, and Science on the west side of Exhibition Road, as was originally planned.

"Were the southern galleries—the old Exhibition refreshment rooms—taken down, and the dangerous spirit museum removed to a safer site, such as the Natural History Museum Gardens, some distance west of the main building, there would be a space of more than four acres between the Natural History Museum and the Chemical and Physical Laboratories, and stretching from Exhibition Road to Queen's Gate, not only with the frontage to which I have referred, but another in Queen's Gate. Here, indeed, it would be possible, as a variant of the plan I have suggested, to erect a Science Museum similar to the one offered by the Commissioners to the Government in 1878, and indicated on their plan. Much of this land is not at present permanently occupied, and the Solar Physics Observatory is under notice to quit, a new site at Caterham having already been fixed upon.

"It seems desirable that this long-standing question of a Science Museum should be again discussed, and

[1] Accounts of what took place will be found in NATURE, February, 1891, and March, 1892, vols. xliii. and xlv.

without delay, because if any buildings are erected on the spaces referred to, any such Science Museum as the Commissioners have had in contemplation during the last thirty years, for which they have freely given their land and offered money, will be impossible of realisation, to say nothing of future extension.

"I have reason to think that if the Commissioners would again take up the question, remind the Government of their continuous action and appeal to the Government to consider the matter, such an appeal would be received sympathetically. If such an appeal could be accompanied by the renewal of the offer, already twice made, to provide a money contribution towards the building, the matter would, of course, become still more hopeful.

"The last Annual Report shows that the Commissioners have in hand funds available for such a purpose, and, speaking as a Commissioner, I can conceive no more worthy expenditure, as it will give full effect to the great purposes the Commissioners have had in view during the whole time they have been engaged in carrying out the late Prince Consort's wise advice as to the best use of their property in the nation's interest."

In 1910 the Commissioners took action in the matter. In the "Further Correspondence" already referred to [Cd. 5673] is given a letter (June 25, 1910) from the Secretary:—

"The Board of Management of the Royal Commission for the Exhibition of 1851 have recently had before them a proposal to establish at South Kensington a permanent building for the accommodation of the National Science Collections. . . .

"Believing that the application to such an object of a portion of their surplus funds would be consistent with the declared policy of the Commissioners, they have resolved to recommend to the Commissioners a repetition of their former offer of 100,000*l*. towards the expense of providing a Museum, subject to their being satisfied that his Majesty's Government are prepared to make provision, so as to secure the erection of an adequate building."

On August 25, 1910, the Treasury accepted this offer. While this correspondence was going on the Office of Works was writing to the Trustees of the British Museum with regard to the Northern Boundary, a subject dealt with in the previous notes.

We now learn from *The Times* report of Mr. Runciman's speech on the Education vote (July 13, 1911) that at last some compromise has been arrived at.

"Since the first announcement was made about the site of the Science Museum I have entered into negotiations with the Trustees of the British Museum, and we have now arrived at an agreement which will give us the land we require for the Science Museum and will not interfere with the development of the Natural History Museum, so that we shall have in South Kensington a group of museums which will be the envy of foreign nations." NORMAN LOCKYER.

THE ROYAL COMMISSION ON TUBERCULOSIS.

THE Reports of Royal Commissions are as a rule based almost entirely on summaries of oral evidence submitted by authorities, expert or otherwise, on the subjects with which these Commissioners have been called together to deal. Such Commissions can be expected to give little more than a *résumé* of what is already known.

In the Final Report of the Royal Commission on Tuberculosis (Cd. 5761; price 6*d*.) it is soon made manifest that here something more than personal opinions of even the most eminent authorities have been brought together. The very genesis of the Commission made this necessary. The greatest living authority on the subject of tuberculosis, Robert Koch, had for long taught that tuberculosis was a disease common to animals and man, a disease induced by a specific micro-organism, the tubercle bacillus. Of this micro-organism there might be varieties in which the virulence or disease-producing activity might be higher in one and lower in another, but they were still essentially and specifically the same wherever they were found in the tuberculous lesions, whether of man or of animals.

At the International Congress held in London in July, 1891, Koch had turned round (perhaps not suddenly, though the announcement of the *volte face* had come with startling suddenness) and had announced that the tuberculous disease of cattle was not the same thing as tuberculosis of the human subject, and that the tubercle bacillus found in the tuberculosis of cattle was non-virulent for man.

The experimental work on which this statement was based was considered by many of the scientific men who heard the pronouncement to be totally inadequate to bear the wide generalisations founded upon it.

Lord Lister, the late Prof. Nocard, Prof. Bang, Sir John McFadyean, Dr. Sims Woodhead, and others were in agreement that the statement, if true, would revolutionise our whole attitude to the tuberculosis problem, and that before it could be accepted independent and corroborative evidence must be obtained.

Sanitarians in the United States appreciated the importance of this to the full, and the morning after Koch's address was given a telegram was received in London from Washington stating that the tenor of the address had been noted, and that arrangements, financial and otherwise, had been made to carry out experiments to test the trustworthiness of Koch's thesis.

Although a resolution asking the British Government to appoint a Royal Commission had been carried at the meeting of the Executive Committee, the business of the closing meeting of the Congress had been practically concluded, and no resolution asking for this Commission had been brought forward, and none could be found. One or two members of the Executive Committee, however, had carried the terms of the Resolution in their memories, they were hurriedly committed to paper, and the matter was placed before the meeting. Lord (at that time Sir James) Blyth had made a most generous offer to place a farm or farms at the disposal of any Committee or Royal Commission appointed, and it was evident that any such Commission set to work to inquire into the question would be able to carry on its investigations under most satisfactory conditions.

In these circumstances the Right Honourable Walter Long, M.P., then President of the Local Government Board, advised her Majesty Queen Victoria to appoint a Royal Commission with instructions to inquire and report with reference to tuberculosis:—

1. Whether the disease in animals and man is one and the same.
2. Whether animals and man can be reciprocally infected with it.
3. Under what conditions, if at all, the transmission of the disease from animals to man takes place, and what are the circumstances favourable and unfavourable to such transmission.

The Commission appear to have laid down a very definite plan, from which there has been no deviation. It was asked to inquire and report on the above questions. No inquiry except an actual experimental investigation seemed to give promise of any trustworthy results, and the scheme of work did not include the taking of oral evidence.

The answers to the questions, though very guarded in many directions, are, where the Commissioners have made up their minds, clean cut and definite. No pretence is made to answer any questions but those contained in the reference, and anyone going to this Report for general information on the subject of tuberculosis generally will come away greatly disappointed, but on the questions the Commission was asked to answer the expert will find ample material for thought.

Is the disease in animals and man one and the same?

Before this question could be answered the Commissioners had apparently to satisfy themselves that the tubercle bacilli found in animals (especially bovine) and man (*a*) were the same, morphologically, culturally, and pathogenetically; or (*b*) they differed in one or other or all of these aspects, and, if they differed, whether any modification of these aspects ever occurred under either natural or artificially produced conditions.

The conclusion at which the Commissioners arrive is that it is practically impossible to differentiate the bacillus found in the bovine animal suffering from tuberculosis from that found in certain cases of tuberculosis in the human subject. The bacilli are alike in every respect—morphology, cultural characters, and virulence. In the human subject, however, especially in cases of pulmonary tuberculosis, a type of tubercle bacillus occurs which, though resembling morphologically that found in bovines suffering from tuberculosis, differs considerably in cultural characters—*e.g.*, rate of growth on artificial media and in virulence. Both types produce rapidly progressive tuberculosis in the human subject and certain other animals, but only one, the bovine type, is specially active when introduced into the bovine animal. It is obvious, then, that wherever a tubercle bacillus is found, it may set up tuberculosis in the human subject, whatever it may be able to do in the cow. Moreover, the disease, when set up in the human subject, always runs much the same course, whether the exciting agent in its production is the one form of the bacillus or the other.

The answer to the second term of reference—"Whether animals and man can be reciprocally infected with it"—follows as a kind of corollary. There is ample evidence put forward to prove that many cases of fatal tuberculosis in the human animal (usually in children) have been set up by the bacillus proved to have been the cause of the disease in bovines. On the other hand, the type found naturally only in the human subject appears to set up in the bovine merely a non-progressive tuberculosis. It was found, however, that adult human beings are sometimes infected by the tubercle bacillus of bovine type, even the lungs becoming involved, whilst it is evident from recorded experiments that cattle have not by any means complete insusceptibility to the attacks of the tubercle bacillus of human type. These facts are of primary importance when, as is evident from the work recorded, there are such gradations in all the differentiating characters in many of the strains of bacilli separated from ordinary cases of tuberculosis in the human subject—a gradation that becomes even more marked and important in the groups of bacilli isolated (*a*) from the lesions in cases of lupus and (*b*) from the tuberculous in the horse.

Granting that the foregoing may be accepted, it follows that the third term of reference concerning the conditions under which transmission of the disease from animals to man takes place can only be answered through a study of the susceptibility (*a*) of the animal and (*b*) of man. The susceptible individual, whether brute or human, will be most affected, and by the widest range of tubercle bacilli as regards gradations of virulence. Each individual affected will constitute a centre of infection, and the greater the number of these susceptible individuals exposed even to "weak infections," the greater the chance of further transmission of the disease. It would appear that residence of a tubercle bacillus in any animal or series of animals for a considerable length of time may increase the virulence of that bacillus for the special species in which it is "cultivated." This certainly occurs in connection with other micro-organisms—*e.g.*, the pyogenic streptococci and certain forms of micro-organisms giving rise to septicæmic processes—still no direct evidence is adduced by the Commissioners that this takes place in connection with the tubercle bacilli, though in the course of their work they came across an enormous variety of grades of virulence in the tubercle bacilli from various sources in man and the lower animals. The bovine type of bacillus occurs with such frequency in children, especially in sites connected with the alimentary canal, that it seems impossible to ignore the causal relationship between tubercle bacilli found so frequently in the milk given by tuberculous cows and the tubercle in the child; whilst, on the other hand, the tubercle bacilli usually associated with pulmonary tuberculosis in the adult human subject being of the human type, have probably passed through a number of men and women, one transmitting it to the other in direct succession.

During the few days that have elapsed since the appearance of the Report some criticism has been directed against it on the ground that all the moot questions concerning tuberculosis have not been answered. This is surely unreasonable, as it cannot be too clearly recognised that the reference to the Commissioners was exceedingly closely defined. They had no authority or power to go beyond this reference. Indeed, the time—ten years—required for the elucidation of the special questions referred to them gives a definite indication of the propriety of the limitations imposed upon and accepted by the Commission.

Many and most important questions bearing on the cause and cure of tuberculosis have still to be answered. This can be done only by well-trained men working on an organised plan, co-operating whole-heartedly for a considerable period, and well supplied with financial means, facilities, accommodation, and equipment. That some organised scheme of work will be devised can now scarcely be doubted, and it is to be hoped that it will be adequately supported by Government. Such legislation has long been under consideration, and it may be that it has been held back until the appearance of this Report. Now, *bis dat qui cito dat.*

Although the Commissioners make no direct recommendation as to legislation, anyone who reads their Report can have little doubt as to their opinion on this matter, and we feel satisfied that those in high places will realise that in bringing forward such legislation as may be necessary to ensure a pure milk supply, their hands are greatly strengthened by the findings here recorded.

The Commissioners were evidently splendidly served by the Secretary and by their staff of scientific assistants, as they insist very strongly on the value of the services rendered by these gentlemen in the carrying out of the scheme of work planned at the outset.

In conclusion, it may be pointed out that one name not hitherto mentioned in connection with the formation of this Commission is that of Sir Herbert Maxwell, who, during the Congress and until the completion of the arrangements for the Commission, planned carefully and worked indefatigably to get together a thoroughly representative Commission.

THE GYROSTATIC COMPASS.[1]

MESSRS. ELLIOT BROTHERS, the English makers of the Anschütz gyro compass, are to be congratulated on the publication of an admirable account of the principle, construction, and practical use of this, the newest and most marvellous of all applications of the gyrostatic principle to a useful purpose. This book is chiefly translated from the German publication by Anschütz and Co., but the more mathematical part, due originally to Herr M. Schuler, has been modified by Mr. Harold Crabtree and Mr. Alfred Lodge so as to be more in accord with English mathematical usage. Commander Chetwynd and Commander Marston have also assisted in making those parts which deal with practice as useful as possible. With such skilled collaboration and with so admirable an original to work upon, it is not surprising that the result is so charming and instructive.

A gyrostat may be supported so that it has three (angular) degrees of freedom, or so that it has only two, one angular motion being constrained. With three degrees of freedom and really perfect balance the axis of rotation would maintain itself indefinitely in space and so the axis of rotation, if it were set parallel to the earth's axis, for instance, at any time and place would, rotation being maintained, retain that parallelism indefinitely, and show both latitude and the ship's course. The trouble is partly the difficulty of obtaining sufficient gyrostatic stability, but chiefly the impossibility of obtaining a really perfect balance, and so, however small the turning couple due to want of balance may be, precession will be set up and a cumulative error will grow and make the indications useless. If, however, the axis of a gyrostat is subjected to an elastic constraint tending to keep it level, but allowing it to tilt in spite of the constraint, and if, further, the gyrostat is supported so that no couple acts upon it in azimuth as resulting from the support, then with sufficient gyrostatic capacity the whole combination cannot rest in any position except that in which the axis is pointing north and south very nearly, and the direction of rotation is in the same direction as that of the earth. For if the axis should be in any other direction the rotation of the earth will, through the elastic constraint, tend to elevate one end of the axis and depress the other, and under this constraint the axis will precess towards the north and south direction. When, however, this direction is reached, the axis will be neither exactly level nor at rest, and the motion would, like a pendulum, continue as far to the other side if some system of damping were not introduced.

In the Anschütz gyro compass the gyro wheel is supported by a hollow steel ring immersed in mercury and with the centre of flotation a little above the centre of gravity, thus giving the necessary elastic constraint to the axis. The whole floating system (Fig. 1) is located by the compound piece, S, T, the two parts of which serve as two electric poles communicating with a three-phase motor within the gyro wheel A in the casing B. The compass card, R, is carried by the casing B. The third electric pole is supplied by the mercury, Q, and floating hollow ring, S, of steel. The whole case for the mercury, K, is carried on gymbal rings, like an ordinary compass. The gyro wheel, A, is run at a speed of 333 turns a second, and is subject to a bursting stress of 10 tons per square inch. Its axle, like that of a de Laval turbine, is sufficiently flexible to enable the wheel to establish its own dynamical axis, and it is supported on ball bearings of the highest perfection.

Beautiful as the invention is, closely as the material and construction approach perfection, perhaps no detail affords such a pleasing surprise as the system by which the damping of the motion, to which reference has been made, is effected. Side holes are provided in the casing, A, for the admission of air, and at the bottom there is a tangential opening through which a blast of hot air escapes. As something like half a horsepower is being absorbed within the casing, this air circulation affords the necessary cooling. The orifice, a, b (Fig. 2), for the escape of air is partly covered by a shutter, u, carried by a pendulum, so that when the gyro axle is horizontal the escape of air is symmetrical on either side of the shutter, but when it is inclined the escape of air is greater on that side on which the axle is elevated. The reaction due to the increased escape of air on one side tends to turn the casing round opposing the precession, and so bringing the axle towards the horizontal position. It therefore comes about that each excursion of the axle is only about one-fifth of the previous one in the opposite direction, and in about three hours from starting with axle level and 45° east or west, it has settled down steadily to its position of rest almost exactly due north and south.

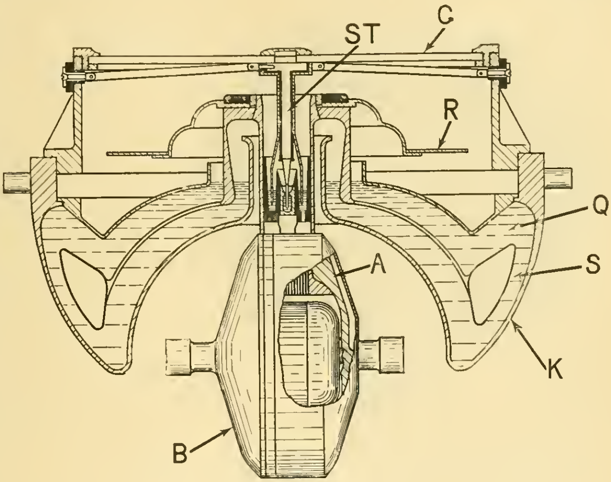


FIG. 1.—Vertical section through the centre of the gyro compass as constructed for use on board ship.

Almost exactly, but not exactly; not that there is any vagueness as to the point of rest, but because there are certain corrections, a latitude correction, with which the little weight, t, has to do, and which

[1] "The Anschütz Gyro Compass. History, Description, Theory. Practical Use." Pp. ii+109. (London: Elliott Brothers, 1910.)

can be made thereby zero for any particular latitude in one hemisphere only. There is a second correction due to the ship's motion in latitude, small and independent of the particular instrument, and there is a third correction, a ballistic correction due to change in the ship's motion in latitude. Space does not admit of these being followed out, but they are fully explained.

The directive force of the gyrostatic compass is about fifteen times as great as that of an ordinary magnetic compass undisturbed by surrounding iron. In addition, therefore, to its being undisturbed by the magnetism of the ship or the movements of heavy magnetic pieces, such as guns, a master gyrostatic compass may be set up in a protected and quiet spot low down in the ship, and there control a number of dials placed in convenient positions for steering or for taking azimuth observations. These local dials are provided with central dials geared up thirty-six times, so that a complete turn corresponds to ten degrees. With such a compass to steer by and steering

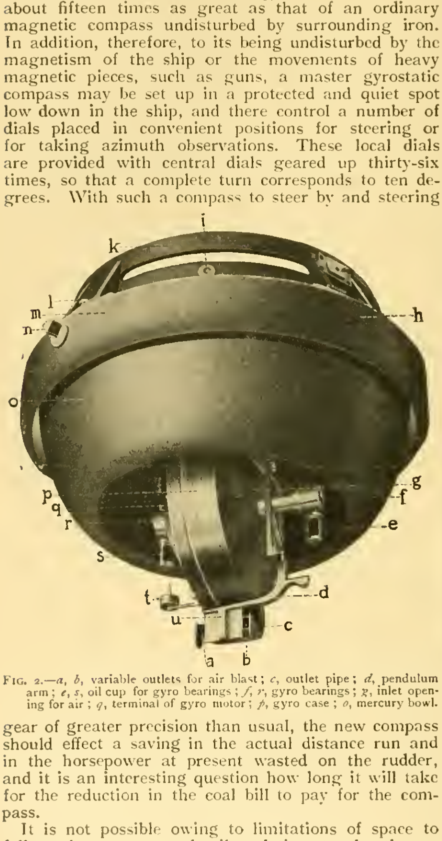


FIG. 2.—*a*, *b*, variable outlets for air blast; *c*, outlet pipe; *d*, pendulum arm; *e*, *s*, oil cup for gyro bearings; *f*, *r*, gyro bearings; *g*, inlet opening for air; *q*, terminal of gyro motor; *p*, gyro case; *o*, mercury bowl.

gear of greater precision than usual, the new compass should effect a saving in the actual distance run and in the horsepower at present wasted on the rudder, and it is an interesting question how long it will take for the reduction in the coal bill to pay for the compass.

It is not possible owing to limitations of space to follow the numerous details relating to the theory, construction, and use of this beautiful instrument, but anyone with a sense of fine mechanics will appreciate this excellent exposition, even though he may never have the chance of running the compass himself.

C. V. BOYS.

THE PRESERVATION OF ANCIENT MONUMENTS.

THE report of the Inspector of Ancient Monuments for the year ending March 31, 1911, is the first by the new inspector, Mr. C. R. Peers. There are 104 monuments under the care of the Commissioners of Works, forty-eight in England and Wales and fifty-seven in Scotland. During the last year fifteen monuments have been placed under the protection of the Ancient Monuments Acts, ten in England and Wales and five in Scotland. Eight of the newly-protected monuments are situate in Anglesey, all prehistoric monuments, three of which have recently been astronomically surveyed by Sir Norman Lockyer and others. Of the two prehistoric Orkney monuments now under protection, the Chambered Mound of Maeshowe has received the attention of the same authority.

Useful linear measures are given of the monuments noticed in the report, and in one case, as a sort of nest-egg, we have the information that the bearing of the dolmen at Trefigneth "comes within one degree of the line of the winter solstice." Never a word is found referring to the available astronomical surveys, while it may safely be asserted that the formal protection of the Anglesey and Maeshowe monuments is largely due to the local interest awakened in the astronomical inquiry. In connection with the statement that "no adequate record has up to the present time been kept of the treatment of each monument year by year," surely the annual reports issued by the Pembrokeshire archæologists should have been mentioned.

"Certain observations of a general character" are most timely and important. "The first Ancient Monuments Act has now been in operation for twenty-nine years. Of the fifty-one prehistoric monuments scheduled by it as worthy of preservation by the State, twenty-six have been placed under its provisions, by the consent of the owners, while the rest, for various reasons, have not been so placed. In regard to these latter, the position of the State is entirely unsatisfactory, and these monuments are in a worse case than if they had not been noticed in the Act." The second Act of 1900 has a wider scope, with the grand result that we have now three castles and three monastic buildings added to the State waifs and strays! This report, like others of its kind, reveals the deplorable ineffectiveness of high-sounding measures. It also shows that where a scientific survey of a monument is first made and the results duly published, owners of such properties are among the first to recognise the necessity for effective protection. Lord Boston, Lord Sheffield, and Major Fox-Pitt have nobly led the way in Anglesey. The first and foremost factor in the case is scientific inspection, and monuments are best preserved in accurate measures.

JOHN GRIFFITH.

THE PORTSMOUTH MEETING OF THE BRITISH ASSOCIATION.

IN about six weeks' time, on August 30, the citizens of Portsmouth will have the privilege of welcoming the members of the British Association for their annual meeting. In many respects this meeting will be a contrast to that at Sheffield last year. Portsmouth cannot offer the attractions of large engineering works or manufactories, but at the same time it holds a unique position as the first naval port of the United Kingdom, and one of the most ancient of its boroughs. The borough of Portsmouth fifty or sixty years ago included only a small portion of the island of Portsea, on which the town is situated. There were walls and gates (which were closed every day at sunset) and a military governor. The walls are gone, but some of the old parts of the town are still well worth a visit. Three years ago the borough boundary was enlarged, now including the whole of the Island of Portsea.

Opportunity will be offered to members of the British Association to inspect the old corporation plate dating from Queen Elizabeth onward, and the old charters of the town, covering the last 500 years, can also be seen in the Town Hall, and are of great interest. The population of the borough has increased during the last decade by upwards of 40,000, the number of inhabitants, as shown by the census just completed, being about 232,000.

Not being a university or large industrial centre, Portsmouth cannot perhaps boast of as many large halls as other cities in which the association has met, but the accommodation will be found quite adequate. The general reception room will be in the Connaught Drill Hall, which is the headquarters of the 3rd Hants Volunteers. Here will be obtained all the literature relating to the meeting, tickets for excursions, postal facilities, &c. Most of the sections will be housed in the Municipal Technical College, a fine building, erected about four years ago at a cost of more than 70,000*l*., and situated close to the Town Hall. This latter building itself will probably accommodate one or two of the sections, and is a magnificent edifice resembling the Town Hall, Leeds. As mentioned above, there are no large works, but several of the excursions will deal with objects of naval interest, such as visits to battleships, the dockyard, Whale Island (the gunnery school), or the *Vernon* (the torpedo and wireless telegraph instruction ship). Other excursions will include visits to Arundel Castle and various parts of the South Downs, and to the Isle of Wight. The Mayor proposes to give a garden-party to all members of the association, as well as a banquet to all the officers.

A good local guide-book is now well in hand, by the aid of which visitors will be able to find their way to the numerous objects of interest without difficulty, and also acquire much interesting information with regard to the borough and environs generally. If the number of visitors is large, the question of accommodation may present some difficulty. The best available accommodation in lodging-houses will probably soon be exhausted, as even at the end of August there are still a considerable number of visitors in the town. There are plenty of hotels, but in view of the above facts it will be well to apply early to the local secretaries for particulars of housing accommodation, as if the housing question is left until a few days before the meeting the choice may be very limited. There is no doubt, however, that the town and outlying districts will be able to accommodate as many as attend the meeting.

Portsmouth has during the last few weeks taken a prominent part in the Coronation Naval Review, and this has to a slight extent interfered with the meetings of the various committees which are dealing with the British Association gathering. Arrangements will, however, now go ahead fast under the guidance of the local secretaries, and in a few weeks we hope to publish further details respecting the meeting, which promises at present to be well up to the standard of any of its predecessors, both as regards work and pleasure.

It will be seen from the subjoined provisional programmes received from recorders of sections, that the scientific proceedings of the meeting promise to be of interest and importance.

Provisional Programmes of Sections.

Section A (Mathematical and Physical Science).—The presidential address, by Prof. H. H. Turner, will be delivered at 10 a.m. on Thursday, September 1. Three discussions have been arranged: one on the principle of relativity, to be opened by Mr. E. Cunningham; one on stellar distribution and movements, to be opened by Mr. A. S. Eddington; the third (in conjunction with Section G) on mechanical flight, with Mr. A. E. Berriman as opener. The following papers have been promised:—Prof. Pettersson, on great boundary waves; parallactic tide set up in the bottom layers of the sea by the moon; Prof. F. T. Trouton, on peculiarities in the adsorption of salts by silica; Major Hills, on the infra-red spectrum; Prof. F. R. Watson (of Illinois), on the effects of air currents on sound; Prof. L. Vegard (of Christiania), on the properties of the radiation producing aurora borealis; and by Prof. W. H. Bragg, on the corpuscular nature of rays.

Section B (Chemistry).—*Discussion on colloids:* The theory of colloids, Prof. Freundlich; (1) colloids in pharmacy, (2) the blue absorption compounds of iodine with starch and other substances, Dr. G. Barger; the colloid theory of cements, Dr. C. Desch; adsorption of bromine by graphite, Dr. E. Wechsler. *Discussion on indicators and colour:* The origin of general and of specific absorption, Dr. T. M. Lowry; absorption spectra of vapours, J. E. Purvis; absorption spectra and refractive power of metallic vapours, P. V. Bevan; the use of indicators in modern physico-chemical research, H. T. Tizard; the application of methyl orange for the determination of the affinity constants of weak acids and bases, Dr. V. H. Veley. Joint meeting with Agricultural Sub-Section (Monday). Discussion on the part played by enzymes in the economy of plants and animals, opened by Dr. E. Frankland Armstrong; some points in the treatment of wheaten flour, A. E. Humphries. *Papers:* Optically active systems containing no asymmetric carbon atom, Prof. W. H. Perkin and Prof. W. J. Pope; the diffusion of gases through water, Prof. C. Barus; the compressibility of mercury, Dr. W. C. Lewis. *Reports:* Electric steel furnaces, Prof. A. McWilliam, and those of the Research Committees.

Section G (Mechanical Science).—Joint discussion with Section A on aëronautics, opened by Mr. A. E. Berriman; over-type superheated steam engine, Captain H. Riall Sankey and Mr. W. J. Marshall; suction gas plants, Mr. Tookey; Diesel engines, Mr. Chas. Day; the vibragraph, Mr. Digby; experiments on wireless telegraphy, Prof. G. W. O. Howe; electrical steering, Mr. Haig; electrical drives for propellers, Mr. H. A. Mavor; smoke abatement, Dr. J. S. Owens; on the origin and production of corrugation on tramway rails, Mr. Worby Beaumont; crude oil marine engines, Mr. J. H. Rosenthal; portable wireless telegraphy equipment, Captain H. Riall Sankey; the gyro compass, G. K. B. Elphinston; the single-phase repulsion motor, T. F. Wall.

Section H (Anthropology).—The proceedings promise to be as interesting and as varied as usual. The chief feature will be a discussion on totemism, to be opened by Dr. Haddon, and to which papers are to be contributed by a number of distinguished foreign guests of the section, including Dr. Kohler, Prof. Graebner, M. A. Van Gennep, Prof. Hutton Webster, and Dr. Goldweiser; among the English anthropologists who hope to be able to contribute papers or to take part in the discussion are Prof. Frazer, Mr. Hartland, Dr. C. G. Seligmann, and Mr. R. R. Marett. Archæological papers will cover a wide field. Miss Adela C. Breton will exhibit paintings and frescoes from the Temple of the Tiger, Chichen Itza, and other ruins in Mexico and Yucatan, and will describe some recently discovered Costa Rican and Peruvian painted vases. She will also give an account of the present position of archæological study in Peru. European archæology will be covered by an important paper on the recent discovery of pleistocene man in Jersey by Mr. R. R. Marett, who has been in charge of the excavations of the caves in which the remains have been discovered; Dr. A. Keith, in a series of papers on palæolithic man will describe a second skull recently discovered in the same locality, and said to be from the same level as the well-known Galley Hill skull, a skull of Magnon type from Dartford, and remains of a pygmy race from Spain. Among papers dealing with the Mediterranean and Egyptian area may be mentioned Prof. G. Elliot Smith's paper on the foreign relations and influence of the Egyptians under the Ancient Empire, and Prof. Flinders Petrie's account of the Roman portraits discovered by him in Egypt during the last season's excavations. In ethnography and the study of religions, the papers to be contributed by Mr. W. Crooke on the cow and the milk, Major A. J. Tremearne's notes on Hausa folklore, M. Malinowski on the economic functions of magic, and Dr. C. G. Seligmann on the divine kings of the Shilluk, are of interest and importance. Mr. J. Gray will bring before the section the important question of the institution of an imperial bureau of anthropology, while a cognate matter will be discussed in a paper by Mr. H. Peake, in which the author urges the desirability of instituting an anthropometric survey of Great Britain.

SECTION I (PHYSIOLOGY).—Presidential address, Prof. J. S. Macdonald; discussion on ventilation in confined quarters, especially in relation to ships, Dr. L. Hill, Prof. N. Zuntz, Mr. L. Woolhard; discussion on inhibition, opened by Prof. C. S. Sherrington, followed by Mr. Keith Lucas, conduction between muscle and nerve, with special reference to inhibition, and Prof. J. S. Macdonald; frequency of colour-blindness in males, Dr. Edridge-Green; heat production and body temperature during rest and work, Prof. J. S. Macdonald and Dr. J. E. Chapman; rhythmical stimulation of cooled frog's nerve, Dr. J. Tait; electrical stimulation of the frog's heart, Dr. J. Tait; photochemical changes in yohimbine solutions, Dr. J. Tait and Dr. J. A. Hewitt; some considerations on the influence of hæmoglobin in the hæmolysis of red blood corpuscles, Dr. H. E. Roaf; the chemistry of heat coagulation of proteins, Dr. Harriette Chick and Dr. C. J. Martin; new researches on phagocytosis, Prof. H. J. Hamburger; a photometer for hetarochromatic photometry, Prof. C. S. Sherrington; model to illustrate Listing's law of the movements of the eyeball, Prof. C. S. Sherrington; comparison between the nervous taxis of the cat's knee and that of the anthropod claw, Miss S. C. M. Sowton and Prof. C. S. Sherrington.

SECTION K (BOTANY).—Presidential address, Prof. F. E. Weiss. Joint meeting with Sections C and E on the relation of the present plant population of the British Isles to the Glacial period, opened by Mr. Clement Reid. Discussion on the principles of constructing phyto-geographical maps. Semi-popular lecture, by Mr. Francis Darwin. *Papers:* Some petrified Jurassic plants from Scotland, Prof. A. C. Seward; recent work on the Jurassic plants of Yorkshire, H. H. Thomas; the structure of the oldest known synangium, and its bearing on the origin of the seed, Dr. M. Benson; on the mode of formation of the Pettycur material as gathered from internal evidence; a fifteen-year study of advancing sand-dunes, Prof. H. C. Cowles; new proposals in ecology, Prof. F. E. Clements; phytogeography as an experimental science, Prof. Massart; the vegetation of pebble beaches, Prof. F. W. Oliver; the brown seaweeds of a salt-marsh, Miss S. M. Baker; the Swiss National Park and its flora, Prof. C. Schröter; the water-content of acidic peats, W. B. Crump; the wilting of moorland plants, W. B. Crump; the presumptive hybrid *Anagallis carnea*, Prof. F. E. Weiss; the morphology of leguminous nodules, Prof. Bottomley; nuclear osmosis as a factor in mitosis, A. A. Lawson; nuclear division in Spongospora, A. S. Horne; the polyphyletic origin of the Cornaceæ, A. S. Horne; the transference of sugar from the host plant to a parasitic Cuscuta, S. Mangham.

SUBSECTION AGRICULTURE.—Presidential address, Prof. W. Bateson; cider sickness, B. T. P. Barker and Mr. Hillier; the effect of grass on apple trees, S. U. Pickering; the inheritance of strength in wheat, Prof. T. B. Wood; crystalline nitrogenous constituents of mangolds, Prof. T. B. Wood; suggestions relating to the existing system of imperial avoirdupois weights, J. Porter. Discussion on bacterial diseases of plants, opened by Prof. M. C. Potter; bacterial diseases of the celery and swede, J. H. Priestley; bacterial gum diseases, F. T. Brooks; bacterial diseases of the potato plant in Ireland, Dr. G. H. Pethybridge; experiments on the wart disease of potatoes, G. T. Malthouse; potato disease, A. S. Horne. *Discussion:* How best may the university agricultural departments come into contact with the farmer, Principal Ainsworth Davis; the American and Canadian systems, R. Hart-Synnot; the place of the agricultural instructor, J. H. Burton. Joint discussion with the Chemical Section. The part played by enzymes in the economy of plants and animals. Popular lecture by Mr. A. D. Hall, the soils and farming of the Southdowns; commercial ovariotomy in pigs, F. H. A. Marshall and K. J. J. Mackenzie; temperature variations during the œstrous cycle in cows, F. H. A. Marshall and K. J. J. Mackenzie; the effects of ventilation on the temperature and carbon dioxide of the air of byres, J. Hendrick; the effect of minute electrical currents on the growth and metabolism of bacteria, Prof. J. H. Priestley and Miss E. M. Lee; the effect of high tension electric discharges and current electricity on plant respiration, Prof. J. H. Priestley and Mr. R. C. Knight; the effect of pyrophosphates on animals, Dr. J. A. Gardner; application of genetics to horse-breeding, C. C. Hurst; the inheritance of milk yield in cattle, J. Wilson. The *chief features* of the programme are: Discussions on problems at present of great importance in agriculture: (1) Bacterial diseases of plants; (2) the University Agricultural Departments and the practical farmer; (3) the *rôle* of enzymes in the economy of plants and animals; (4) some important live stock questions; (5) semi-popular lecture: a scientific study of the local agriculture.

NOTES.

THE Brussels correspondent of *The Times* announces that Prof. W. Spring, professor of general chemistry in the University of Liège, died on July 17 after an operation on the throat.

THE Council of the Royal Society of Arts attended at Clarence House on Friday, July 14, when the Duke of Connaught, president of the society, presented its Albert Medal to the Hon. Sir C. A. Parsons, F.R.S., "for his experimental researches into the laws governing the efficient action of steam in engines of the turbine type and for his invention of the reaction type of steam turbine and its practical application to the generation of electricity and other purposes."

A MEETING of the Institution of Mechanical Engineers will be held on July 25 and 26, at Zürich. The meetings will be held in the Swiss Polytechnikum. Among the papers to be read may be mentioned:—Electric traction in Switzerland, by Mr. E. Huber-Stockar, of Zürich; results of experiments with Francis turbines and tangential (Pelton) turbines, by Prof. Franz Prášil, of Zürich; some new types of dynamometers, by Dr. Alfred Amslér, of Schaffhausen; rack-railway locomotives of the Swiss mountain railways, by Mr. T. Weber and Mr. S. Abt, of Winterthur; high-pressure water-power works, by Mr. L. Zodel, of Zürich.

THE annual general meeting of the Society of Chemical Industry was held last week in Sheffield, under the presidency of Mr. Walter F. Reid, a summary of whose address appears elsewhere in this issue. Dr. Rudolf Messel, of London, was elected president for the ensuing year. The applied science department of the University was visited, and in an address given to the visitors, Prof. Arnold said that for the future students of the Royal School of Mines, if they wish to obtain the School of Mines diploma for iron and steel metallurgy, must take their fourth year of study in the metallurgical department of the University of Sheffield, and must pass its examination. Numerous visits were made to factories in and near Sheffield, and the visitors were entertained at several receptions.

AN important Act has been adopted by the New York legislature dealing with the sale in New York State of wild American game. Owing to the efforts of Senator H. R. Bayne to secure the passing of the Bill, the new Act is often called the Bayne law. Stated briefly, the new law prohibits in New York State, at all seasons, the sale, or importation for sale, of any species of American wild game, save hares and rabbits. These rodents have been declared a pest to fruit-growers. No longer will it be possible for ruffed grouse, pinnated grouse, any American quail, woodcock, snipe, or any American shore-bird, wild goose, brant, or wild ducks of any species, to be sold in the State of New York, no matter where they may have been killed. The Bayne law provides, however, that certain species of game that can be reared successfully in captivity, and killed by hand, may be sold and consumed, under certain restrictions.

The twenty-sixth congress of the Royal Sanitary Institute is to be held in Belfast on July 24 to 29. Dr. Louis C. Parkes, deputy-chairman of the council of the institute, will deliver a lecture to the congress on "The Prevention of Tuberculosis: A National Task." Prof. H. R. Kenwood will deliver the popular lecture on "The Open Window." More than two hundred authorities, including foreign and colonial Governments, Government departments, county councils, county boroughs, and other sanitary authorities, have already appointed delegates to the congress; and as there are over four thousand members and associates in the institute, a large attendance is expected. A health exhibition of apparatus and appliances relating to health and domestic use will be held, as practical illustration of the appliances and carrying out of the principles and methods discussed at the meetings. There will be many exhibits relating to the planning of cities and towns arranged by the executive committee of the Town Planning Exhibition. The meetings of the congress have been arranged in two sections, one concerned with sanitary science and preventive medicine, the other with engineering and architecture. Conferences have been arranged during the meeting of municipal representatives, port sanitary authorities, medical officers of health, engineers and surveyors, veterinary inspectors, sanitary inspectors, women on hygiene, and on the hygiene of childhood. The local honorary secretaries are Messrs. W. H. Bailie, J. Munce, and J. G. Harris.

The fifteenth International Congress on Hygiene and Demography will be held in Washington, D.C., from September 23 to 28, 1912, under the honorary presidency of the President of the United States. Dr. H. P. Walcott, president of the State Board of Health of Massachusetts, will be the active president. Twenty-two Governments have accepted already an invitation to participate, and in addition each of the States of the Union has received an invitation which includes its contained cities. The committee on organisation includes Dr. Hermann Biggs, Dr. John S. Billings, Prof. R. H. Chittenden, Prof. Irving Fisher, Prof. Theobald Smith, and Prof. W. H. Welch. The secretary-general is Dr. John S. Fulton, Army Medical Museum, Washington, D.C. The official languages will be English, French, and German. The work of the congress will include an exhibition of recent progress and the present condition of the public health movement in the cooperating countries, and scientific meetings. For the latter the congress will be divided into nine sections. The sections, with the presidents, are:—(1) Hygienic Microbiography and Parasitology, Prof. Theobald Smith; (2) Dietetic Hygiene, Hygienic Physiology, Prof. R. H. Chittenden; (3) Hygiene of Infancy and Childhood and School Hygiene, Dr. A. Jacobi; (4) Industrial and Occupational Hygiene, Dr. G. M. Kober; (5) Control of Infectious Diseases, Dr. Hermann Biggs; (6) State and Municipal Hygiene, Dr. Frank F. Westbrook; (7) Hygiene of Traffic and Transportation, Dr. W. Wyman; (8) Military, Naval and Tropical Hygiene, Dr. H. G. Beyer; (9) Demography, Prof. Walter J. Willcox. Inquiries and applications for membership should be addressed to the secretary-general.

The account in the July issue of *Man*, by Miss A. C. Breton, of some of the museums of archæology and ethnology in America, will excite among British students of these sciences mingled feelings—admiration at the enterprise and liberality of the American people, and regret that the contrast between the institutions of America and those in England is so clearly to our disadvantage. The museums described in this paper are the New York Natural History Museum, the Brooklyn Institute, the Peabody Museum of Harvard College, the Yale University Museum, the Philadelphia Academy of Sciences, the National Museum at Washington, and the National Museum of San José, Costa Rica. Practically all these representative collections are provided with suitable buildings and adequate staffs; each has its library, to which access is readily permitted, and arrangements are made by which the officials usually spend part of each year in field work, and are thus in a position to supply to inquirers first-hand information.

The present uncertainty of some of the evidence on the ethnology of the Australian race is embarrassing to those who are engaged in the study of the aborigines of that continent. Prof. Frazer, for instance, in his recently published treatise on "Totemism and Exogamy," bases his conclusions regarding the customs of the Arunta tribe on the researches of Messrs. Spencer and Gillen, and dismisses the sources upon which the Rev. Mr. Strehlow has drawn in his description of another branch of the same tribe as "deeply tainted." Again, in the July issue of *Man* Mr. R. S. Mathews contradicts the statement of Dr. Howitt that descent among the Kaiabara tribe is patrilinear, and suggests that this error has led Mr. A. Lang into erroneous conclusions regarding them. Mr. Lang, again, in the June issue of *Man*, disputes Mr. Mathews' view that the phratries represent two ancient distinct races, one of the Papuasian type, with curly hair, the other fairer, with straight hair, akin to the Dravidians and Veddahs. It is much to be desired that the Federal Government, by the establishment of an ethnological bureau or by the appointment of a special commission, should undertake an official investigation into the ethnology of the aborigines before they finally disappear, and arrange for the preparation of a series of authoritative monographs on the native races, such as the valuable series which we owe to the enlightened Government of the United States on the American Indians.

In *The Entomologists' Monthly Magazine* for July, Mr. E. G. Bayford directs attention to the potency of electric light in attracting insects, and its consequent value to collectors, more especially those to whom beetles are the chief favourites.

To *Naturwissenschaftliche Wochenschrift* for July 2, Mr. P. J. du Toit, of Zürich, contributes an elaborate and well-illustrated summary of Dr. Broom's views with regard to the derivation of mammals from the theromorphous or (in the wider sense of the term) anomodont reptiles. After referring to the development of the idea of the existence of such a relationship, the author describes the mammalian features observable in the theromorphous limb-skeleton and limb-girdles, and then proceeds to discuss Seeley's views as to the reptilian nature of Tritylodon. While admitting the possibility of that genus being a mammal, Mr. du Toit points out that its resemblances to the theromorphs are so marked that there is considerable justification for including it in that group. As regards the mammalian features in the theromorph skeleton, the following are regarded as the most important:—The union of the pubis and ischium to form an innominate bone, which is unknown in any other reptiles except certain chelonians. An entepicondylar foramen to the humerus, found also in the tuatera. The fusion of the coracoid with the scapula—paralleled among certain salamanders. The differentiation of the teeth into series. The union of the quadrate with the adjacent elements of the skull. The relations and mode of articulation of the two-headed ribs. The resemblance of the tarsus (especially as regards the tibio-tarsal position of the line of flexure) and phalanges to those of the monotremes. These features become more and more pronounced in the specialised types until they culminate in a form like Tritylodon, which may be regarded as a reptile actually in process of conversion into a mammal. By an increase in the length and strength of its limbs, accompanied by increasing power of sustained locomotion, and likewise by a special development of its dentition and jaws, one of the primitive theriodonts acquired, in consequence of this greater activity, a better kind of blood-circulation, warm blood, and a mobile, hairy skin—in other words, became a mammal.

PROMINENT among the articles in *Tropical Life* (June) is an account of two plantations of Ceara rubber in German East Africa. In this colony the trees of *Manihot Glaziovii* mature so rapidly that tapping of a very light nature is permitted already, in the third year. At this stage the incision method of pricking necessitates careful manipulation, and is said to produce about ½ lb. of rubber per tree. In the first instance the trees were planted about 10 feet apart; but latterly a more open formation, in which they are set 13 feet apart, has been adopted. The chief pest is the white ant, which has to be combated by discovering and destroying its communities.

AN article on the Coniferæ, communicated by Dr. A. W. Gothan to *Naturwissenschaftliche Wochenschrift* (June 18), deals mainly with the distribution of the various subfamilies in past epochs as compared with their distribution at the present time, but the author takes the opportunity of referring to changes in family relationships that have been proposed as a result of paying more attention to vegetative characters; in this connection reference is made to the proposition enunciated by Dr. F. Vierhapper, that the Taxaceæ, Taxoideæ, and Cupressineæ should be united in one family, the Taxocupressaceæ, on account of similarity in wood and leaf structures. The author also directs attention to the interest attaching to the fossil genus Baiera as a constituent of the group of Gingkophyta.

THE sweet potato, *Ipomoea Batatas*, is one of those cultivated products of which the origin may be conjectured, but cannot be positively determined, and the varieties are so numerous and confused that identification and classification present unusual difficulties. These complexities are discussed in a bulletin issued as vol. iv., No. 1, of Contributions from the Botanical Laboratory of the University of Pennsylvania, where the author, Dr. B. H. A. Groth, describes a novel analytical method of scheduling that offers certain advantages, as in the incorporation of new forms. Representing each character by a letter, and the different variants of this character by numbers, each variety is scheduled under a series of arbitrary marks; thus the index of the variety Georgia begins A1B2C1D1 . . ., while A2B2C2D2 . . . is the beginning of the index of the variety Ticotea.

WE learn from *The Agricultural News*, No. 236, that the Botanic Gardens of St. Vincent contain the only known specimen of *Spachea perforata*, a large tree estimated to be at least 100 years old. The leaves are lance-shaped, while the flowers are borne in terminal racemes, each flower containing small rosy petals and stamens, which are all fertile; the fruits are small. It is further stated that the flowers are distinct and attractive, and produced in great profusion; they are largely visited by bees. The tree is not only of botanical interest, but is decorative as well.

FROM the report on the operations of the Department of Agriculture of the Madras Presidency, 1909–10, recently to hand, it is possible to obtain a fair general idea of the work a handful of Englishmen are doing among the natives in improving systems of agriculture that have for centuries remained unchanged. Much of the time of the staff is occupied in teaching; but the value of their work is being increasingly recognised, and numerous samples are now sent in to the laboratories for report. Each year the report shows that some fresh progress has been made and some new economy discovered; the value of drilling seeds, of saving on the seed rate, and other matters are dealt with here.

THE Bulletin of the Department of Agriculture, Jamaica, vol. i., No. 4, contains an excellent account, by Mr. Cousins, of the cultivation of the banana and the conditions under which success has been attained. Restricted as this plant was in the early days to virgin soils only, it was thought to be a crop that must soon cease to count in the islands. But the growers have learnt how to irrigate bananas, and also how to grow them on heavier types of soils, so that now there seems no obstacle to their cultivation wherever they would be thought useful. There are also some articles on local farm animals that will be of much interest to the technical reader, and, as usual in this publication, some excellent illustrations. Altogether the bulletin is an excellent number, on which its editor may be congratulated.

IT has long been recognised that a liberal supply of protein is necessary for dairy stock, and the earlier German investigations pointed to the conclusion that a cow in full milk should receive 2·5 lb. of digestible protein daily per 1000 lb. live weight, and that the albuminoid ratio, *i.e.* the ratio of digestible protein to non-nitrogenous foodstuffs should be 1 : 5·4. But practical men soon began to depart from these values, and investigations in America justified their action, showing that less protein was necessary. An investigation recently published by Messrs. Woll and Humphrey, and published as Research Bulletin No. 13 of the University of Wisconsin Agricultural Experiment Station, while emphasising the need of an ample protein allowance, brings out the fact that only large milk-yielders can economically receive a large protein diet.

COLORADO affords an interesting example of a country formerly devoted to ranching, and now becoming more closely settled, and consequently requiring a more general system of farming. An agricultural college and experiment station has for some time been engaged in studying the numerous problems involved in the transition, and the members of the staff issue frequent bulletins giving advice to settlers. No subject is too trivial for study; among a batch recently to hand is one on the care of farm machinery, and another showing how to build a wall or a house of adobe, a local soil that may be made to set like concrete. Exportable crops like fruit and potatoes naturally come in for considerable attention, and directions are also given for raising such crops as are needed for home consumption.

MR. E. C. ANDREWS, of the Mines Department of New South Wales, has issued in the Journal of the Royal Society of New South Wales (vol. xliv., 1911, pp. 420–480), an interesting paper on the structure of eastern Australia. He adopts the view that Australia has not been subjected to any recent folding, and that the main features of its present relief are due to vertical earth movements. Australia has been thus divided into a western "horst" and an area of Eastern Highlands separated by the Great Plains. The Eastern Highlands are a peneplane, which, according to the author, were in Miocene times but little above sea-level.

The whole of the eastern coast of Australia is a geographical unit, and is due to a series of step faults. Mr. Andrews accepts this coast as constructed on the Pacific type. He holds that Australia was uplifted at the end of the Tertiary, and the resultant plateau has since been deeply dissected by the formation of the canyons. For the period of the uplift he proposes the name of the Kosciusko Period after the highest part of the plateau. His paper includes a valuable list of the fault scarps and sunken areas in eastern Australia.

A RECENT number of *The Geographical Journal* (vol. xxxvi., pp. 537–553) includes a valuable paper by Messrs. A. E. Kitson and E. O. Thiele on the geography of the Upper Waitaki basin in New Zealand, illustrated by a series of beautiful photographs. The authors describe the structure of this country in some detail, and with especial reference to its glaciation. In opposition to Haast's view, that the country was a plateau dissected by glacial action, they claim that the great valleys were all formed in pre-glacial times. From the authors' summary of the recent literature on the glacial geology of this part of New Zealand, it appears to be now generally accepted that the glaciers have only modified valleys which were pre-glacial in origin. The authors conclude that the lakes, valleys, and fiords originated along radial fractures. Their work throws considerable doubt upon the existence of the ice sheet, which is supposed by some authors to have covered most of the South Island of New Zealand. The three great lakes of the Waitaki basin are shown to be moraine dammed.

THE Board of Education has issued the reports for the year 1910 (price 9*d*.) on the Geological Survey, the Geological Museum in Jermyn Street, the Science Museum at South Kensington, and the work of the Solar Physics Committee. The activity of all these bodies represents an important contribution by the State to scientific education. We note that, among many practical questions considered by the Survey, building stones are to be placed on the roof at Jermyn Street for comparative tests of the effect of the London atmosphere. We have also received three recent publications of the Geological Survey from the Board of Agriculture and Fisheries. Mr. Strahan describes the geological model of Ingleborough and district, now in the museum at Jermyn Street. This pamphlet (price 4*d*.) is beautifully illustrated by a geological map and a photograph of the model before colouring, and will appeal to teachers of geography. Dr. B. N. Peach provides another educational pamphlet in his "Description of Arthur's Seat Volcano" (price 6*d*.), which includes a geological map showing the relation of the mass to the city of Edinburgh. Messrs. Reid, Barrow, and Dewey have written the explanation of the colour-printed sheets 335 and 336 of the English map (price 1*s*. 6*d*. each), the memoir being on the country around Padstow and Camelford (price 2*s*. 3*d*.). The petrography is of interest, especially in connection with the pillow-lavas, and the district includes old workings for stream-tin, pits in china-clay, and the great quarry of Delabole in slate of Devonian age. A quarto palæontological memoir by Mr. T. Thomas deals with the British Carboniferous Orthothetinæ (price 2*s*.), and is accompanied by a fine plate by Mr. Brock.

THE officiating director-general of Indian observatories (Mr. J. H. Field) has issued a memorandum, dated June 8, on the conditions prevailing before the advance of the south-west monsoon of 1911. The monsoon rainfall in India is known to be affected by many external conditions, and among those believed to be the most important are the barometric pressure in South America and the Indian Ocean and the snowfall in North-west India, &c. After examining these conditions on the plan adopted by Dr. Walker, it is estimated that the total rainfall for the period June–September will not differ from the normal by more than about 5 per cent., a defect being more likely than an excess.

THE results of rain and river observations made in New South Wales during 1903–8 have been published by the Commonwealth Bureau of Meteorology. These include all available rainfall totals from 2298 stations, with monthly maps and notes for each of those years. In addition to the rain maps and tables for the above period, the records are given for all previous years. These values have been included in an average map for all stations for which means of not less than fifteen years were available; some of the results of this map were referred to in NATURE of September 22, 1910. The list of heavy daily rainfalls previously published by the late Government astronomer has also been brought up to date.

THE Akademische Verlagsgesellschaft of Leipzig has issued a small pamphlet on "Radiumnormalmasse und deren Vervendung bei radioaktiven Messungen," by Prof. Rutherford. It deals with the necessity of producing an international standard of radium, which has arisen owing to the differences recently discovered between the standards used in different countries. For the comparison of standards it suggests a compensation method, depending on the use of a constant source of radiation like uranium oxide and of the inverse square law. For small standards, such as are used in the determination of the radium content of rock specimens, solutions of radium salts containing one millionth of a milligram of radium per cubic centimetre are suggested. The conclusions as to the establishment of the radium standard arrived at by the Brussels conference last year are reproduced. They have already been given in these columns (October 6, 1910, vol. lxxxiv., p. 430).

THE *Revue General des Sciences* for June 30 contains the annual *revue* of astronomy for the year 1910 by M. P. Puiseux, of the Paris Observatory. It is divided into sections, which are devoted to planets and comets, the sun, the stars and nebulæ respectively. In the first section, the work of Cowell and Crommelin on Halley's comets, of Eddington on the theories of formation of the tails of comets, of Backlund on Encke's comet, and of Lowell, Campbell, and Albrecht on the markings of Mars, all receive attention. The section on the sun is devoted mainly to the work of Hale and of Deslandres on the constitution of sun spots; that on the stars to the spectroscopic work which has been done in order to determine the motions in the line of sight of a greater number of stars, and so provide means of testing more accurately the theories of Kapteyn and of Eddington that there exist two lines of main drift in their proper motions.

IT is difficult for anyone with normal colour-sense to appreciate the mental picture of a colour-blind person. An interesting experiment for illustrating what is seen by people with a defective red sensation—the commonest form of colour-blindness—has been devised by Mr. C. R. Gibson. The device consists of a pair of spectacles with plane signal-green glasses and a series of coloured wools. When the glasses are put on, of course, no red rays can enter the wearer's eyes, so he is in the position of a person who cannot distinguish red as a colour. He will thus match scarlet wool with black, yellow with green, pink with light blue, or crimson with dark blue, and will see any coloured object as the majority of colour-blind people see them. The experiment is instructive as well as amusing, and it provides a simple means of realising the effects of colour-blindness. The spectacles and wools are manufactured by Mr. J. Trotter, optician, Glasgow, and the price at which they are sold is 2*s*. 6*d*.

We have received from Messrs. Isenthal and Co. their latest publication on Moscicki condensers, and Giles valves as applied to the protection of electric power transmission lines against atmospheric disturbances and surges. High-tension condensers for radio-telegraphy in particular are also dealt with. The publication is exceedingly well produced, the theory of surges and the practice of line and station protection being dealt with in part i., while part ii. deals chiefly with condenser batteries and choking coils and radio-telegraphy. A summary of the contents of various standard books dealing with these subjects is briefly given and set out with remarkable clearness in the brief description given. A noteworthy chapter is that dealing with the selection and design of plant, including generators, motors, transformers, and switches, and some very useful tables are included, giving safety coefficients for cables. The pamphlet is well illustrated with photographs and diagrams of the apparatus described. The Moscicki condensers and Giles valves are once again very fully dealt with, together with a list of places where they have been installed.

Messrs. Watson's price list of apparatus for electro-therapy and diagnosis is too well-known to require detailed description. The novelties are principally found in the therapeutic section. The "Prana" carbon dioxide snow apparatus is described and illustrated. It is intended for the treatment of nævi and lupus, warts, and other superficial diseases. The apparatus is made in three different sizes. The carbon dioxide is contained in a cylinder, and is allowed to escape into a receptacle which permits of free evaporation with the production of carbon dioxide snow in the form of a crayon 5 inches long by 1 inch or ½ inch in diameter. A special high-frequency apparatus is constructed for diathermy or thermo-penetration. In this apparatus the heating effect of the high-frequency current is encouraged and used. Considerable benefit appears to have been obtained in various rheumatic conditions and neuralgia, sciatica, &c. These new high-frequency currents are at a voltage less than 3000 volts, but currents of 500 to 3000 milliamperes are used, and with the strongest doses the patient feels absolutely nothing except the increase in temperature. Thermometers introduced in animals prove that the increase is internal, and greatest in the path between the electrodes. Beyond the effects produced by the heat there are no other physiological or chemical effects. When the current is employed long enough, albumin coagulates; and tumours, &c., can be destroyed by these means: coagulated tissues behave like foreign bodies, and are gradually expelled. In the radio-active substances meso-thorium, of the same activity as pure radium bromide, is quoted for at the price of 12*l*. 10*s*. per milligram. Radio-thorium is listed at the price of 1*l*. per gramme. Several special radium applicators are illustrated.

Engineering for July 14 contains an illustrated description of a "Stock" oil-fired converter which is in operation at the works of the Darlington Forge Co., Ltd. All classes of steel can be manufactured in this converter, from soft-steel castings to special steels of the highest class. In form it resembles the ordinary Bessemer converter; it is lined with ordinary silica fire brick, and is used, not only for the conversion or blowing of iron, but also for melting the actual charge of iron and scrap by means of oil fuel, no separate cupola being required. The oil fuel—crude petroleum—is used for melting the charge, and when this has been effected the oil pipes are withdrawn and blowing commences. The air does not enter at the bottom and pass up through the molten metal as in a Bessemer converter, but is blown down on the top of the metal. For a three-ton converter, melting takes about 1½ hours and blowing from fifteen to twenty minutes, the total time, including charge, being about two hours. As an example of the punishment the steel will stand, the following may be mentioned: A steel wheel, about 4 feet 9 inches in diameter, was dropped edgewise on a steel ingot from the following heights—5 feet, 10 feet, 15 feet, and 20 feet, without showing signs of fracture. A drop of 40 feet on the rim broke one spoke. After this four more drops of 40 feet on edge caused no further fracture either to the rim or the spokes, and the wheel was finally broken up by a steel three-ton ball dropped ten times on the boss from a height of 40 feet. Some remarkably thin castings have been made.

OUR ASTRONOMICAL COLUMN.

Comet, 1911*b*.—Observations of the new comet discovered at the Lick Observatory on July 6 are recorded in No. 4511 of the *Astronomische Nachrichten*. Prof. Abetti, at Arcetri, on July 8, estimated the magnitude as 6·0, and Prof. Wolf found, the same day, that the photographic magnitude was 7·5; his photographs show a tail.

MM. Lagrula and Schaumasse observed the comet at Nice on July 8, and, in No. 2 of the *Comptes rendus* (July 10), they describe it as a bright object presenting a globular condensation surrounded by a nebulosity which is extended towards the S.S.W.; the whole appears to have a diameter of about 2·5′.

From observations made on July 6, 8, and 9, Prof. Kobold has determined the following elements, which are said to be similar to those of Comet 1790 I.

Elements.

$$T = 1911 \text{ June } 20{\cdot}6354 \text{ (M.T. Berlin)}$$

$$\left.\begin{array}{l}\omega = 99^\circ\ 31'{\cdot}99' \\ \Omega = 172^\circ\ 27'{\cdot}52 \\ i = 148^\circ\ 39'{\cdot}25'\end{array}\right\} 1911{\cdot}0$$

$$\log q = 9{\cdot}89936.$$

An ephemeris derived from these elements gives 4h. 26m. 27s., +32° 54·0′ as the position for July 20 (12h. Berlin M.T.), with a daily decrement of about 2m. in R.A. and 13′ in declination. The calculated magnitudes for July 12 and July 20 are 6·5 and 6·4 respectively. Given a clear horizon the object should be visible, with opera-glasses, from midnight to dawn; at about 10.30 it rises some 30° east of north, and at 2 a.m. is about 20° above the horizon. The present position is about one-third the distance between ι Aurigæ and ζ Persei from the former star along a straight line joining the two.

The Solar Eclipse of April 28, 1911.—Dr. L. A. Bauer sends us a detailed narrative of a journey to Tau Island of the Manua group, where observations were made of the total solar eclipse of April 28, 1911. The U.S. cruiser *Annapolis* took Dr. Bauer from Pago-pago harbour, Tutiula Island, to Tau. Dr. Bauer's prime object was to secure magnetic observations during the eclipse, and he arranged for simultaneous observations to be made at the five magnetic observatories of the U.S. Coast and Geodetic Survey, as well as at Apia, Christchurch, and Melbourne. His attention was, therefore, devoted to this subject, and the astronomical observations were made by officers of the ship.

Mr. Abbot, director of the Astrophysical Observatory of the Smithsonian Institution, provided Dr. Bauer, at short notice, with a hand-driven, equatorially mounted, double-lens camera of about 11½ feet focus, and suggested one exposure of 15s., and another as long as possible—about 1m. 10s. These exposures were made, and four negatives were obtained as the result. On account of a difficulty with the sighting telescope just before totality, a hastily-constructed finder had to be employed, and this did not prove wholly successful as a means of keeping the image central upon the plates. The photographs show, however, the inner corona and some details and extensions mainly on the north-eastern and south-western edges, reaching out in places to a distance of more than half the sun's apparent diameter. The size of the photographic image of the sun's disc upon the plates is nearly one and one-fifth inch. No member of the shore party, or of the party aboard the *Annapolis,* reported having seen these coronal extensions, or any stars, which fact is probably due to the comparative brightness during totality, writing being easily legible. The times of the four contacts were observed by the shore party, as well as aboard; the observed duration of totality was 2m. 1s.

The magnetic observations cannot be discussed until those made at other stations within and without the eclipse track are available for comparison.

THE LIGHT OF ALGOL'S COMPANION.—In a previous paper Mr. Joel Stebbins arrived at the conclusion, from his selenium photometer observations, that the companion of Algol is brighter on one side than the other, the difference being caused by reflection and by the heating effect of the primary on the one side, chiefly the latter. His argument for the untenability of the reflection theory having been questioned, he returns to the subject in No. 5, vol. xxxiii. of the *Astrophysical Journal,* and shows by a different method that only a small portion of the extra light can be due to reflection. Our knowledge of the radiations emitted by the satellite is insufficient to determine the question definitely, but it is evident that radiation, and not reflection, is the chief cause of the extra brightness of the one side.

OBSERVATIONS OF MIRA.—The maximum of Mira which took place in July, 1910, was observed at the Catania and Utrecht observatories, and the results appear in No. 4506 of the *Astronomische Nachrichten.*

Dr. Bemporad finds that the maximum, mag. 3·3, took place on July 21, 1910, and the neighbouring minima on March 25, 1910, and February 17, 1911, respectively; for the maximum, this was fourteen days earlier than predicted by Guthnick's ephemeris. The mean period would appear to be about 318 days, and the range of magnitude nearly 7.

Prof. Nijland's observations give a maximum, of mag. 3·2, on July 20, 1910, and a tabulated comparison of observed dates, with predicted dates for the last seven maxima, shows a period ranging from 342 to 310 days.

MICROMETER MEASURES OF JUPITER.—Dr. Lau continues his series of papers on Jupiter in No. 4509 of the *Astronomische Nachrichten,* where he records the micrometer measures, made during the opposition of 1910, of many different features. A number of minor changes from the previous oppositions were noted, the matt-white egg-shaped mass which was so marked a feature of the 1905 opposition being totally invisible. The geometrical network joining bands iii. and iv. was frequently seen and its points measured. Sketches of the Red Spot region show that while on April 10, 1910, the spot was of the usual pointed-egg shape, on May 4 its western extremity had become rectangular, and on May 10 dark masses of matter at the middle of both sides gave it an egg-boiler form.

PHOTOGRAPHS OF THE AURORA BOREALIS.—Prof. Carl Störmer, of Christiania, sends us abstracts from the *Comptes rendus,* in which he describes his method of taking simultaneous photographs of the aurora for the purpose of determining its altitude, and gives the results so far obtained. The photographs accompanying the paper of May 1 are very striking, and were taken in northern Norway during February and March, 1910, while from the diagrammatic summary of the results it is seen that the greatest proportion of auroræ measured were at altitudes ranging from 100–150 kms.

THE EPHEMERIS FOR HALLEY'S COMET.—Preliminary measures of plates showing Halley's comet, taken with the Crossley reflector during the period March 27 to May 27, are published by Dr. H. D. Curtis in No. 4506 of the *Astronomische Nachrichten.* A comparison with Dr. Ebell's ephemerides shows that the necessary corrections to the latter are of the order of only +12s. and $-0{\cdot}2'$ to $-0{\cdot}9'$.

THE DIFFERENTIAL QUALITY OF THE MOON'S REFLECTED LIGHT.—No. 4510 of the *Astronomische Nachrichten* is accompanied by a splendid two-colour photographic reproduction of the full moon, showing the different quality of the light reflected by different regions of the lunar surface. The reproduction is from negatives obtained by Dr. Miethe and Herr Seegert, whose work and results have already been described in these columns.

SUTTON DOUBLE STAR OBSERVATIONS.—Dr. Doberck continues his record of double star observations made at Sutton in No. 4507 of the *Astronomische Nachrichten.* These particular observations were made during 1910–11, and deal with more than 100 doubles, including α Geminorum and α Leonis.

THE CANYON DIABLO, OR COON BUTTE, METEORITES.—An interesting paper by Mr. C. R. Keyes, dealing with the multeity of meteorites in the Painted Desert, Arizona, appears in No. 9, vol. xix., of the Transactions of the Academy of Science of St. Louis. After discussing the volcanic nature and the general geology of the surrounding land, the author arrives at the conclusion that Coon Butte, a conspicuous mound, was not formed by any abnormal meteoric fall, as has been frequently suggested, but is probably of volcanic origin. That such immense numbers of meteoric stones ("heavy stones" or "green stones") have been secured in the immediate neighbourhood he explains by the extraordinary dryness of the atmosphere preventing weathering, and the assiduity with which the objects have been sought; in fact, he suggests that any desert district enjoying similar climatic conditions would probably prove as fruitful in these objects as has the Painted Desert.

UNIVERSITY DEVELOPMENT IN WALES.

OPENING OF NEW BUILDINGS BY THE KING AND QUEEN.

THE visit of the King and Queen to North Wales in connection with the historical ceremony of investiture of the Prince of Wales at Carnarvon has been happily associated with two events of international as well as national interest: the opening of the new buildings of the University College of North Wales at Bangor by the King, and the laying of two foundation stones of the National Library of Wales at Aberystwyth by King George and Queen Mary.

The development of the university movement in Wales will probably stand out as a unique feature in contemporary history, owing to the large extent to which its success depends on popular enthusiasm and support. It owes its inauguration to the foundation, in 1872, of the institution in Aberystwyth, which still bears the name, "University College of Wales." When the establishment of colleges for North and South Wales was decided on as a result of the deliberations of the Government Committee appointed in 1880, the appeal for funds met with an enthusiastic response, not only from the wealthier, but also from the poorest classes of the community, the miners and quarrymen at Bethesda contributing their shillings, and even the children in the board schools contributing their pence. The question of permanent buildings was, however, deferred until the movement had time to mature, with the result that the work of the University College at Bangor has up till this year been carried on entirely in the buildings of the old Penrhyn Arms Hotel, while until recently the college at Cardiff was wholly located in what had previously been an infirmary.

It was only four years ago that King Edward laid the foundation stone of the buildings which were opened by his son last Friday, and in the interval there has been raised in Upper Bangor a fine college, the architectural features of which will compare favourably with those of the more ancient foundations of Oxford and Cambridge. As will be seen from the illustrations, the college stands on a hill overlooking the old town of Bangor, in a park the slopes of which are in the spring covered with bluebells. It is quadrangular in form, the class-rooms being on the first and second floors facing the park, while the other sides of the quadrangle are occupied by administrative buildings, examination rooms, and studies, and the Prichard Jones hall. On the left of the tower are seen the museum and library, which, when the scheme is completed, will form the side of a great outer quadrangle, the remaining sides being allocated to the science departments. The work of these is, however, for the present, being continued in the old college. The new building, in which the arts departments are located, thus forms the first step in a larger scheme, for the completion of which further funds will have to be raised. It has been built at a cost of 130,000*l.*, and was opened by the King nearly, if not quite, free of debt.

The largest individual contribution has been the *Aula magna*, given by Sir John Prichard Jones, whose name it bears, built at a cost of 15,000*l.* The library, given by the Drapers' Company at a similar cost, is an excellently equipped building, which, though so new, reminds one of the college libraries at Cambridge. In addition to this gift, the Drapers' Company has further maintained for many years a department of electrical engineering in conjunction with the department of physics. But in passing between these buildings we notice a stained glass window bearing the inscription, "Presented by the Postmaster and Staff of the Bangor Post Office." As another example of the varied character of the contributors, we note the recent donation of 100*l.* to the building fund by a member of the teaching staff of the Girls' County School. The site of the college, valued at 15,000*l.*, was given by the "Mayor, Aldermen, and Citizens of Bangor," and this gift was followed by a further contribution of several thousands to the building fund from the same source.

A special feature of the new college is the open cloisters outside the lecture rooms, as shown in our second illustration, thus ensuring efficient ventilation.

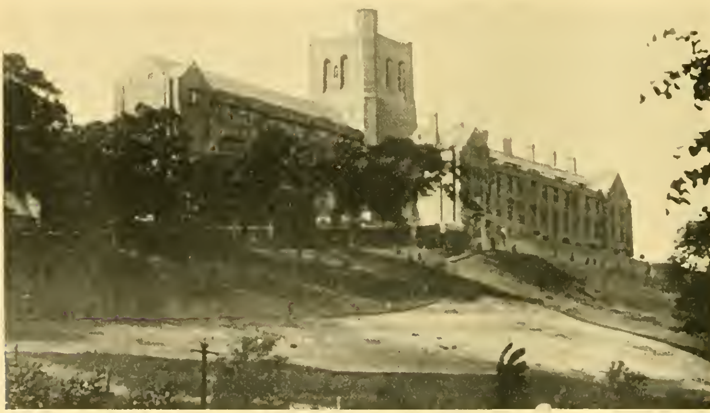


FIG. 1.—Front view of the new buildings of the University College of North Wales, Bangor. To the left of the tower are the museum (lower floor) and library (upper floor). Right of the tower are students' common rooms (ground floor), opening on terrace, lecture room (first and second floors) and Professors' rooms (in the attics).

The opening ceremony was performed in the presence of a large and representative gathering. We had Mr. Balfour and Mr. Lloyd George, not only sitting together on the same side of the house, but sharing a programme; Lord Hugh Cecil, the master of the Drapers' Company, and other distinguished guests. At the preliminary banquet, Mr. Balfour, in his speech, expressed the opinion that those who have planned and carried out this work have proceeded on right lines. They have not been modest in their ambitions, and they have been right. The building was planned on a scale that is not only adequate, but has the germs of development, which will render it adequate to future strains. Much of the advantage of a university education lies in the memories of those who have enjoyed it. When great architecture is linked with beautiful surroundings, subtle impressions are formed which move men until their dying day. It is well worth while to have great ideals as to the work. This breadth of view as to the ideals of education and culture is animating all those who preside over and control the courses of study, and Mr. Balfour advised them to be as magnificent in their ideas as the architect has been in the edifice. There are those who attach supreme value to the training of the youth and the utilisation of opportunities otherwise unused, of talents that would otherwise fall out. We should not narrow our ideals to training intelligent youths to pass difficult examinations. Apart from examinations, youths educate each other often most effectually, and each one who looks back on what he gained at the university finds that it does not always consist only in the advantage derived from lectures. There is another function that every university should aim at. In dealing with knowledge, art, and literature they should be the custodians of all that is highest, and not the less so because we are living in a democratic age. Wales and its colleges feel this ideal as much as any community. Wales has had its share of those divisions of opinion that are the effects and causes of national vigour, but in university education Wales is a land of brothers. All classes are animated by the same ideals, and make the same sacrifices in the great cause. But this brotherhood goes far beyond the limits of nationality. This place is not merely a Welsh seat of learning, for learning knows no limitations; it will take its place in the wider brotherhood which extends throughout the civilised world. There are many occasions on which national differences may arise, but the function of a university is to make the country a community of nations, one army conquering the same enemy, one band of workers united in a common cause.

The National Library of Wales, the foundation stones of which were laid at Aberystwyth the following day, owes its origin to the same movement. It was founded by Royal Charter in March, 1907, and its objects embrace "the collection, preservation, and maintenance of every form of literary and artistic production, whether printed or manuscript, relating to Wales and to the Celtic peoples and languages, as well as all literary works, whether connected or not with Welsh subjects, composed, written, or printed in whatsoever language, on whatsoever subject, and wheresoever published, which may help to attain the purposes for which the University of Wales, the university colleges, and other educational institutions were created and founded, *especially the furtherance of higher education and of literary and scientific research.*" The foundation of this library is largely the result of the efforts of Sir John Williams, Bart., who for more than thirty years has been purchasing books, which he has presented to the library. These have been temporarily housed in the Aberystwyth Assembly Rooms.

The site of the permanent buildings, situated on a hill overlooking the town, has been presented by Lord Rendle. The Exchequer grants which the library has received up to the present have been proportionally far below those made to similar institutions in Scotland and Ireland. The new library will, it is hoped, receive some of the privileges enjoyed by the libraries of Oxford and Cambridge with regard to the acquisition of copyright books. It is, however, clearly understood that a condition of such a concession is the maintenance of the international character of the library, and of the provision contemplated in the charter as a safeguard against its becoming a purely Welsh institution. In these circumstances we confidently hope that scientific literature of all nations will be adequately represented. At the same time, it is important for English workers to realise the scientific importance of much that comes under the more Welsh side of the library. At present numbers of manuscripts and documents, full of historic interest, are scattered about in remote districts, and the foundation of a central collection cannot fail to bring to light important new contributions to our knowledge of history and anthropology. A further step in the same direction is the National Museum at Cardiff, of which the foundation stone will be laid next year, and which will, it is hoped, serve to preserve records of the druidical and other remains which are gradually disappearing under the devastating influence of utilitarianism. The astronomical interest connected with these remains will be well known to readers of NATURE. A photographic survey of the antiquities of Wales might, one would think, be inaugurated with

FIG. 2.—Interior of the quadrangle, showing the open cloisters by which the lecture rooms are approached. On the left-hand side is the block containing the Assistant Lecturers' private rooms; on the right a corner of the tower.

advantage in connection with either the library or the museum, perhaps both.

The proceedings in Aberystwyth were attended by delegates from most of the universities of the United Kingdom, as well as the Royal Society and similar bodies, and these received hospitality at the Alexandra Hall (the residence of the women students), which thus became the scene of pleasant meetings between the brotherhood of university workers so well described by Mr. Balfour. The memories which we shall carry away of this gathering will be ranked in the same group with our pleasantest reminiscences of British Association meetings. We could have wished that royal honours had been conferred on some representative of science, as it is probable that such a distinction would have given an impetus to an aspect of the university movement which must always be kept prominently in the foreground.

G. H. BRYAN.

TECHNICAL TRAINING AND UNIVERSITY GRANTS.

IN the House of Commons on July 13, in Committee of Supply, the President of the Board of Education made his annual statement reviewing the work of the Board during the previous year.

Dealing with the museum work of the Board of Education, Mr. Runciman referred to the controversy over the question of a site for the Science Museum. He said:—"Since the first announcement was made about the site of the Science Museum I have entered into negotiations with the Trustees of the British Museum, and we have now arrived at an agreement which will give us the land we require for the Science Museum and will not interfere with the development of the Natural History Museum, so that we shall have in South Kensington a group of museums which will be the envy of foreign nations."

In the course of his further remarks, Mr. Runciman referred to technical training and university grants. Subjoined are a few extracts from *The Times* report of his speech.

HIGHER TECHNICAL TRAINING.

"I regret to say that from all I learn of the work done in the provinces and of the work done on the Continent, I have to confess that it is in the field of higher technological forces that we have most leeway to make up.

"It is true that in many directions large sums of money are being devoted to the endowment of technological chairs in almost every modern university. Great bequests have been made during the past year. The University of Liverpool has recently founded a professorship of naval architecture, largely owing to the generosity of Mr. Elder. They have also created a department for the study of the problems of town planning—a new and rather interesting department. There are at the present time at least two departments in modern universities for the study of aëronautics. A professorship has been founded at Leeds for the study of the gas, coal, and fuel industries. In the same university instruction is being provided in woolcombing and spinning, for which the Clothworkers' Company has given a sum of no less than 50,000*l.*, making, I believe, the school at Leeds one of the most valuable technical schools in Europe. In the north of England a sum of 35,000*l.* has been applied for the teaching of mechanical engineering, and in three universities sums of 30,000*l.*, 50,000*l.*, and 70,000*l.* respectively have been provided for the promotion of chemical science.

"In London 60,000*l.* has been set apart by the University Association for the training of women in the study of the science of the household. Great progress has been made, I am glad to think, in the departments of metallurgy and chemistry in the north. In the sciences at the Imperial College great improvements have been made in the last twelve months, and I believe now that the leaders of the great industries are well alive to the fact that in the development of higher technological work lies much of the hope for their future success. I need not mention agriculture except in passing. Two agricultural colleges have been linked up with modern universities.

"When one records all, there is still left the feeling that in England there is not full appreciation of higher technological work, and when we make comparison of the number of students at German and English universities it is all to the advantage of Germany and not to our credit. In the eleven modern universities of England at the present time full time students number 9600, and if you add 7000 at Oxford and Cambridge of under- and post-graduates, you have a total for England and Wales of 16,600 students. It sounds like a large number, but when you remember that Germany has 63,000 students in similar institutions we may well say we have a long journey before us."

UNIVERSITY GRANTS.

"The most important departure made in the administrative work of modern universities is to be found in the change in distribution of the Treasury grant. Over a long period the Treasury grants given in large sums were spent at the discretion of the modern universities under the advice of a committee set up by the Treasury. There is no other education work for the Treasury to do, and there was unfortunately a certain amount of overlapping, because technological work came under the Board of Education, and it was felt that for administration in these matters and, I think, also for the simplification of regulations under which modern universities work, it was of the first importance to avoid waste in administration and overlapping, and the universities themselves agreed. With that object the Government have decided to transfer the distribution of this annual grant to the Board of Education, and now the only Government department modern universities have to deal with is the Board of Education. I am glad to think this meets with the approval of modern universities, and in the many conferences I have had with their representatives they have shown the desire to do their best to work with us for the common end, the extension and efficiency of the work falling under their guidance and control.

"I cannot pretend to say that the Board of Education is at the present time sufficiently equipped to do the whole of the work undertaken by the advisory committee appointed by the Treasury. I have, therefore, set up a small advisory committee to deal with the distribution of these grants. I am glad to say I have secured the service of Sir William McCormick as chairman, who is well known for his services under the Carnegie bequest, and was one of the most active members of the Treasury committee. Associated with him are Sir J. A. Ewing, C.B., F.R.S., Sir William Osler, F.R.S., Miss Emily Penrose, Sir Walter Raleigh, Sir John Rhys, and Sir Arthur Rücker, F.R.S. They are a small and, I may add, a very distinguished committee, and they have already started their meetings, one of their first arrangements being to give Hartley College, Southampton, now struggling to exist as a university college, another year in which to accumulate funds for carrying on university college work."

APPLICATIONS OF SCIENCE TO INDUSTRY.

THE annual meeting of the Society of Chemical Industry was held at the Cutlers' Hall, Sheffield, on Wednesday, July 12, the president, Mr. Walter F. Reid, being in the chair. In his presidential address, Mr. Reid dwelt on the rapid developments of the application of science to industry, and said it was quite impossible for anyone to keep up to date in all branches of applied science. But, though the tendency of the present age was towards specialisation, too minute sub-division had its disadvantages, and there would always be a demand for trained men who had a good general knowledge of science and of the methods of applying it. Manufacturing chemists frequently receive advice from those engaged in other industries to employ more skilled assistants in the factories. Mr. Reid quoted some figures given by Mr. Barker North, in his recent presidential address to the Association of Teachers in Technical Institutions at Southport, showing that the chemical factories stood at the head of all our great industries as regards the proportion of skilled supervision employed. The value of the net annual output per head of those employed in the manufacture of chemicals, coal-tar products, drugs, and perfumery, was also considerably in excess of that in any other of the nine chief trades of the country, the amount being 185*l.* per year, while the next was iron and steel with 118*l.*

It was sometimes alleged that the nature of the training given to students in this country was not of a sufficiently practical character, and that some foreign nations were superior to us in this respect. He did not think it could at present be said that the facilities for acquiring knowledge were less in Great Britain than in any other country—in fact, in some of our institutions they were superior. The most important piece of evidence upon which a final judgment could be passed, however, was wanting. They had no information as to the careers of students after they left the colleges or universities. This alone was the final measure of success. Degrees or examinations were but milestones along the road, although they were sometimes quoted as if they were the main end to be attained. Each centre of tuition could, no doubt, give the names of some former students who had been successful in their careers, but what interested him most was the ultimate fate of the rank and file, who supplied the bulk of the assistants in factories. Frequently he had had to engage assistants for various industries, and in one respect they were all deficient. They did not realise that the object of the industrial chemist, like that of the alchemist, was to produce gold, and that every factory operation must yield a profit, failing which it must inevitably cease. In this direction their German colleagues were, perhaps, more advanced, for "Waarenkunde," or knowledge of merchandise, was a recognised subject of tuition, and current price lists were not unknown to students.

In another way, students met with difficulty at the beginning of their career; they were not taught what kind of apparatus and plant was likely to be available for them in practice. Teachers who had not worked in factories could not properly teach students practical work in industrial chemistry. The problem for the student was how to acquire practical knowledge at the commencement of his career. In this he thought employers might materially assist by giving their younger employees more leisure to attend meetings of societies such as the Society of Chemical Industry, and by procuring journals and other literature which the assistant was unable to purchase. A good factory library was of the greatest pecuniary benefit both to employer and employed, but in how many factories did they find one? The rapid march of progress necessitated continuous study. They must all remain students. Sometimes an apparently casual observation might lead to important results if it was followed up, but if the factory chemist was taught to consider himself merely as a kind of teaching machine, and original observation was discouraged, business could not progress.

Mr. Reid recalled how many great industries had arisen from very small beginnings. The fixation of atmospheric nitrogen as an industry was still in its infancy. In 1781 Cavendish found that, on passing an electric spark through a mixture of carbon dioxide and hydrogen, nitrous acid was produced. He communicated his observation to Priestley and Lavoisier, neither of whom could obtain the same result. Cavendish's observation was more accurate than his method, for he made his experiments in vessels containing only a partial vacuum, and the nitrogen and the residual air yielded nitrous acid. In 1784 R. Kirwan repeated the experiment with atmospheric air, and again found acid. Here we had the English origin of what was destined to become one of the great industries of the world, but which was being developed chiefly in foreign countries. When Tyndall made his classic researches on glaciers, he little imagined that factories would arise in the Alps with a glacier at one end of the system and nitric acid of 98 per cent. running into carboys at the other.

The history of the development of modern smokeless powder had never been told. Soon after graduating at Berlin, Mr. Reid was commissioned by the Argentine Government to report on the mineral resources of that country. In carrying out the work, he had to penetrate into a wild region where his gun was the chief source of the daily food. There were few opportunities for cleaning the gun when work was finished, and as a result the gun was ruined by rust. When he returned to England, he endeavoured to find some means whereby rust might be prevented. He heard of the work done by Von Lenk with gun-cotton, and he also heard from the officials of the Patent Safety Gun-cotton Co., Stowmarket, that the manufacture of powder for firearms had been abandoned because of the great irregularity of the explosions and the number of accidents that had happened. He made a long series of experiments, and finally found that by gelatinising nitrocellulose, either completely or partially, the explosion could be rendered quite uniform. Some of the first experiments were made with a paste forced through a perforated plate similar to those used in the gutta-percha industry. The threads thus produced were cut into short lengths, and gave good results. But in those days, when cartridge cases and gun or rifle chambers were adapted to black powder, which was twice the bulk of the new product, there was a great disinclination to make the necessary alterations. A partially-gelatinised, bulky powder had, therefore, to be made for the market. It was called "E.C." powder—the initials of the Explosives Co., Ltd., who were then owners of the Stowmarket Works. It was only recently that sporting guns and cartridge cases had been specially made to suit the fully gelatinised powder, which had now almost supplanted black powder for sporting purposes. The utility of the new powder for military purposes was evident to civilians from the beginning, but our military authorities, after testing it, said that it could not be adopted, because the trajectory was so much flatter than any powder then in use, and that the sights of all army rifles would require alteration. The British rifles being so short-sighted, he had no option but to turn to our neighbours of France. In November, 1881, he showed the powder and method of manufacture to the military attaché at the French Embassy, but it was some time afterwards before the French produced their powder "B," and this forced the hand of our military authorities at home. To-day, even the sights of our military rifles had been altered; in fact, he believed there was no part of either rifle or cartridge that had not been altered, and the art of war had been changed throughout the world.

Fifteen years after the process had been worked out, he learned that a German botanist, Hartig, had made experiments in the same direction in 1847. The pamphlet in which he described his experiments was extremely scarce. He knew of only one copy of it in Great Britain, and he had been unable to obtain it in Germany, so that his ignorance on the subject in 1881 might perhaps be excused.

The president next gave illustrations of the discovery of the method of silvering glass, a paper on which was written as long ago as 1867 by Justus von Liebig; of the discovery of Portland cement by Aspdin, the Leeds mason; and how both these discoveries led to important industrial results. He showed how fogged photographic plates led to the discovery of the Röntgen rays. Bolsover, in repairing the handle of a knife composed partly of silver and partly of copper noticed that these metals adhered to one another when fused. This laid the foundation for Sheffield plate. Dr. John Wright's invention of the use of cyanide of potassium in electro-plating was the outcome of research, and about the same time another inventor was busy on the same subject. One of the brothers Siemens found a method of electro-plating which he considered new, and brought it to England, where he offered it to Elkington. The latter was able to show him an almost identical process already at work. Mr. Reid next referred to the discovery of the vulcanising of india rubber by Hancock, which showed the necessity, not only of patient work, but also of perseverance and careful observation. Hancock had made a number of mixtures of india rubber with various substances, none of which appeared to have any particular advantage. The samples were put on one side for some months, when the whole of them were treated with oil. It was noticed that a portion of one sample was not acted upon by the oil, and on looking up his records of the samples Hancock found that this particular one had been heated to about 300° F., and that it contained sulphur. Incidents of this kind could be multiplied. He hoped he had shown the younger members of the society the advantages, first, of original work in connection with their industries; secondly, of careful observation and diligent inquiry into anything that might appear new to them; and thirdly, of perseverance until they had obtained some definite result.

TRIALS OF ROAD MATERIALS AND CONSTRUCTION.

THE use of motor vehicles has so completely altered the conditions of the wear and tear of the roads, that it has become necessary to find some new method of maintaining the surface and preventing the nuisance of the dust arising from the wear of the surface by the wheels of the motors. During the last few years various processes have been tried, chiefly directed to finding some more durable means of binding the surface material with which the roads are covered. The most successful so far have been by the use of tar asphalt or oil for binding the broken granite or other road material used for repair.

The new Road Board, with the view of securing a service test under uniform conditions, has made arrangements with the Kent County Council for carrying out a series of experiments on trial lengths of a main road, to be carried out under the direction of its advisory engineering committee. The site selected for these experimental trials is on the main road from London to Folkestone between Eltham and Sidcup. This road is thoroughly representative of the average condition of heavy road traffic. The average number of vehicles using this road in one day includes 322 motors of all kinds, and 454 horse-drawn vehicles, the traffic density amounting to 500 tons per yard of width.

The experiments are to be carried out under the direction and superintendence of Mr. Maybury, the county surveyor of Kent, who has paid special attention to this subject, and has so far succeeded in maintaining the surface of the main roads in Kent in excellent order. The special subjects to be taken into consideration are:—The first cost of the coating, and the future cost of maintenance and efficiency. Twenty-three different processes are to be given a trial, each extending over a length of a hundred yards. They include ordinary water-laid and rolled macadam; the same with a tared surface; tar macadam; and several patent processes.

Arrangements have been made for an inspection of the work while it is going on by those interested, and a pamphlet has been issued by the Road Board, giving full particulars and copies of the conditions and specifications under which the trials are to be carried out. This pamphlet is to be obtained at Messrs. Waterlow and Sons, London Wall, E.C.; price eighteenpence.

METEOROLOGICAL REPORTS.

PHILIPPINE *Weather Bureau* (1908).—The part of the annual report now received includes (1) the administrative report for the fiscal year ending June 30, 1908, and (2) hourly meteorological observations made at the Manila Central Observatory during the calendar year 1908. The activity and popularity of the department dealing with storm warnings may be gauged from the fact that during a typhoon 160 telephonic inquiries were received in a single day. Telegraphic observations were received twice daily from twenty-nine foreign stations, and include reports from Japan, China coast, Formosa, and Indo-China. Special attention is directed to the "immense service" to shipping and other interests which the Eastern Extension and Great Northern Telegraph Companies have for years rendered in allowing free transmission of meteorological messages. The mean temperature of the year 1908 was 79·2° (rather below the normal); the maximum, 97·2°, occurred in May, and the minimum, 61·7°, in February. The rainfall was 97·7 inches (about $21\frac{1}{2}$ inches above the normal); none fell in April (the average being 1·2 inches). Among the large number of seismic disturbances reported from different localities in the fiscal year only one violent shock occurred, viz. on November 24, 1907, in south-east Luzon.

Davos Meteorological Station (1910).—The annual summary, printed as a supplement to the monthly weather charts published by the Curverein, gives the mean maximum temperature in January and July, respectively, as 29·7° and 59·5° F.; mean minimum, 12·9° and 39·6°; absolute maximum, 77·5°, in July; minimum, −9·6°, in February. Rain (and melted snow) amounted to 45·6 inches (9·3 inches above the normal). Snow fell in every month except June and August. Sunshine was recorded during 1605·6 hours, which was much below the average (1790·7 hours for 1885–1905).

Bombay and Alibag Observatories (1910).—The mean temperature of the year was 79·1°, being 0·3° below the normal; the maximum hourly temperature was 92·7°, in June, and the minimum 61·5°, in January. The rainfall was 67·86 inches, being 7·3 inches below the normal (1873–96); June received a fall of 23·92 inches, being $3\frac{3}{4}$ inches above the average. Milne's seismograph registered fifty-seven earthquakes; those of November 9 and December 13 and 16 were great disturbances. The mean magnetic declination was 0° 57′ 43″ E.; inclination, 23° 35·7′; horizontal force, 0·36845 C.G.S. units. During the year there were 102 calm days, 236 days of small, 25 days of moderate, and 2 days of great disturbance. Part of the observatory is still infested by white ants, although the floor has been cemented; it is now proposed to use Minton tiles.

Falmouth Observatory (1910).—The report of this important station, maintained by the Royal Cornwall Polytechnic Society, and one of the normal meteorological observatories subsidised by the Meteorological Committee, is of more than usual interest. It contains meteorological means for the lustrum 1906–10, and for the forty years 1871–1910; also sea-temperature observations taken about one mile outside the harbour for the same lustrum, and means for thirty-one years, compiled with great care by the superintendent, Mr. E. Kitto. The monthly means of air temperature in 1910 were:—January, 44·2°; July, 58·2°; year, 51·1° (0·4° above the normal). Rainfall for year, 52·84 inches (7¾ inches above the normal, due partly to an unusually heavy fall, 9·22 inches, in December). The percentage of possible duration of sunshine was 38 (which was exactly normal). The mean temperature of the sea in 1910 was 52·1°; the only months in which the mean was below that of the air were May–August. In the valuable work of terrestrial magnetism the observatory received grants amounting altogether to 100*l.* from the Royal Society and British Association. The principal mean values for the year were:—declination, 17° 41·6′ W.; inclination, 66° 29·1′ N.; horizontal force, 0·18802 (C.G.S. units).

The Fernley Observatory, Southport (1910).—The principal station of this important observatory is situated in the Hesketh Public Park; the equipment is very complete and in duplicate. There are also branch stations at Marshside (for anemographs), Birkdale, and Barton Moss. The director, Mr. Joseph Baxendell, is an enthusiast in the work, and meteorologists are indebted to him for various improvements in self-recording instruments and for inquiries into many interesting details. Among several such matters in the present report we may mention (1) the alteration of a Richard hair hygrograph to enable daily instead of weekly traces to be obtained from the instrument, and some valuable results have already been obtained. (2) Careful experiments have shown how the readings of a thermometer were vitiated by the metallic fittings of an instrument in the enlarged Stevenson screen. The mean temperature of the year was 48·7° (0·5° above the average); maximum, 78·2°, in July; minimum, 16·0°, in January. The rainfall was 35·04 inches (2·14 inches above the average). Bright sunshine, 1568·4 hours (11·9 hours above the average). A rather surprising cold wave was felt by the deeper underground thermometers; its greatest effect was at 10 feet in February and at 20 feet in March. The very useful table of comparative statistics at other health resorts and large towns again appears in the report.

Mysore Meteorological Department (1909).—This seventeenth annual report, carefully compiled by Mr. N. V. Iyengar, chief observer in charge, contains detailed observations at the high-level stations Bangalore (3021 feet), Hassan (3149 feet), Mysore (2518 feet), and Chitaldrug (2405 feet), with means for the seventeen years 1893–1909. As in former years, the results have been worked out in great detail. Over the province as a whole the departure of the mean annual temperature from the normal was insignificant. The highest monthly mean maximum was 96·1°, in March and April at Chitaldrug, and the lowest mean minimum was 57·2°, in January at Hassan. Absolute maximum, 100·6°, in April at Chitaldrug; minimum, 52·2°, in January at Hassan. The mean rainfall was nearly 16 per cent. above the average. The rainfall statistics have been separately published (NATURE, February 16).

Deutsche überseeische meteorologische Beobachtungen (1909).—The nineteenth volume of this series of observations, published with the assistance of the Colonial Department, now extends to 116 quarto pages, and is divided into three sections:—(1) monthly and yearly means at certain hours at stations under the immediate control of the Deutsche Seewarte in various parts of the world; (2) observations at stations in German East Africa; and (3) observations in Togoland (West Africa). The monthly and yearly results for all stations in sections (2) and (3) will be eventually published in the *Mitteilungen* from German protectorates by Baron v. Danckelman. Full particulars about instruments and references to information about stations are given, and the extreme values are printed in thick type. These observations are of the greatest importance to meteorological science, and yearly increase in value.

Sonnblick Society (1910).—As a preliminary to the investigation of the influence of climate upon the variations of the Goldberg glacier it was decided, with the financial assistance of the Vienna Academy of Sciences, to have a survey made of the district. After removal of many difficulties, Baron v. Hübl proposed to make use of Dr. Pulfrich's stereoscopic method; the work was satisfactorily carried out by the Military Geographical Institute, and a coloured plan has been added to the present report. The following are some of the meteorological results for the Sonnblick Observatory (Rauris, Austria), altitude 10,187 feet:—mean temperature: January, 7·9° F.; July, 30·4°; year, 19·6°; absolute maximum, 47·7°, in July; minimum, −13·5°, in January. Melted snow and rain, 67·8 inches, on 258 days. Fog occurred on 281 days; each month had at least twenty days. Particulars relating to other mountain stations are given, as in previous reports.

BIRD-NOTES.

THE April number of *The Emu* contains an interesting account, by Mr. S. W. Jackson, of the nesting haunts of the rufous scrub-bird (*Atrichornis rufescens*), which, together with *A. clamosa* of Western and South-Western Australia, represents a peculiar family group. The expedition, which took place in September, 1910, was directed to the high Dorrigo scrubs at the head of the Bellinger River, New South Wales, where the first known nest and eggs were taken twelve years earlier. In addition to obtaining a second nest and eggs, it was the object of the expedition to procure a female, of which no example was then known. The nest finally discovered, of which photographs are given, was a large dome-shaped structure, with a tubular entrance, built amid thick bush in a tussock of dead carex grass. It was constructed of this grass and leaves, with a lining of a hard dry material made of wood-pulp, upon which the two eggs rested. The latter were removed by constructing a kind of extemporary ladle, but were eventually returned for a time to the nest as a lure to the female, who, however, eluded all attempts at her capture. A pair of lyre-birds had their nest and playground a short distance away.

To the May number of *British Birds* Mr. A. L. Thompson contributes a summary of the most recent records of stork-migration. It is now established that there is a south-easterly migration of storks across Europe in autumn, birds ringed in Denmark having been taken respectively at Brandenburg, near Frankfort-on-Oder, and in Austrian Silesia. This migration is remarkable in that its line cuts at right angles the route taken by the great majority of birds at the same season. As regards migration to and from Africa, Prussian storks have been taken in Syria, Palestine, and near Alexandria in some instances in the first, and in others in the second, year after marking. One Hungarian stork was also taken in Syria. On the other hand, three Prussian storks were severally taken during their first autumn near Lake Chad, on the Blue Nile, and on the Victoria Nyanza; a bird which left Pomerania at the end of August was taken in north-east Rhodesia early in December, while a Prussian stork was shot in the Kalahari during its first winter. Further, there are records of seven Prussian storks taken in the Transvaal, Natal, Basutoland, and the north of Cape Colony, and also of about a dozen Hungarian birds from the same area, while one was obtained so far west as German South-West Africa. With one exception, all these birds were taken during the northern winter; but the exception was captured in July. So far as the records admit of generalisation, it appears that storks generally return to their original summer haunts; but there is a notable exception in the case of a bird hatched near Brunswick in 1908, which made its appearance a couple of years later about 437 miles away, in eastern Prussia. This instance, together with the Lake Chad and German South-West African records, and the one noted below, indicate that further inquiry is necessary before our knowledge of the subject can be regarded as anything like complete. Very remarkable is the capture near Barcelona in September, 1910, of a bird hatched in the neighbourhood of Cassel, as this west German stork took a line of flight almost exactly the opposite of that followed by its fellows hatched in Denmark and north-east Germany.

Mr. J. H. Gurney in the course of his report on Norfolk birds for 1910 (*Zoologist* for May) alludes to the increasing scarcity of the corn-crake—which he attributes to the shooting of these birds in the south of France—and likewise to the recent visitation of crossbills. Most of the latter have departed, but when and where they went is another matter. A crane shot at Thornham in August was one of the rarities. In a note on the food of starlings, the author adduces evidence to prove that these birds are harmful to young wheat and oats, eating the sown grain as, or before, they sprout. On the other hand, they undoubtedly destroy large numbers of noxious insects.

Among several "Educational Leaflets" received from the American National Association of Audubon Societies, reference may be made to the so-called Virginian quail, or "Bob White" (*Colinus virginianus*), a bevy of which forms the subject of the illustration here reproduced. The

A Bevy of Californian Quail. From U.S. Educational Leaflet."

bird is a valuable asset to the United States, partly on account of the revenues derived from shooting rights and partly owing to the quantity of noxious insects and weeds it destroys. It is estimated that a family of a dozen quail would consume about 800,000 insects and 60,000,000 weed-seeds in the course of a year. When reposing, the members of a bevy arrange themselves in a circle with their heads directed outwards, and in such a position, except, of course, when snow lies on the ground, are stated to be almost invisible, even at a very short distance.

To the June number of *British Birds* Messrs. Ticehurst and Jourdain contribute an article, illustrated with maps, on the distribution of the nightingale in Great Britain, the subject being treated county by county. As regards the extreme south-western and northern limits of the range of the species, the authors endorse the view that neither in Devonshire nor Yorkshire has there been any extension within the period when, if it had occurred, it could be definitely traced. In Yorkshire, nightingales appear to have bred a century ago as far north as they normally do at the present day, occasional occurrences beyond the usual range having probably occurred in the past in much the same manner as is the case nowadays. It is noteworthy that the range of the bird in Yorkshire is strictly limited to the lowlands, only one instance of its breeding above the 250-feet contour being recorded. The alleged instances of the occurrence of nightingales northward of Yorkshire are regarded as not proven.

In an article in *The Irish Naturalist* for June Mr. R. M. Barrington attributes the great rush of birds observed in the south-east of Ireland during the night of March 29 to a combination of special circumstances affecting the ordinary spring migration. Owing to the prevalence of north-east winds over a great part of Europe, the birds had probably to halt in the south, where they collected in numbers. At Valentia, Pembroke, and the Scilly Islands the wind veered to the south on March 29, although north-east winds continued over the rest of the British Isles. The night was moonless, and after the birds had crossed the Channel they encountered a bank of fog off Ireland, which caused their hosts to become disorganised and attracted first by the lighthouses and then by the lights of the towns.

Exquisite photographs of birds and other animals illustrate a pamphlet on the "Ross Bird-stalker," written by Mr. C. Dixon, and published by Ross, Ltd., New Bond Street. The pamphlet advertises a stereo-prism binocular, stated to be well fitted for the purposes of the field-naturalist. R. L.

AMERICAN ETHNOLOGY.[1]

THE study of the Chippewa songs and music collected by Miss F. Densmore in Minnesota is of exceptional interest. Every phase of Chippewa life is expressed in music. Many of the songs are very old, and are found in several reservations; others are said to be the more recent compositions of certain men who composed them "during a dream" or "upon awaking from a dream." It is still customary for the Chippewa to celebrate an important event by a song. None are the exclusive property of families or clans; a young man does not inherit the right to sing his father's songs, but if he likes he may learn them by giving the customary gift of tobacco. As with the songs of the Murray Islanders of Torres Straits, the melody is considered more important than the words. It is permissible and customary to compose new words for old tunes, but they are always similar in general character to the words previously used, the idea being the important thing. Indian songs are not recorded in a definite system of notation, and a standard of absolute exactness is lacking; the melody-trend and the principal rhythm of the song, however, are constant. "Indian music seems to belong to a period in which habit takes the place of scale consciousness. Habit in the choice of musical intervals is formed by following a line of least resistance or by a definite act of the will, or may be the result of both, the voice at first singing the intervals which it finds easiest, and afterward repeating these intervals voluntarily. . . . The present study is not an analysis of fractional tones, but of melodic trend and general musical character; therefore the ordinary musical notation is used, with the addition of a few signs in special cases." A vibrato or wavering tone is especially pleasing to the singers; it is difficult for them to acquire, and is considered a sign of musical proficiency.

The songs fall into several classes, such as Dream songs, War songs, Love songs, Mocassin-game songs, Woman's-dance songs, and *Mide* songs. The *Mide* (Grand Medicine) is the native religion of the Chippewa. It teaches that long life is coincident with goodness, and that evil inevitably reacts on the offender. Its chief aim is to secure health and long life to its adherents, and music forms an essential part of every means used to that end. Both men and women are eligible for membership. There are eight degrees, persons being advanced from one degree to another on receiving certain instructions and bestowing valuable gifts. Meetings are held in the spring of each year, but it is permissible to hold initiation meetings in the autumn.

[1] Smithsonian Institution, Bureau of American Ethnology. Bulletin 45.—"Chippewa Music." By F. Densmore. Pp. xix+216. Bulletin 37.—"Antiquities of Central and South-Eastern Missouri." By G. Fowke. Pp. vii+116. (Washington: Government Printing Office, 1910).

All members are expected to attend one meeting each year for the renewal of their "spirit power." The life enjoined on the members is a life of rectitude. They are taught that membership does not exempt a man from the consequences of his sins. Lying, stealing, and the use of liquor are strictly forbidden. Various stages of initiation are described, and the appropriate songs with their music are given, each of which is accompanied by a reproduction of the mnemonic pictograph. All the songs are recorded in mnemonics on strips of birch bark, each record serving as a reminder of the essential idea of the song. The following examples illustrate these pictographs.

The Medicine song, illustrated by a figure, is: "Light—Around you—Chief—Woman." The picture was drawn by a woman, who stated that the horizontal line represents the edge of the wigwam, along which are arranged various articles of value indicated by the dots. At each end are torches, the light of which falls on the gathered wealth, causing many of the articles to glitter. These articles belong to a woman standing with upraised hands and wearing a pearl necklace with a locket. In singing this song the woman pointed to one portion of the picture after another, tapping the birch bark lightly as she sang.

The fourth song (p. 59), for initiation into the Sixth Degree of the *Midewiwin* (Grand Medicine Society), is: "Who is this—Sick unto death—Whom I restore to life?" The pictograph represents the body of the person to be initiated, on whom are seen lines representing the "strength" he is to receive through the *Mide*. "The words of the song refer to the person who is being initiated. Many sick persons are initiated in order that they may be restored to health. The *Mide* comprehends health of body, mind, and spirit in one general idea." It is somewhat unfortunate that this short memoir is simply entitled "Chippewa Music," for on reading the title a non-musical person might be led to overlook a piece of work which, as we have seen, covers a much wider ground.

As the result of two seasons' field work, Mr. Gerard Fowke has published a memoir on the mounds near the Missouri river, mainly between Gasonade River and Moniteau Creek. The mounds were erected on narrow ridges, with no regard to orientation; each contained a vault with sides sloping outwards, and composed of irregular stones. They contained one or more skeletons, either doubled up or disarticulated, the flesh having been first removed; in these cases the bones sometimes appear to have been thrown carelessly into the vault. The bones were in such a decayed and friable condition that very few could be preserved or measured. Dr. A. Hrdlička states that most of the crania are of the dolichocephalic Indian type, two or three being extreme forms in this respect, suggesting similar specimens recovered in New Jersey from the burials of the Delawares and also from the mounds of the Illinois River. A large number of the vaults are figured, as well as objects found within them. The author states that:—"As the Osage Indians never ascended the Missouri farther north than the Osage River, and as the stone vaults above that point show progressively more skill in their construction, we must attribute them either to the Kansa Indians or to some tribe whose name is now lost."

A. C. HADDON.

RADIANT MATTER.[1]

THE velocity with which helium is cast out by radio-active bodies at the moment of change varies considerably from one element to another. Thus the radiant atoms of radium C possess a far higher velocity than those of uranium or ionium. This fact is apparent in the greater distance to which the α rays of the former will penetrate in air or in any other substance. The distance traversed in air is known as the "range." The following table shows the ranges of α rays from the various known radio-active elements. Thus we see that whereas the helium from radium C is projected nearly 7 centimetres, that from uranium only reaches 2·7 centimetres. In the thorium series, one of the elements, thorium C, attains a range of 8·6 centimetres. This is the longest known.

Range in Air.

	cm.		cm.
Radium C	7·06	Thorium C	8·6
Radium A	4·83	Thorium X	5·7
Emanation	4·23	Thorium emanation	5·5
Radium F	3·86	Thorium B	5·0
Radium	3·54	Radiothorium	3·9
Ionium	2·8	Thorium	3·5
Uranium	2·7		

	cm.
Actinium X	6·55
Actinium emanation	5·8
Actinium B	5·5
Radioactinium	4·8

By a most ingenious series of observations, Bragg has revealed some unexpected and interesting features attending the ionisation effects of the α rays upon gases through which they are projected. By measuring the amount of ionisation effected at different points along the path of the ray, Bragg and Kleeman have shown that at first, when the velocity is greatest, the ionisation effected is least, and that the amount of ionisation—that is, the number of ions created greatly increases just before the atom comes to rest.

Let the ray be supposed to move along the line AB—this line representing the range. If at each point of its

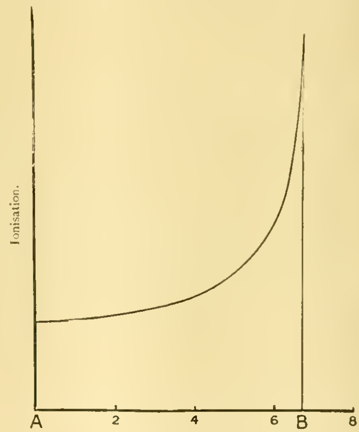


FIG. 1.—Range in cm. of air.

path we erect a perpendicular line proportional to the number of ions created by the flying helium atom, then, by joining up the ends of these lines, we obtain the curve shown. It will be noticed that a very well-defined maximum exists, after which the ionisation rapidly drops to nil. The curve reproduced is due to Geiger, who has added considerably to our knowledge of the subject.

Here is a small speck of the substance, pitchblende—the uranium ore from which radium is derived. All the elements of the uranium series are present. We are sure, then, that every α ray proper to this series, the ranges of which are given in the table, is being emitted by this particle of pitchblende. Let us form a mental picture of what is going on around it.[1]

Furthest out of all, the helium from radium C is projected. It attains a distance of 7 centimetres. The greater part by far of its ionisation is done near the end of its flight. Hence, remembering that these rays are darting radially in all directions from the piece of pitchblende, there is a shell of intense ionisation of spherical form existing around this pitchblende, and at a distance

[1] From a lecture delivered before the Royal Dublin Society on February 3, by Prof. J. Joly, F.R.S.

[1] This might, possibly, be realised by condensing water vapour upon the ions according to the method described by C. T. R. Wilson (Proc. R. S., June, 1911).

of between 6 and 7 centimetres from it. This is entirely due to radium C. Within this shell we have a spherical shell due to radium A. It is the next we meet as we go inwards. It has an extreme diameter of 4·8 cm. The next shell is created by emanation. Its radius is 4·2 cm. The shell due to radium F succeeds at 3·8 cm.; then comes that made by radium, and, lastly, a very intense one due to the nearly coincident effects of three rays, two due to uranium and one to ionium. The weight of this particle of pitchblende is about one-tenth of a gram. If all its rays escaped freely at its surface, some 9600 α rays would leave it per second, and the number of ions created in the air per second would be about 960 millions. The diagram (Fig. 2) shows the successive shells, as they could be formed in air, to half scale.

We shall now pursue the study of radiant matter within the confines of another branch of science—that which deals with the nature, origin, and structure of the rocks. We gain this much by the transfer, that the invisible effects we have just been endeavouring to picture to ourselves as taking place around a radio-active body in equilibrium may be studied at our leisure, visibly inscribed in the ancient rocks. We require the microscope, however, in order to carry on our observations.

If we extract a flake of brown mica from the granite near Dublin and look at it through the microscope, we

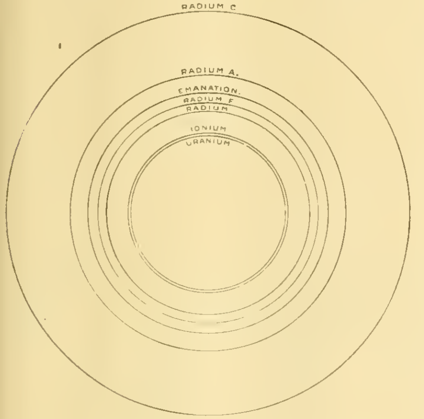


FIG. 2.

find here and there dark circular or disc-shaped marks. In the centre of each is a small crystal. This in most cases is the mineral zircon, which became enclosed in the mica at an early stage in the formation of that mineral. The dark area extends around the zircon like a darkened border, and, if the crystal is small enough, takes on the form of a perfectly true circle.

The remarkable occurrence of these dark circular spots, or "pleochroic haloes," as they are called, has been known to more than one generation of petrologists, and has always excited interest. Their origin has until lately been unexplained. Sollas, some years ago, prophetically stated his belief that they were to be ascribed to the presence of some rare earth in the zircon. When the minerals of the rocks were searched by Strutt for radio-active bodies, it was found that zircons were intensely radio-active—a concentration of uranium having in some manner taken place in these early formed bodies. The minerals apatite and allenite are also sometimes conspicuously radio-active, and around these, also, haloes often exist.

Let us then suppose that the halo is due to the radioactivity of the minute crystal around which it extends. We know that the radio-active elements in the zircon discharge helium atoms at high velocity into the surrounding mica. If these α rays have power to affect the mica by ionisation, just as they colour glass or affect a photographic plate, then there will be a certain region affected extending just so far as the rays can penetrate and no further. It will be a test of this explanation if the radius of the circular marks is found to be just the correct distance to which the rays could travel in mica.

Now Bragg and Kleeman have determined the principles upon which we may estimate from the observed ranges in air the range of α rays in any substance the chemical nature and density of which are known. Accordingly, we may calculate the ranges of several α rays in biotite. The table below gives the results.

Range in Biotite.

	mm.		mm.
Radium C	0·033	Thorium C	0·040
Radium A	0·023	Thorium X	0·026
Emanation	0·020	Thorium emanation	0·025
Radium F	0·018	Thorium B	0·023
Radium	0·017	Radiothorium ...	0·018
Ionium	0·013	Thorium	0·016
Uranium	0·013		

We see, as might have been expected, and as, indeed, was shown to you at the beginning of this lecture, that the mica is much more effective in stopping the rays than is the air. The extreme penetration of the rays from radium C is only thirty-three thousandths of a millimetre—a distance invisible to the unaided eye. This should be the limiting radius of a halo formed from the elements derived from uranium. If the thorium series was responsible, then we might expect haloes having a radius extending to the range of thorium C, that is, about forty thousandths of a millimetre. Now these are just the dimensions we find in the rocks when, by suitable appliances, we measure the sizes of haloes. Some have a radial dimension of 0·033 mm., and are then easily identified as due to the uranium series, and some scale 0·040 mm.; these are thorium haloes. Many scores of measurements confirm these results. Actinium haloes are not found; and this fact supports the inference already alluded to, that this element is derived from uranium as a very subordinate derivative, its effects being masked by the much greater vigour of the radiations from the radium series of elements. There is, then, no doubt, from the foregoing evidence alone, that haloes are the result of radiant matter.

It is of much interest to note that Rutherford has generated the equivalent of a halo in glass. In the course of experiments in which he had radium emanation contained in a capillary tube, the halo developed as a coloured border around the capillary, the radial dimensions being just such as corresponded with the penetration of α rays in glass. In the figure (Fig. 3), which I owe to the kindness of Prof. Rutherford, the central dark band is the capillary, the bordering narrow shaded area the halo.

It may also be mentioned that the experimental application of radium to biotite produces just such a darkening of the mica after some months as we see in the natural halo.

The circular or disc-like appearance of the halo is due to the fact that it is presented to us as the cross-section of a sphere. The true form is spherical. This is proved by the fact that when a crystal of mica is cut across the cleavage, the form is still circular (Fig. 5). This shows that the α rays are projected equal distances, or at least produce equal effects, along and across the cleavage—a fact not without considerable interest in itself, for it would hardly be expected on first consideration.

In the haloes which we have seen upon the screen there is no differentiation between the effects of the slower moving rays and those which move faster. The effects of the former must lie inside those due to the latter. The obliteration of the inner shells or spheres of ionisation is explained on the same principles as account for the loss of detail upon an over-exposed photographic plate. In the case of over-exposure the contrast is lost, because the effects of the lower lights have overtaken those of the higher lights, a uniform blackening ultimately resulting. If the radiant matter has been acting intensely on the mica for a very long time, the several shells of ionisation are merged in the accumulation of the feebler effects which are always progressing at all points along the path of the ray as shown in the Bragg curve.

We should expect, however, to meet cases where, either from the smallness of the quantity of radio-active material or from the recentness of the formation of the rock, there is a proper or correct exposure, so that the successive shells of ionisation, which we may picture to ourselves as surrounding a particle of pitchblende in air, would, as developed in the mica, be made visible to the eye. In this anticipation we assume that Bragg's laws apply to the ionisation of a solid.

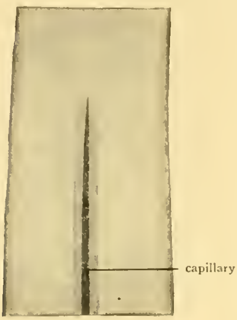


FIG. 3.

Now we do indeed find the several spheres of ionisation—or at least many of them—beautifully depicted in certain minerals, and thus we, at one and the same time, find additional, indeed overwhelming, evidence that the haloes are due to α rays, and also, what would be hard to establish experimentally, that Bragg's laws govern the effects in the solid medium.

Here is a group of well-exposed haloes in the biotite of co. Carlow. You see the outer ring due to radium C, and the gap of feebler ionisation between it and the shell due to radium A. We even find some which are actually "under-exposed." These often have got no further than the record made by the intense triple effect due to uranium and ionium. I show you this photograph again, but this time with an engraved scale of hundredths of a millimetre, which was photographed without disturbing the microscope; so that it is possible for you to verify the fact that the dimensions of the fully formed haloes are all over the plate alike, and just that which the radiant matter from the uranium series of elements would account for.

It is possible to trace the development of haloes by observation of those arising from a feebler and feebler central radiation. A succession of photographs taken to the same enlargement reveals that the innermost sphere is first formed. Then this widens under the rays from radium and emanation, and the outermost sphere, for some unexplained reason, often becomes conspicuous before radium A has produced much effect. The effects of the latter rays sometimes appear as a distinct ring.

We find a striking comment on the immense age of the haloes and of the containing rocks by a study of these objects, for it is easy to show that the growing haloes we have now been looking at are the accumulated effects of ionisation acting with extreme slowness. It is calculable directly that, even if we supposed the minute nuclei of some of these haloes to consist, not of zircon, but of the most radio-active ore known, pitchblende, the rate of expulsion of the α rays has, owing to the smallness of the quantities of radio-active substances involved, been fewer than eighty in a year. But this is not all. Some of the nuclei are identified with certainty as zircons. If we ascribe to these a radio-activity even greater than Strutt found in his highest measurements, one or more years would have elapsed between one expulsion of consecutive helium atoms and another. But geological time is long; and we may still recognise in the feeblest haloes the work of many millions of atoms of radiant matter, each exerting its own small effect, but these effects carefully preserved and accumulated. In short, we recognise the halo and detect its nature and origin on the same principles as we recognise by their light-effects accumulated upon the photographic plate the presence of stars invisible to the eye.

We find, then, in the rocks a record of the laws of radiant matter in the handwriting of the radiant matter itself—a record which took many millions of years to inscribe. Haloes are not found in the younger rocks. We must clearly recognise the halo as the result of the integration of effects of unimaginable feebleness; and as we see them in the Archæan granites, they probably date their beginnings from times long antecedent to the appearance of life upon the globe, not fewer than 100 million years ago.

They assure us, therefore, of the remote antiquity of the atomic instability which calls radiant matter into existence. But even more they tell us of the enduring stability of the ordinary elements. If the common and abundant elements which occur in and around the mica emitted radiant matter, even at the slowest rates, the clear transparency of the mica must long ago have vanished, and the whole become obscured under the effects accumulated during the ages which have elapsed since the formation of the rocks.

We seem entitled to conclude that the atomic stability and instability which we observe to-day have prevailed during geological time.

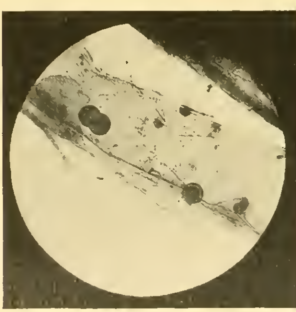


FIG. 4. Radium haloes in cleavage plate of biotite (co. Carlow); enlarged about 76 diameters. Two overlapping haloes are present, as well as a few under-exposed haloes.

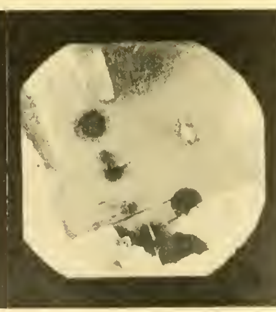


FIG. 5.—A radium halo (lower right-hand part of the field) and a thorium halo (upper left-hand part) in brown mica in a granite. The mica is cut across the cleavage. Enlargement about 114 diameters. The thorium halo shows an inner sphere due to the thorium X. The ratio of the diameters of inner and outer spheres will be found to be as 2·6 : 4·0.

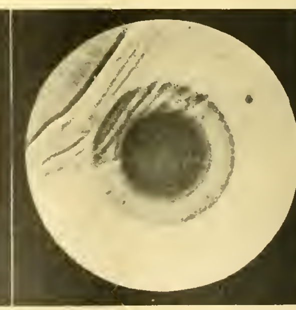


FIG. 6.—A single radium halo from the Carlow biotite. It is enlarged to about 500 diameters. The inner dark disc is due to emanation. The radium A sphere succeeds and appears to be less developed than that of radium C. Viewed on cleavage.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—A special degree congregation is to be held on July 27 in connection with the meeting of the British Medical Association, in Birmingham, at which it is proposed to confer the honorary degree of LL.D. on the following gentlemen:—The Rt. Hon. John Burns, President of the Local Government Board; Sir Francis Lovell, K.C.M.G.; Dr. R. H. Chittenden, professor of physiology in Yale University, U.S.A.; Prof. H. Oppenheim, Berlin; Prof. Paul Strassman, Berlin; Dr. Byrom Bramwell, president, Royal College of Physicians, Edinburgh; Dr. J. A. Macdonald; Dr. R. A. Reeve, professor of ophthalmology, Toronto; and Prof. Sims Woodhead.

IT is announced in *The Times* that the Chinese Minister has consented to become patron of the United Universities' scheme for a university for China. The Rev. W. E. Soothill has been appointed acting president of the university for five years. Mr. Soothill was formerly principal of the Imperial University, Shan-si, China, and is the author of standard works on the Chinese language.

THE French Physical Society, the International Society of Electricians, and other learned societies, are cooperating in the inauguration of a fund to honour the memory of the late M J. Joubert, of the Pasteur Institute. The object of the fund is to found a scholarship, with which the name of Joubert will be associated, tenable at one of the institutions with which he was connected as pupil or teacher. Subscriptions may be sent to M. Gauthier-Villars, 55 quai des Grands-Augustins, Paris.

THE issue of the *Johns Hopkins University Circular* for May takes the form of the "Johns Hopkins University Register, 1910–11." The historical statement with which the volume opens shows that the university was incorporated on August 24, 1867, and its original endowment amounted to about 600,000*l.* This fund has been supplemented by several gifts, including 200,000*l.* in 1902, until now the income-bearing funds amount to more than 900,000*l.*, the total assets being 1,300,000*l.* In June, 1909, the General Education Board offered to contribute to the university 50,000*l.* towards the endowment, provided the institution could secure, on or before December 31, 1910, a supplemental sum of 150,000*l.*, in cash or pledges. By the date mentioned the sum of 188,600*l.* was secured, more than sufficient to meet the condition imposed by the General Education Board. The Legislature of Maryland, too, has this year made a grant of 5000*l.*, which will be repeated next year.

THE fifteenth Oxford Summer Meeting will be held at Oxford from August 3 to 28. The general scheme of lectures is intended to illustrate the place and part of Germany in world history, and its contribution to literature, art, science, theology, and philosophy. The inaugural address will be given by Viscount Haldane. One section of the meeting will consist of lectures on the epoch-making names in German science. These discourses include: Humboldt, by Mr. H. J. MacKinder, M.P.; Helmholtz, by Sir Joseph Larmor, F.R.S.; Liebig and Bunsen, by Sir William Tilden, F.R.S.; Johannes Müller, by Prof. F. Gotch, F.R.S.; Von Bär—the founder of modern embryology, by Prof. G. C. Bourne, F.R.S.; the evolution of medicine in Germany, 1850–1900 (Virchow and Koch), by Sir W. Osler, F.R.S.; and Gauss and modern astronomy, by Mr. J. A. Hardcastle. There will also be a special class for instruction in field map-making under Mr. Mackenzie, and classes in educational psychology.

THE Royal Commissioners for the Exhibition of 1851 intend to put into operation at an early date a scheme of industrial bursaries. The scheme is as follows. The commissioners propose to establish a scheme of industrial bursaries for young men who, after a course of training in a university or approved technical college, desire to enter engineering, chemical, or other manufacturing works. The bursaries are intended to enable suitable applicants to tide over the period between their leaving college and obtaining remunerative employment in industry. The value of the bursary will depend on the circumstances of the candidate, but will, as a rule, not exceed 100*l.* a year. A bursar will be elected in the first instance for one year, but the tenure of his bursary will ordinarily be prolonged for a second year provided that the commissioners are satisfied with the work done by the bursar during his first year. In special circumstances a bursary may be renewed for a third year. The appointments to the bursaries will be made by the commissioners from among candidates recommended by the authorities of certain selected universities and technical schools. In dealing with these recommendations, great weight will be given to evidence that a candidate has the practical abilities likely to lead to his advancement in manufacturing work, academic success alone being an insufficient recommendation. The candidate must be a British subject under the age of twenty-five. The candidate must have been a *bona fide* student of science for a term of three years. The candidate must further satisfy the commissioners (*a*) that he has obtained, or can within one month of election obtain, a post in some engineering or other manufacturing works approved by them; (*b*) that he is in need of pecuniary assistance to enable him to accept such a post. A bursar may, if the commissioners approve, spend part of the tenure of his bursary in studying a special industrial process or processes in works either at home or abroad. No bursar shall enter a firm as a premium pupil without the special consent of the commissioners. A bursar must submit a report of his work to the commissioners on the expiration of each year of his bursary. Forms of application may be obtained from the secretary to the commissioners.

SOCIETIES AND ACADEMIES.

DUBLIN.

Royal Dublin Society, June 27.—Prof. T. Johnson in the chair.—Prof. G. H. **Carpenter**: Injurious insects and other animals observed in Ireland during the year 1910. The points of interest in this paper are the record of a second brood of the codling moth (*Carpocapsa pomonella*) in the south-west of Ireland, and the occurrence of the maggots of *Scaptomyza flaveola* and an unknown Cecidomyid on turnips in county Louth.—Prof. J. **Joly** and L. B. **Smyth**: The radium-emanation content of soil gases and its escape into the atmosphere. The emanation content of soil gas is measured by filling a suitably calibrated electroscope with gas drawn from certain depths in the soil. The rate of its escape at the surface of the soil is investigated by means of a collector, which covers a certain area of the soil, and beneath which a slow current of air circulates. The air current is finally led through a charcoal absorption tube. It is believed that natural conditions are best realised by this collector. It is found that the conditions favouring the maximum rate of exhalation are dryness and openness of the capillaries of the soil. These conditions also lead to a fall in the emanation-content beneath. In accordance with this, the daily readings of emanation-content and of exhalation at the surface when plotted show opposing curvatures. The amount escaping at the surface is very considerable. The rate of escape is often more than sufficient to account for the decay of the emanation in a radio-actively homogeneous atmosphere extending to a height of 5 kilometres, and possessing an emanation-content equal to the average found by Eve and others. Soil within the city of Dublin is found to contain less emanation and exhale less than soils in the suburbs. To the south of the city the soil is specially rich, the quantity of contained emanation near the surface per litre being such as would be in equilibrium with a quantity of radium of the order 10^{-9} gram, the quantity exhaled per square metre per hour being also of this order. The causes influencing the quantity of radium emanation in the soil are under investigation, as well as the influence of the emanation upon vegetable life.

PARIS.

Academy of Sciences, July 10.—M. Lippmann in the chair.—B. **Baillaud**: Remarks on a volume of the photographic catalogue of the sky, Paris zone.—M. **Renaut** was elected a correspondant for the section of anatomy and zoology, in the place of the late M. Armand Sabatier.—MM. **Lagrula** and **Schaumasse**: The Kiess comet, 1911*b*. Observations made at Nice. Three observations are given for July 8. The comet appears as a bright globular condensation surrounded by a nebulosity.—

M. **Javelle**: The Wolf comet. Observations made at Nice with the Gautier equatorial of 76 cm. aperture. Data given for July 5 and 7. The comet appears like a star below the 14th magnitude.—Silvanus P. **Thompson**: A new method of harmonic analysis by the algebraic summation of determined ordinates. The method described is specially adapted for the harmonic analysis of tides, of diurnal magnetic variations, and of the periodic motion of the mechanisms for the distribution of steam in steam engines.—G. **Sagnac**: Interferential strioscopy and striography analogous with the Foucault and Töpler optical method of striæ.—Ch. **Fabry** and H. **Buisson**: The radiation from mercury vapour lamps. The numerous applications of quartz mercury vapour lamps renders desirable precise measurements of the yield of radiation, visible and ultraviolet, under various conditions of employment. The proportion of ultraviolet rays emitted by a given lamp depends greatly on whether it is water-cooled or not, and also upon the age of the lamp.—L. **Benoist**: The application of the chemical harmonica to chronophotography. An acetylene flame, issuing from a fine jet, is placed in a glass chimney, and from the pure note thus obtained the time of vibration can be determined with considerable accuracy. A mirror is fixed to the rotating apparatus the velocity of which it required to measure. The high actinic power of the flame renders the application of photography very easy.—M. **Girousse**: A means of suppressing the troubles caused on telegraph lines by energy-carrying cables. A description of a simplification of the method proposed by Voisenat. The immunity obtained against an alternating current has been proved experimentally, and details are given.—R. **Boulouch**: The sine relation of Abbe is a condition of stigmatism. The condition of true aplanetism.—A. and L. **Lumière** and A. **Seyewetz**: The development of photographic images after fixing. If a very dilute solution of sodium thiosulphate is used for fixing, the Neuhauss method can be much simplified. The formulæ of the solutions taken are given, and also an alternative solution containing mercury salts instead of silver.—Marcel **Guichard**: The extraction of the gases from copper heated in a vacuum. The complete elimination of the gases from copper by heating is difficult to realise, and requires in all cases a very lengthy period of heating.—H. **Gault**: The lactonisation of the α-ketonic esters, α-ketoadipic ester, and in general, the esters of α-ketomonoacids and α-ketodiacids under the influence of condensing agents, forms lactones by the elimination of a molecule of alcohol between two molecules of the ester. Several examples are worked out in detail.—Ph. **Dumesnil**: The preparation of some unsymmetrical benzyl-dialkylacetic acids. Starting with ketones of the type $C_6H_5.CO.C(R_1R_2R_3)$, prepared by the method of Haller and Baur, the prolonged action of sodium amide in boiling xylene upon these ketones gives the amide $NH_2.CO.C(R_1R_2R_3)$, from which the corresponding acid is readily obtained by hydrolysis with sulphuric acid.—E. **Léger**: The constitution of some nitro derivatives obtained by the action of nitric acid upon the aloins.—A. H. **Richard**: A dimethylpentene obtained by the action of heat upon a dimethylcaoutchouc. Methyl-isoprene polymerises in exactly the same manner as isoprene. Under the influence of light and heat it gives a rubber-like mass: the dry distillation of the latter gives a homoterpene as the principal product.—M. **Gard**: Is the law of uniformity of hybrids of the first generation absolute? It has been found that for the genus Cistus the uniformity found by Naudin is not fixed.—J. E. **Abelous** and E. **Bardier**: The influence of oxidation on the toxicity of urohypotensine. The toxic power of urohypotensine is increased by oxidation.—H. **Bierry** and J. **Larguier des Bancels**: The action of the light emitted by the mercury lamp upon solutions of chlorophyll.—M. and Mme. **Lapicque**: The useful duration of the discharges of condensers: experiments on the snail.—A. **Imbert**: A graphical study of work done by a file. The curves obtained showed clearly the differences between an apprentice and a practised workman: pathological conditions in the latter are also clearly brought out, a fact of medico-legal importance.—J. **Bergonié**: The respiratory exchanges in chronic articular rheumatism and the modifications which they undergo by muscular exercise electrically stimulated. The respiratory exchanges, in subjects affected by chronic articular rheumatism, are very appreciably lowered, in one case to about 3/5 of the normal. The light bath appeared to be without any influence on these cases, but muscular exercise, electrically stimulated, caused these exchanges to approach the normal.—Jules **Courmont** and A. **Rochain**: Vaccination against the pyocyanic infection by the intestinal method.—A. **Sartory**: The value of Meyer's reagent in the examination of the blood. Meyer's reagent ought not to be considered as a specific test for blood in chemico-legal researches, and should only be used for corroborative purposes.—A. **Fernbach** and M. **Schœn**: Some observations on the mechanism of the mode of action of the proteolytic diastases.—Alexandre **Lebedeff**: The mechanism of alcoholic fermentation.—J. **Wolff** and E. **de Stœcklin**: The specificity of various combinations of iron from the point of view of their peroxidasic properties. A reply to some criticisms of H. Colin and A. Sénéchal, the authors giving the results of fresh experiments in support of their views.—Paul **Hallez**: The double function of the ovaries in some Polyclads.

CONTENTS.

THURSDAY, JULY 27, 1911.

THE ENCYCLOPÆDIA BRITANNICA.

The Encyclopaedia Britannica: a Dictionary of Arts, Sciences, Literature, and General Information. Eleventh edition. Vols. xv.–xxix. (Italy—Zymotic Diseases, and index volume.) (Cambridge: University Press, 1911.)

A GENERAL notice of fifteen volumes of the dimensions of "The Encyclopædia Britannica" can, at best, be based only on a process of "browsing" through them, and of turning to a subject here and there as it strikes the mind. In these volumes there is ample scientific material on which to examine two claims that have been put forward on behalf of the work on general grounds. The first is that its use as a work of reference purely, for the discovery of one isolated fact or another, is not its only use, not even its primary use, since for this purpose a reference book of less ample size probably fulfils any demand that the ordinary inquirer is likely to make. Not that "The Encyclopædia Britannica" fails in this object; the number of its article headings is well known to have been enormously increased in the present edition, every judicious addition of a heading adds to its value as a work of reference simply, while the existence of an index volume, though somewhat elaborating the mechanical process of discovering an isolated fact, eliminates the necessity of exercising imagination in finding information to which no article heading directly points. But beyond this, it is claimed that the work is usable by readers as a library in itself, and, secondly, that the desire to make it thus usable has justified the new editorial policy of making the articles under the broad scientific or other headings, not exhaustive treatises on the whole of each subject, but, wherever possible (it is not always so), comparatively brief notices confined strictly to main lines, and indicating to the reader the further headings to which he may turn if he desires to pursue the subject. Another most important aid in this pursuit has been given, as will presently be seen, as a new feature of the index volume.

A few of the articles under general scientific headings in the second half of the volumes may be taken as illustrating the above thesis. Dr. A. N. Whitehead's article on mathematics covers little more than four pages; it defines the science, briefly reviews its history, and indicates its scope and application, and in doing the last it indicates upwards of fifty other headings, under which any branch of the subject may be pursued. Dr. Max Verworn's notice on physiology is laid out on similar lines; anatomy, cytology, digestive organs, respiratory system, touch, smell, taste, vision, hearing, plants (physiology), are a few of the branch lines to which this concise summary shows the way. In the article on zoology, Sir E. Ray Lankester writes at greater length, it is true, than do either of the authors just named in their general treatises, but he does not go outside the history of the whole subject, with particular reference to the various important systems of classification which have been laid down, leading up to that adopted in "The Encyclopædia Britannica" itself. It may be added here that the editors have not feared the adjectival heading (a form open to much abuse in reference books, as such headings are not easy of preconception by the reader) when it appears appropriate, from the point of view of the specialist, to a clearly defined compartment of a general subject. Thus Zoological Distribution and Zoological Nomenclature are very properly made the headings of separate articles, instead of being made great sections under the general heading of zoology. The one is dealt with very clearly by Mr. Lydekker, who has contributed a great mass of zoological matter to the whole work; the other is by Dr. Chalmers Mitchell, who incidentally gives his high authority to the subject of zoological gardens.

The index has in a large degree followed the model of that provided in the tenth edition, but certain obvious improvements have been introduced. By the use of a distinctive type it is made clear when any index heading is also an article heading in the text. The reader is thus able to appreciate at once that any references which follow under such an index heading are merely supplemental to the article itself, and it would appear that a more judicious selection of such "casual" references has been made than was made in the index to the last edition. Indeed, some of the larger blocks of index references, as, for example, those dealing with the history of large countries, have obviously been made, not by simply collecting and editing the references gathered by independent indexers in the course of their work, but by means of a selection (by one hand) of the verbal references which a user of the index would naturally expect to find, and the subsequent attachment of the proper page and volume numbers to them. This must have involved a great deal of research, and as such work was dependent upon the completion of the whole of the text, it may be said that the index has been issued with laudable promptitude.

But the new feature of the index volume referred to above, as an aid to the pursuit of a given broad subject through the whole of the work, is perhaps more worthy of praise than the index itself. This is the classified list of articles, which the editors "believe to be the first attempt in any general work of reference at a systematic catalogue or analysis of the material contained in it." Under such broad divisions as art, biology, geography, history, medical science, physics, &c. (there are twenty-four of these divisions in all), and under appropriate departments within each, practically the whole of the article headings in the "Encyclopædia" are classified and subclassified, so that a reader who wishes for a bird's-eye view of all the article headings in the department (say) of pathology, therapeutics, and surgery, can turn up that group and see them at a glance. This is a most important addition to the use of the "Encyclopædia," not as a work of general reference, but as a special encyclopædia on any given subject. Incidentally it furnishes perhaps a more remarkable conception of the magnitude of the work than do even the textual volumes themselves; the department of pathology, therapeutics, and surgery alone is found to contain nearly 250 separate articles, exclusive of biographies (which are always classified together at the end of each main division or department). The editors of the list have evidently been faced with an exceedingly difficult problem in allocating some of the headings to their most appropriate department; any system of duplication which would have allowed every department to indicate every article which had any bearing upon it would have become hopelessly cumbrous, and those who use this list may sometimes have to turn from their own special subject to a kindred department. But the whole list is so clearly arranged that this process presents no difficulty.

It would be improper to attempt a detailed notice of any one branch of science in a general survey of a series of volumes which include such notable contributions as the article on Palæobotany by Dr. D. H. Scott, Prof. Seward, and Mr. Clement Reid; Prof. H. F. Osborn's Palæontology; Mr. Leonard Spencer's Mineralogy and Prof. J. F. Kemp's Mineral Deposits; Dr. Stockman's Pharmacology; Prof. Poynting's article on Sound; Magnetism, by Shelford Bidwell, and Terrestrial Magnetism, by Dr. Chree; Map by Dr. Ravenstein and Col. C. F. Close; Prof. Abbé's Meteorology; Ocean and Oceanography, by Dr. H. R. Mill and Prof. Krümmel, and a host of others. But it is possible to refer in general terms to the satisfactory character of the illustrations which classify so many of these important treatises, from the admirable textual sketches which serve to illustrate the main features of some of the remarkable ancient maps described by Dr. Ravenstein, to the coloured plates accompanying the articles on pathology and parasitic diseases. The coloured plates are for the most part exceedingly good; most of them (such as the beautiful Orders of Knighthood, in the preparation of which King Edward VII. took so great an interest) fall outside the scientific articles. Reference, however, may be permissible to the admirable illustration under "Process" of the four stages of the three-colour process, worth far more than its bulk in textual explanation. The half-tone reproductions can only be criticised on the score of occasionally showing evidence of printing at high pressure, while there are some faults of manufacture—in the volumes before us we have happened upon one plate bound in duplicate, while a certain plate-map which is indexed does not appear. But as a whole the half-tones are excellent, and some which call for high detail, such as those illustrating "Lace" or "Pathology," are beyond praise. Engineers will value the cosmopolitan series of plates and line diagrams in the articles on ship and shipbuilding, to which Sir Philip Watts and the Rev. Dr. Warre have contributed. The line drawings throughout the work have printed satisfactorily on the thin paper, and the fineness of some of the zoological drawings (for example), or those illustrating Mr. A. H. Smith's article on jewelry, is admirable.

It will be understood that the examples named are chosen at hazard out of hundreds, for the illustrations, if their treatment by the manufacturers is open to the criticisms already made, afford evidence of systematic editorial arrangement and of no sparing hand on the part of the publishers.

The statistician has found less material for his use in the present than in past editions of the "Encyclopædia." It is no doubt a misfortune that the publication of the whole work had to be timed a little in advance of a period at which there became available that most important series of statistics, the decennial census returns. But the editors have deliberately disregarded (save in exceptional cases) the often deceptive intercensal estimates of population. In other departments it would probably have passed the wit of man to devise mechanism for the insertion of the latest figure in every statistical statement in twenty-eight volumes published almost simultaneously, even if it had been thought desirable, which (as the "Encyclopædia" is not an annual publication) it was not. But whereas the notices on the divisions and towns of the United Kingdom and the United States have been relieved of a considerable mass of statistics, the two general articles under these titles have been made the receptacle of a large number of figures, brought down to the latest available dates, which, being set in tables or other comparative forms, will probably be of use to a greater number of readers than if they had been distributed through the lesser articles.

The principal conclusion of a general survey of the completed work is that the editors deserve to have it realised that they have made a library—not only a dictionary—not a year-book. The work may contain some errors of detail, whether the result of the march of events during its compilation, or simply of a compiler's human fallibility; it would be beyond human work if it did not. But it appears to be surprisingly free of editorial misjudgment in respect of the selection of article headings and the apportionment of space to every department of knowledge. The existence of the classified list shows that the editors are not afraid of exhibiting their selection, and the reader who finds an apparent gap in it will probably discover on reference to the index that the subject he seeks is really an indivisible part of a wider one. And by following this process he will probably be paying the makers of the "Encyclopædia" the compliment of using it as they intend it chiefly to be used.

COMPARATIVE ANATOMY.

Vorlesungen über vergleichende Anatomie. By Prof. O. Bütschli. 1 Lieferung, Einleitung; Vergleichende Anatomie der Protozoen; Integument und Skelet der Metazoen. Pp. viii+401. (Leipzig: W. Engelmann, 1910.) Price 12 marks.

THE method of studying comparative anatomy that will ever be associated with the honoured names of John Hunter and Gegenbaur appeals strongly to the student of medicine, and those who specialise in human anatomy, as being the most interesting and instructive way of learning the significance of the animal economy. The comparison of homologous structures in the whole range of the animal kingdom and the realisation of their varying development and differing arrangement throw light upon their functions, and in our day explains the process of evolution of complex from simple structures. John Hunter embodied this method in the arrangement of his museum; Gegenbaur developed it in his lectures and his books.

But many systematists, whose chief aim in life is to study the differences with which they hedge round their multitudes of species, view with suspicion a method of studying zoology which lays chief stress upon the resemblances that help us to link together the various members of the animal kingdom.

Thus Prof. Bütschli's text-book, continuing as it does the best traditions of the famous Heidelberg school, is sure of a warm welcome from the morphologist, whatever view the species-monger and the devotees of the type-system of teaching zoology may think of it.

It was with mixed feelings that those who had been "brought up" on Gegenbaur's great book and had come to revere the great master, read the new edition of the Comparative Anatomy which was issued twelve years ago, after he had passed three score and ten years. When a man has reached that age it becomes impossible to keep in touch with all the manifold ramifications of such a science as morphology, even when, as in the late Prof. Gegenbaur's case, he had grown up with it and taken a principal, if not the leading, part in making the new branch of learning.

It required a younger man to write the new and simplified book that was urgently wanted; and no one was more fitted to undertake this task than Gegenbaur's pupil, who took charge of the course of lectures in zoology at Heidelberg in 1884, when his teacher relinquished the task. It is these lectures which are embodied in the book under consideration. The English student who may have spent weary hours trying to puzzle out the meaning of some of Gegenbaur's cryptic German and involved sentences will appreciate the lucidity of Bütschli's style and the ease with which his meaning can be grasped.

This volume represents only the first part of the text-book, and consists of four sections:—(1) An introduction, explaining terminology, and the scope and general conceptions of comparative anatomy; (2) a very complete, yet concise, summary of the distinctive features of all the considerable groups of animals; (3) the comparative anatomy of protozoa; and, finally (4), more than three-fourths of the volume are devoted to the account of the tegumentary and skeletal systems.

The integument and its various specialisations, scales, hairs, feathers, and glands, receive very full treatment. This is all the more welcome and valuable, as this branch of anatomy suffers from neglect more often perhaps than any other. A great mass of information concerning both invertebrates and vertebrates is crowded into a comparatively small space without any sacrifice of clearness.

After a general discussion of the nature of skeletal structures and the forms they assume in invertebrates, the early forms of the notochord are described, and then a succinct account is given of the forms assumed by each bone of the skeleton in the vertebrata.

One of the great features of this book is the abundance and the excellent educational value of the illustrations. Although they consist of semi-diagrammatic line drawings or half-tone reproductions of simple drawings, they are so free from unnecessary and confusing detail, so clearly labelled and really illustrative of the text, that the reader experiences no difficulty in following and understanding the descriptions.

Prof. Bütschli can be congratulated on having produced the first part of an introduction to comparative anatomy which is both of exceptional scientific merit and singularly well adapted to the needs of elementary students.

G. E. S.

THE BENIN GROUP OF NEGROES.

Anthropological Report on the Edo-speaking Peoples of Nigeria. By N. W. Thomas. Part i., Law and Custom. Pp. 163. Part ii., Linguistics. Pp. ix+251. (London: Harrison and Sons, 1910.)

THE Niger Delta, from Yorubaland on the west to the Cross River on the east, is a field of African ethnology which is only very slightly made known to us at the present day, but promises to yield some very interesting and important additions to our knowledge of negro races, when fully worked. Owing to its physical conditions, the area covered by the delta of this river—some 260 miles by 100—is still unexplored in some portions; indeed, down to about fifteen years ago the land everywhere at a distance of one mile from the banks of the navigable creeks had scarcely been seen by a European. Though there are within the delta tracts of undulating, well-drained soil much of the district is excessively swampy or covered with very dense bush, scrub, mangrove thicket, or magnificent but impenetrable forest. Mosquitoes and large Tabanid flies swarm and the former serve to inoculate the blood of the European with the germs of malarial and black-water fever. Yet (I write from old personal experience) where there is no native population at hand to supply from its blood the malarial *bacilli*, the Niger Delta is not necessarily unhealthy to Europeans, and the stinking mud around the mangrove swamps, though it smells mephitically, is not, so far as we know, the cause of any disease.

In addition to the great difficulties of land-transport, which hitherto have limited the routes of the Delta explorers to the water-courses, the disposition of numerous tribes is still very hostile to the European. Consequently from one cause and another, a wholesome fear of savage cannibals and poisoned arrows, of enormous crocodiles, of thunderstorms, lightning, torrential rain and tornadoes of wind, of a sunshine which is sometimes sickeningly hot, of sparsity of food supplies, and dread of fevers and dysentery, we are still very deficient in our knowledge of the tribes of the Niger Delta. Rumours of late from well-informed sources point to the existence in the region between the Forcados and the Nun of a pygmy or dwarfish people said to be yellow-skinned and steatopygous, and speakers of a "clicking" language; from the Rivers Pennington and Middleton comes a singularly savage and prognathous type of negro, so wild and barbarous that it is still (I am informed) difficult to get speech of them.

In addition to these unclassified folk of the least-known part of the Delta (Forcados to the Nun), the negroes of the Niger mouths and their accessory streams are now arranged in the following ethnic groups. Beginning on the west, the Edo or Benin peoples, treated of in the book under review; the Jekri on the south or south-west of these; the Ijō, south-east of the Edo (Sobo), and especially in the eastern part of the main delta, between the Nun mouth and Opobo; the Ibo, north of the Ijō; the Arō ruling caste (almost semi-Caucasian in their physiognomy and skin-colour), between the Ibo and the Cross river; and the semi-Bantu Kwō and Akwa tribes between the Opobo and the Efik people of Calabar. Some of the Arō men and women resemble the Fula in their clear-cut, delicate profiles, their thin, well-formed lips, and lithe, finely-shaped bodies; and (as already remarked) there are savages from the western part of the delta, which, to the reviewer, seemed of an exceptionally low and brutal type.

The Edo-speaking people of the ancient kingdom or confederation of Benin are mainly the subject of Mr. Northcote Thomas's monograph, though allusions to and some comparisons are made with certain of the other tribes of the Delta and with the Yoruba of Lagos hinterland. Linguistically and racially the Edo group seems to be allied to the Yoruba and also to the E'we family (of Dahome). Their somewhat remarkable civilisation (like that of the Arō and Efik to the east and south, so strikingly superior to the barbarity of the Ijō and Kwō) has come to them from the north and north-east, and may perhaps be traced back to the Songhai culture of mediæval Nigeria.

Mr. Thomas has very little to say about the bronze-casting which has made the culture of Benin famous in ethnology. It seems to have died out almost entirely amongst the Edo people of to-day, who confine themselves to forging brass and iron ornaments and implements.

The work under review deals in part i. first with the affinities of the Edo people and the surrounding tribes, so far as there are any. Then comes a brief sketch of the Edo speech, followed by ethnological notes on this people, between pp. 11 and 123; an appendix on the pronunciation of the Edo speech, together with sample vocabularies for filling up by other inquirers. Also there is an interesting appendix on genealogies and terms and degrees of kinship; and another on suggestions, for other anthropologists, as to the best procedure in photographing African peoples. (Though not without interest these appendices on linguistics and on photography are disappointing to the already trained ethnologist, who expects Mr. Thomas's book to be entirely filled with the results of his own researches.) Part ii. contains (*a*) a number of interlineally translated texts to illustrate the Edo, Ishan, Kukuruku (and numerous dialects), and Sobo languages; (*b*) a grammar of the Edo (Bini, Benin) language; (*c*) a comparative dictionary of the Edo languages and dialects; and (*d*) an Edo-English dictionary.

The index comes near the end of the first part, and is singularly poor and inadequate. It is strange that this should be so in a work which is sufficiently good and important to merit very full indexing. For it may be said without more ado that Mr. Northcote Thomas's study of the Edo-speaking people will take a prominent place in ethnological works dealing with the negro. It is all first-rate, first-hand information, and errs only by omission and not by commission. Particularly valuable are the sections dealing with religion and magic; with marriage and birth customs; with native law and trial by ordeal; and the notes on the native calendar. The texts taken down from the many native informants not only exhibit the exact structure of the different languages, but illustrate very effectively the subject-matter of negro stories, the somewhat gross indecency of speech in regard to certain legends, and in general the outlook on the world around them of negroes that have hitherto been almost entirely uninfluenced by the modern European.

In arranging the English version in his comparative dictionary, Mr. Thomas should have invited the assistance of someone acquainted with African zoology. There are no "pheasants" or "crow pheasants" in Africa, and no "badgers." H. H. JOHNSTON.

COLOUR AND CONSTITUTION.

Die Beziehungen zwischen Farbe und Konstitution bei organischen Verbindungen. By Prof. H. Ley. Pp. viii+246+Taf. ii. (Leipzig: S. Hirzel, 1911.) Price 7 marks.

MANY chemists will welcome Prof. Ley's work on the relations existing between selective absorption and constitution in the case of organic compounds. The subject has attracted considerable attention of late years, and probably more definite conclusions would have already been reached had physicists rather more knowledge of organic chemistry and organic chemists a better acquaintance with physical conceptions.

The work is divided into two parts, 204 pages being devoted to the subject indicated in the title, whilst the remainder of the book deals with the methods of spectroscopic work. Prof. Ley insists at an early stage on the necessity of making no distinction in kind between selective absorption in the visible and ultra-violet regions of the spectrum, and proceeds to a consideration of Beer's law, "extinction-coefficient," and the influences, such as concentration, solvent, and temperature, which cause variation in absorption spectra.

In dealing with the different theories which have been proposed to account for the colour of organic compounds, Prof. Ley starts with the early efforts of Graebe and Liebermann and of Witt, and divides the chromophors into eight groups. One cannot fail to be struck with the universal existence of conjugated double linkages in compounds which show selective absorption, though in the ketenes chromophoric properties seem to be associated with adjacent double linkages. The triple linkage, on the other hand, seems to have little effect, and benzoylphenylacetylene is a colourless compound. The quinonoid constitution of many coloured compounds and H. Kauffmann's more recent development of the auxochrome theory are then discussed, whilst considerable attention is devoted to the influence of the solvent and the variation of the position of absorption bands which is likely to be produced by association of solvent with solute. Due recognition is given to the importance of the work now being carried out by Purvis on the selective absorption of substances in the state of vapour, in which case the influence of solvent is quite eliminated.

Considerable interest attaches to the attempted physical explanation of selective absorption, and use is made of the mass of experimental material accumulated by Hartley, Baly, and others. Baly's idea of "isorropesis" does not commend itself to the author, who is in favour of an electronic theory.

As may be expected in a book written in the Leipzig laboratory, much attention is given to the quinonoid rearrangement frequently assumed when a change in colour accompanies salt formation. One might gather from this portion of the work that "chinoide Umlagerung" was specially associated with Leipzig; *e.g.* on p. 169 one finds regarding phenolphthalein :—

"Der Beweis, dass den Salzen chinoide Konstitution zukommt, beruht auf der Existenz zweier verschiedener Äther. Neben dem farblosen laktoiden Dimethyläther existiert ein roter chinoider Äther, der zuerst von Green und King dargestellt und eingehend auch von K. H. Meyer und Hantzsch, untersucht wurde."

One would scarcely realise the great importance of Prof. Green's work on the phthaleins by reading this passage; and it may be pointed out (see pp. 176–7) that the hydroxy- and amino-azo-compounds have engaged the attention of several workers.

The colours of complex salts introduces some inorganic chemistry, whilst in the last few pages—devoted to method—spectroscopes, spectrographs, &c., are described, and an outline of the manner of working with these instruments is given. J. T. H.

THE NON-METALLIC MINERALS OF ECONOMIC VALUE.

Die wichtigsten Lagerstätten der Nicht-Erze. By Dr. O. Stutzer. Erster Teil, Graphit, Diamant, Schwefel, Phosphat. Pp. xv+474. (Berlin: Gebrüder Borntraeger, 1911.) Price 16 marks.

THIS work is designed to supplement the treatise of Prof. Beck on "Mineral Veins and their Contents," by giving an account of the deposits of those useful mineral substances which are not classed as "ores." The first volume, now published, is evidently the fruit of a vast amount of labour and bibliographical research, and deals only with four classes of materials, to each of which the amount of space devoted is as follows—graphite, 88 pages; diamonds, 94 pages; sulphur, 81 pages; and phosphates, 198 pages. In the case of each of these materials, the author, after preliminary notices of its mineralogical characters and modes of occurrence, proceeds to compile from the most varied sources descriptions of each of the districts in which it occurs. These descriptions are illustrated by page blocks (of which there are no fewer than 108 in the volume) giving sketch maps, sections, drawings, and photographs. Very miscellaneous information is supplied in these accounts of localities, including statistics of annual yield with prices and total values, and even, in some cases, examples of forms of agreement between sellers and buyers. In the case of the South African diamond fields, however, these statistics are, unfortunately, not brought down to later date than the year 1908.

As a rule, the references to authorities are ample and satisfactory, but we notice some marked exceptions. The author's acquaintance with British scientific literature would appear to be much more limited than his knowledge of German, American, and even Japanese sources of information. Thus a section of the Upware phosphatic beds is stated to be "after W. Keeping-Penrose," and the puzzled English reader is left to find out that the information about British deposits is obtained, at second hand, from a Bulletin of the United States Geological Survey, written by Mr. R. A. F. Penrose, jun., in 1888! We are reminded of the ingenuous remark of a compatriot of the author, who, when it was pointed out to him that a research he had published had been long before anticipated in this country, said, "Ah, that was buried in the catacombs of the Royal Society's Transactions!" In like manner, we find that Mr. Teall's interesting account of the phosphatised trachyte of Clipperton Atoll, published in the Quarterly Journal of the Geological Society in 1898, is ignored, while many less interesting deposits in the Pacific are fully described.

After the discussions of the distribution and statistics of the materials in the various districts, the author proceeds to consider such general questions as their origin, artificial formation, and metamorphoses. The treatment of these more purely scientific problems, however, is quite subordinate to that of economic and statistical questions, and little of novelty or special interest is to be found in these sections of the book.

An exception to this may, perhaps, be found in the useful abstract, on pp. 254 to 262, of the views that have been put forward concerning the origin of beds of sulphur, including the possible production of some of these deposits through the agency of bacteria, like Beggiatoa and Chromatium. On the whole, however, the work is to be commended for its technological rather than its scientific value.

ELECTRICITY AND MAGNETISM.

(1) *Beispiele und Uebungen aus Elektrizität und Magnetismus.* By Prof. R. Weber. Fünfte Auflage. Pp. viii+330. (Leipzig and Berlin: B. G. Teubner, 1910.) Price 4.80 marks.

(2) *Experimentelle Elektrizitätslehre, verbunden mit einer Einführung in die Maxwellsche und die Elektronentheorie der Elektrizität und des Lichts.* By Prof. H. Starke. Zweite Auflage. Pp. xvi+662. (Leipzig and Berlin: B. G. Teubner, 1910.) Price 12 marks.

(1) THIS is a collection of nearly nine hundred examples in electricity and magnetism. They are all numerical in character, and each is completely

worked out. Where required, the exercise is explained by means of a diagram. It is recognised that certain preliminaries are required to enable the student to understand electrical problems, and, to this end, the earlier questions relate purely to mechanics, hydrostatics, and heat. The examples are very varied in type, and include cases of interest, both theoretically and practically. There follows a short section in which the various mechanical, thermal, and electrical units are defined, and the book concludes with numerous tables, in which these units are collected, together with others giving the values of the various physical constants required in the working of the exercises.

It is somewhat doubtful whether the procedure of asking a question and at once giving the answer can be of much benefit to a student. It surely tends to discourage the use of the student's own initiative. A few illustrative worked examples should suffice, the rest being left for the learner to undertake.

The book is well printed, but it may be mentioned that some six of the introductory pages are missing from the copy submitted to the reviewer; it is to be hoped that this mistake does not extend to the whole edition.

(2) The second edition of this excellent treatise on electricity and magnetism, by Prof. Starke, has been brought thoroughly up to date by the addition of numerous paragraphs and chapters. Besides all the experimental and theoretical considerations usually found in text-books on this subject, many special electrical applications are deal with at length. Particular attention is given to the production and properties of electro-magnetic waves and to the practical uses of the latter in wireless telegraphy and telephony. As indicated in the title, the electro-magnetic theory of light is also dealt with, especially the explanations of the various optical phenomena upon the electron theory. In the thirteenth chapter this theory is extended to thermal and electrical conduction, and to the different thermo-electric effects. The section devoted to the conduction of electricity in gases has been largely added to, so that most of the latest work in this department of physics is considered. The new chapter on radio-activity gives a brief general outline of the rapidly progressing work which has been done in this direction, and includes a table giving the various radio-active substances at present known, their life-periods, types of rays, and physical properties. Finally, the author devotes an appendix of considerable length to the theory of moving electrons and the principle of relativity.

In every respect this book has claims to be regarded as a standard work on electro-magnetism. The alterations and additions in this edition have brought it, as far as possible in a general text-book, to the level of modern scientific research. To all those desirous of becoming acquainted with the present state of knowledge in this subject it can therefore be thoroughly recommended. It may also be mentioned that the type, diagrams, and paper are excellent.

CELLULOSE EPHEMERIDES.

Literatur der Zellstoff- und Papier-Chemie und der Papier-Technik im Jahre 1909. In Auszügen dargestellt. By Prof. C. G. Schwalbe and A. Lutz. Pp. 158+xix+94. (Berlin: Gebrüder Borntraeger, 1911.) Price 5 marks.

Zur Kenntnis der Cellulosearten. By Dr. W. Schulz. Nebst einem Vorwort, by Prof. C. G. Schwalbe. Pp. vi+100. (Berlin: Gebrüder Borntraeger, 1911.) Price 3.20 marks.

THESE publications are indicative of the extraordinary specialisation of cellulose chemistry, and at the same time of a tendency to intensive elaboration of detail in investigation, and more particularly of records, which, however interesting to the specialist, are drawn in too narrow a perspective to rank in the general literature of the science.

The former is a bibliographical record, sufficiently defined by its title. It is produced under the auspices of a youthful technical society, the "Verein der Zellstoff- und Papier-Chemiker," which is doing much useful work, and very fully justifying its foundation and existence. The matter of the volume is exhaustive, the records take the form of abstracts, which are duly concentrated and presented under a well-considered scheme of classification, with full indexes.

The second volume is a record of research towards establishing a method of diagnosing the more important industrial celluloses in terms of differentiating factors. This work is evidently inspired by Prof. C. G. Schwalbe, and in a short preface he claims for the author's results at least a definite promise of achievement, a claim which is somewhat at variance with the conclusions recorded *en résumé* on pp. 85–86, 99–100; these are rather of negative import.

The main scheme of investigation is a study of acid hydrolysis, taking as a measure of the degree of hydrolysis the reactions of the products with alkaline cupric oxide (Fehling's solution), and as a first stage (*a*) combination in the cold with cupric oxide (hydrate), and secondly (*b*) reduction to cupric oxide, on boiling.

The quantitative determinations are recorded under a special nomenclature, thus:—"Cellulosezahlen" (*a*) "Korrigierte Kupferzahlen" (*b*–*a*); and after the particular hydrolytic treatment "Hydrolysierzahl" (*b*′) and "Korrigierte Hydrolysierzahl" (*b*–*a*′).

The numbers recorded for a selection of ten typical marks of sulphite celluloses are, as the author admits (*loc. cit.*), unconvincing. An *a priori* consideration of the method would, we think, have enabled the author to predict the generally inconclusive result. It has been long established that the hydrolytic resolutions of cellulose can proceed very far under the action both of acids and alkalis without liberating CO groups. It is clear therefore that cupric reduction is only a partial measure of cellulose hydrolysis. And generally oxidations by alkaline cupric oxide are highly complex reactions, even the classical reactions with the sugars are by no means well defined, and remain therefore of essentially empirical order. Without detracting in any way from the author's results as quantitative observations, we suggest that they should have been recorded in simple terms, that is, without the adventitious aid of a special nomenclature, which merely obscures their significance.

A more important section is that devoted to a careful study of the supposed total hydrolysis of cellulose to hexose groups, and the implied problem of fundamental constitutional import. The author rightly recognises that the experimental verifications of the view that "cellulose is a polyhexose anhydride," are wholly defective; indeed, with progress in investigation the actual yields of sugars or their immediate derivatives obtained from (cotton) cellulose are extremely variable and generally much below the statements of the earlier observers, Braconnot, Béchamp, Flechsig.

The later investigations of Ost and Wilkening indicate that the hydrolysis is complicated by the formation of acids of low molecular weight, and their results with the author's present contribution undermine the plausible assumption that cellulose is a close analogue of starch.

In his study of the hydrolysis of the normal cellulose, the author has taken as his starting point the well-known intermediate products obtainable as colloidal hydrates, thus Guignet's "Cellulose Colloide," Flechsig's typical "Amyloid," "Parchmentised Cellulose," and Ekström's so-called "Acid Cellulose." These products, tested in relation to Fehling's solution, and the particular scheme of hydrolysis previously described, gave extremely variable numbers, thus for the "Korr: Hydrolysierzahl" 7·3, 26·7, 17·6, 30·4, for the products in the above-named order. Following the section devoted to a careful study of these proximate products, is the complementary section on "Die Abbauendproduckte der Baumwollecellulose und des Sulfitzellstoffs."

From the preface (Schwalbe) we abstract the important result of these laborious observations, which is that the author obtained from cotton cellulose only 40 to 50 per cent. of its weight of the hexose (dextrose), either as such, or calculated from the yield of ozazone, and from sulphite celluloses less than one-half this yield.

This work we commend to the careful study of those who take a special interest in cellulose chemistry. In this case also we can commend the author's minutely detailed record of experimental conditions, which are quite essential. The only criticism we offer is that the work would have been more fruitful if spread over a smaller range of the intermediate products.

The differentiation of these is relatively unimportant. The concentration of the investigation upon the endeavour to account in any one case for the 100 parts of cellulose taken into work, in terms of the final products of hydrolysis, would have furnished a much more valuable and positive contribution to *the* fundamental problem.

As a further suggestion, the resolution of the acetate or "Acetolysis" of cellulose appears to be more promising of attaining to ultimate hydrolysis, the elimination of OH groups keeping the breakdown of the complex on simpler lines of cleavage (comp. W. Schliemann, *Annalen*, 378, 366, 1911).

Much work is being done in this direction, and we may expect before long to integrate the contributions from the two directions of experimental study into comprehensive schematic constitutional formulæ for the typical celluloses. We may anticipate from this a new light on "organic" chemistry in the full sense of the term.

OUR BOOK SHELF.

The Law of Sex Determination and its Practical Application. By Laura A. Calhoun (Mrs. E. E. Calhoun). Pp. 254. (New York: The Eugenics Publishing Co., 1910.) Price 1.50 dollars net.

THE theory suggested in this book is that "the sex of the embryo in man and the higher animals is determined in the ovary from which the ovum in question is developed. In the normal female the ovary of the right side yields ova which on fertilisation develop as males, and the ovary of the left side yields ova which are potentially female." "The writer is not in a position to furnish absolute verification, through methods of anatomy or physiology, of her theory. She has no laboratories nor methods of precision by which her theory can be directly tested. But she is convinced of its truth from her own extensive experience in its practical application for a period of thirty years." She has instructed her friends, and "the results have always verified the law, which during thirty years of observation and testing have never failed."

We shall not give away the ingenuous author's practical recipe, but the general theory is that the right ovary is responsible for the males. This will be good news for those who believe that men are always in the right. "In normal mothers the right ovary always produces ova that, when fertilised, develop as boys. The left ovary always produces ova that, when fertilised, develop as girls. And the mother determines the sex of her child when she consciously or unconsciously directs the fertilising spermatozoa to her right or left ovary." The evidence in support of the theory consists of references to a relatively small number of cases where obedience to the author's practical suggestions was followed by the appearance of a girl or a boy as desired.

A theory similar to the above was brought forward in 1909 by Rumley Dawson, and in dealing with either of them we are met by the difficulty of applying precise experimental tests in the case of man. The experiments of Doncaster and Marshall, reported in the *Journal of Genetics*, November, 1910, show that "in the rat it is not true that ova determining one sex are produced from one ovary, and those determining the opposite sex from the other, for each rat, with one ovary completely removed, produced young of both sexes. This does not, of course, prove that the "right and left ovary hypothesis" is not true for man, but its definite disproof for another mammal detracts from its probability." It may also be recalled that birds have only one ovary.

The book before us is in great part made up of quotations, mostly from sound authorities, such as E. B. Wilson, W. E. Castle, L. Cuénot, and T. H. Morgan. It is a well-intentioned book, but it does not contribute much to the difficult problem discussed.

New Zealand Plants and their Story. By Dr. L. Cockayne. Pp. viii+190. (Wellington: John Mackay, 1910.)

FOR some years past it has been Dr. Cockayne's endeavour to arouse amongst the settlers in the Dominion a better knowledge and appreciation of their exceptionally interesting native flora, and with this object he has, in addition to his various official reports, contributed from time to time popular botanical articles to different local journals. The material for several of these articles has been worked up into the more homogeneous ecological account now published by the Government of New Zealand for the benefit of private individuals and for instruction in schools.

The wealth of botanical treasures is truly great. Thus the forests comprise mixed forests—in which the ancient kauri pine, *Agathis australis* and *Beilschmiedia tarairi*, are conspicuous—and pure forests of *Podocarpus dacrydioides* and Nothofagus. The mixed forests are the homes of abundant lianes—to mention only species of Metrosideros, the liliaceous *Rhizopogon scandens* and *Lygodium reticulatum*—many tree ferns and epiphytes. No less interesting are the shrubs, chief amongst which are the subalpine species of Olearia, Cassinia, and Veronica, while the manuka, *Leptospermum scoparium,* and allied species play an important part in the physiognomy of the native heaths. Then again the alpine meadows are rich in floral gems, notably species of Euphrasia, Ourisia, Celmisia, and Ranunculus. Amongst plant curiosities the vegetable sheep, *Raoulia eximia,* is the most unique.

In addition to the ecology, chapters are devoted to an account of the early explorers, naturalised plants, the stories of four common plants—New Zealand flax, manuka, Fuchsia, and *Cordyline australis*—and plant cultivation. The few examples noted above will serve to indicate how rich and unique is the New Zealand flora; Dr. Cockayne's treatment is fully equal to his subject, and one could only wish that he had much more space to enter into greater detail. The numerous illustrations, although imperfectly reproduced, contribute a better realisation of the plant scenery.

De la Méthode dans les Sciences. Deuxième Série. by B. Baillaud, L. Bertrand, L. Blaringhem, E. Borel, G. Lanson, L. March, A. Meillet, J. Perrin, S. Reinach, and R. Zeiller. Pp. iii+365. (Paris: Félix Alcan, 1911.) Price 3.50 francs.

THE first series of studies in the methods of science by distinguished French writers was reviewed in NATURE on September 23, 1909 (vol. lxxxi., p. 361). The present volume has the same general characteristics, though the point of view is more technical and less philosophical. The following branches of science, which were not dealt with in the former volume, receive attention—astronomy, physical chemistry, geology, botany and palæobotany, archæology, literary history, linguistics, and statistics. The essays should assist in providing the reader with a broad general view of scientific methods, and help to correct the narrowness which may result from a too exclusive absorption in a restricted field of scientific investigation.

Essays in Historical Chemistry. By Sir Edward Thorpe, C.B., F.R.S. Third edition. Pp. xii+601. (London: Macmillan and Co., Ltd., 1911.) Price 12s. net.

PREVIOUS editions of this valuable work have been reviewed in these columns at some length, the first in our issue for April 12, 1894 (vol. xlix., p. 551), and the second in that of August 14, 1902 (vol lxvi., p. 365). The present edition differs from the last in including the memorial lecture on Julius Thomsen delivered to the Fellows of the Chemical Society on February 17, 1910. We also notice an addendum to the life of Prof. Stanislao Cannizzaro, who died at Rome on May 10, 1910.

School Planning at Home and Abroad. By William H. Webb. Pp. 42. (London: The Sanitary Publishing Co., Ltd., 1911.) Price 1s. net.

AT the annual congress of the Royal Sanitary Institute, held in September last at Brighton, Mr. Webb read a paper on "Large Public Elementary Schools in Town Districts." The paper is here published in book form, and illustrated by plans and other diagrams. Mr. Webb's inquiries respecting the characteristics of school buildings in various parts of Europe and America enable him to provide those responsible for the design of new schools with many useful hints.

LETTERS TO THE EDITOR.

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

The Rearing of Sea Urchins.

I ENCLOSE a photograph which may interest your readers. It is one of a water-colour painting of a sea-urchin, magnified 4 diameters, which has been reared in my laboratory by Dr. Cresswell Shearer. It is a hybrid, a cross between *Echinus milearis* (male) and *E. esculentus* (female), both obtained from the Plymouth Marine Laboratory. The cross was effected in the early part of March last. It was kept in thoroughly aërated seawater for

some time, but has for the last three months been living in a bell-jar with part of an old crock covered by worm tubes, without the water being aërated in any way. It generally shelters in the day time under the crock. When disturbed, it moves actively away from the light, and still appears thoroughly healthy. It shows what may be done in an inland laboratory with simple appliances.

J. STANLEY GARDINER.

Zoological Laboratory, Cambridge, July 10.

Absorption Markings in "K" Spectroheliograms.

MR. EVERSHED'S remarks in NATURE of May 11 cause me to think that possibly an essential difference in the method employed for reproducing original negatives for journalistic purposes might go far towards explaining the difference of definition and richness of detail in M. Deslandres' plates. Anyhow, we are now assured that the Kodaikánal negatives show in the main the same structures as those taken at Meudon. Yet if the former admittedly permit such a great amount of K_2 radiation to mingle with K_3, it seems to me risky to base certain reasonings on the appearance of the resulting spectroheliograms. Accepting Prof. Hale's interpretation, given now many years ago, that K_3 represents the highest level and K_2 an intermediate one, I submit that the Meudon plates are more likely to represent the true spectroheliographic aspect of the sun. It may be, as Mr. Evershed says, that the dark concentrations called flocculi are entirely due to variations in the intensity of the narrow absorption line (or, in my opinion, rather the other way about); but is not this variation due, if not entirely, at least to a great extent, to the presence or absence or degree of intensity of the K_2 radiations on either side of K_3? A study of M. Deslandres' spectroheliograms taken on the sectional principle leads one irresistibly to think so. From the preceding remarks anyone can gather why I considered, and still do, the assumption of alternating appearance and disappearance of the large flocculus covering the range of prominences during March and April, 1910, rather unlikely.

As regards the points raised by me about absorptively acting clouds seemingly cutting off the range of prominences sharply at one common level, I must adhere to my statements. They are the result of *repeated* direct observation, and the phenomenon was strikingly on view again only as recently as April 26, when a fine range of prominences on the north-east limb showed it fairly well. I have given in *The Observatory* recently a summary of my observational experiences up to date, and amongst other matters also refer to the often seen phenomenon of dark matter being interposed between solar prominences and the observer at levels attained by the luminous portions of the prominences themselves. Such observations have by no means remained unique, and I possess, through the kindness of Mr. Slocum, a pair of excellent photographs depicting it in a case of some fine prominences seen during October, 1910. As regards my several visual observations of apparently overlying flat and dark clouds (*darker* than the general dark tint of the surrounding sky) abruptly stopping the bright upwards flowing prominence vapours, I feel certain that if Mr. Evershed had been at my side at the time his practised eye would not have failed him to see what I saw, but whether he would have been able to record it on a photographic plate in monochromatic light (Hα) without an eclipse I hesitate to say. I hope, however, that the hypothetical overlying cloud will not be taken as of the nature of "smoke" over a fire. In my opinion it is more a case of the rather abrupt entry of rising hot vapours into a well-defined, more or less horizontal, stratum of considerably less temperature, and that at a comparatively abnormally low solar level. I readily admit that the cases are few where the circumstances necessary for the phenomenon favourably combine with the all too rare cases of the equally necessary perfect definition.

ALBERT ALFRED BUSS.

"Barrowdale," 22 Egerton Road, Chorlton-cum-Hardy, Manchester, May 13.

IF it is true, as Mr. Buss suggests, that variations in the intensity of the components of the emission line K_2 on either side of the absorption line K_3 are sufficient to account for the dark markings occasionally found in spectroheliograms, then the Kodaikánal plates should show them as conspicuously as those taken with a high dispersion instrument, which isolates the central line. Yet this, as Mr. Buss has himself pointed out, is not the case. In studying high dispersion spectrum photographs of the solar disc, one occasionally discovers places where the K_3 line is abnormally dark, and the same thing may also be well observed in the line Hα. When the spectroscope slit chances to cross one of these linear markings, an intensely black spot is seen on the absorption line, and this will usually remain visible or run along the line if the solar image is moved slightly. In the case of the lines H and K, the components of the emission lines H_2 and K_2 are, I think, always weak at the points of greatest darkness in the absorption lines, and for this reason they may possibly contribute somewhat to the final result in our plates.

The intermittent character of the absorption marking described by me in *The Astrophysical Journal* for January is, I think, demonstrable from a careful study of our spectroheliogram negatives, notwithstanding the fact that these plates are of a somewhat composite character, representing the sun in K_2 and K_3 radiations. The disappearance of the enormously extended marking between March 25 and 26, 1910, could be accounted for, it is true, on the supposition that in the interval between these days there was a development of velocity in the line of sight exceeding 15 kilometres per second; this would alter the wavelength sufficiently to throw the dark K_3 line entirely off the camera-slit. But such motion in a prominence usually, if not always, presages a complete dissolution.

Instances of the rapid disappearance of these curious absorption markings are not infrequently met with in Hα spectroheliograms, which show them so much more clearly than do the low dispersion calcium plates. Since completing the construction of the new auto-collimating spectroheliograph of this observatory, I have obtained a nearly continuous daily series of Hα plates during April and May of this year. These are taken with the camera-slit adjusted on the central portion of the line, and represent the highest levels on the sun. The images show most of the prominences as absorption markings on the disc, and some of them are so dark as to appear like clear glass in the negatives. Already in this short series several cases have been noted of the disappearance within twenty-four hours of very large masses of absorbing material.

An interesting example was photographed on May 27 at 2h. 28m. and 2h. 53m. a.m. G.C.T. The disc of the sun in these plates appears to have had a large letter S engraved upon it with great distinctness. If drawn out into a straight line, the S would measure more than 150,000 miles in length. On the following morning we examined the plates with great curiosity to see what the next letter might be! The main portion of the marking had, however, entirely disappeared, and only a few small patches remained. This marking came into being with equal suddenness, for an excellent plate taken on May 26 shows no trace of it.

While agreeing with Mr. Buss as to the occasional presence of small patches of absorbing matter interposed between a prominence at the limb and the observer, I am sorry that both our visual and photographic records are entirely at variance with him with regard to the supposed absorbing clouds overlying certain prominences, which appeared to Mr. Buss to be cut off at one common level. I have before me the K-line negatives and the drawings in Hα of the prominences of March 17 and 18, 1910, and April 26 and 27, 1911, both of which Mr. Buss has cited as instances. These prominences were observed here and photographed under almost as good conditions as can be had at 7700 feet altitude, and the photographs show a mass of detail in the higher parts, especially in the prominence of 1910. Yet there is no trace of any such appearance as Mr. Buss has described; the highest filaments rise to many different altitudes, both on the drawings and photographs.

I may perhaps mention that reproductions of our photographs of the 1910 prominence, as well as some of the solar disc showing the absorption markings, have been sent as an exhibit to the Indian Section of the Festival of Empire.

J. EVERSHED.

Kodaikánal Observatory, June 12.

Hamilton and Tait.

THOUGH I did not miss the passage in his Life of Tait to which Dr. Knott refers in NATURE of July 20 (p. 77), I forgot about it when I wrote my review. The point as to Hamilton's activity in quaternionic work is not of very great importance, but my statement is borne out by Graves's Life of Hamilton, which I read long ago, and have again referred to, as well as by the published correspondence. Tait's introduction to Hamilton took place in 1858; Graves states (vol. iii., p. 97) that Hamilton allowed himself to be diverted *in 1857* from quaternions—the task, he says, of writing the "Elements"—by the subject of definite integrals. According to Dr. Knott, Hamilton did not begin the composition of the "Elements" until a good deal later, and this view would appear from Dr. Knott's statement, and from Hamilton's own language in his letters, to be correct.

A. G.

OTHER CONTEMPORARIES OF MAN AND THE REINDEER AT MENTONE.[1]

IN NATURE, October 10, 1907, appeared a notice of the stratigraphical and anthropological results obtained from the examination of the Baoussé-Raoussé caves at Mentone. In the work at present under review we obtain the no less important geological and palæontological results. It may be said at the outset that this subsequent volume is in every sense a worthy companion to the preceding volumes, which fulfilled in an exemplary manner the many tedious requirements which modern archæology exacts from those who undertake the investigation and description of these valuable and irreplaceable records of the past. Not the least part of the debt which archæologists owe to MM. Boule, Verneau, and de Villeneuve is due to the admirable methods which they have instituted.

The volume at present under review contains a full account of the various animal bones recovered from these caves. The bones of each animal are first carefully considered, and so far as is possible a general idea is obtained of the animal as it is represented in the deposits within these caves. The information thus obtained is next checked, confirmed, and extended by comparing the Baoussé-Raoussé specimens with those contained in the various museums of Europe. A no less interesting comparison is then instituted between these extinct forms and the forms living at the present day. Attention is next directed to the exact stratigraphical position in which the bones were discovered, and from this evidence the order of arrival of the Pleistocene mammals in the Mentone district is deduced. Not content with this, M. Boule furnishes us with a series of most useful maps of Europe and the adjoining parts of Asia and Africa showing the areas from which the remains of some of the larger and more important animals have been reported. The methods employed will thus be seen to be as perfect and exhaustive as they were no doubt laborious. Measurements of bones are almost entirely eschewed, M. Boule believing, with many others, that measurements arbitrarily chosen are in no way superior to simple observation, nor are they likely in his opinion to disclose such specific characters as would be likely to be hidden from the trained and experienced eye. Instead of long lists of measurements of dubious value, the text is enriched with a large number of admirable photographs, which in some respects possess an advantage over the actual specimens themselves.

The bones recovered were obtained from the Grottes du Prince, des Enfants, and du Cavillon. They comprised parts of the skeletons of the following:—*Elephas antiquus, Rhinoceros merckii, Equus caballus*, Hippopotamus, *Sus scrofa, Bos primigenius, Bison priscus, Cervus capreolus, Cervus elaphus, Cervus samonensis, Cervus tarandus, Cervus alces, Rupicapra tragus*, and *Capra ibex*.

The presence of *Elephas primigenius* was uncertain; *Rhinoceros tichorhinus* was absent. The Equidæ were represented by specimens which, though relatively few in number, were of wide distribution, being scattered through and recoverable from all the beds. M. Boule believes that he can recognise with considerable confidence the remains of *Equus asinus*. The vast majority of the specimens, however, belong to *Equus caballus* and to the subdivision of that species which has been variously named *Equus caballus*, Linn., *Equus caballus typicus* (Cossar Ewart), *Equus robustus* (Frank). Contrary to the expectations of those who have studied the carvings and engravings of the reindeer period, neither *Equus przewalskii* nor the zebra can be shown to have been present.

Map showing the area from which the remains of *Elephas antiquus* have been reported.

Pigs were abundant. In the Mentone neighbourhood *Bos primigenius* made its appearance quite as early as *Bison priscus*, if indeed not earlier. *Bos longifrons* was absent. *Cervus capreolus* was present as a vigorous form of the existing animal. *Cervus elaphus* and *Cervus samonensis* were considerably larger than modern specimens. *Cervus tarandus* made its appearance suddenly in Mid-Pleistocene deposits; it was only found in any numbers in the Grotte du Cavillon. *Rupicapra tragus* was of a vigorous type showing affinities to the chamois of the Alps and of the Pyrenees. *Capra ibex* was represented by such a large number of specimens that M. Boule hopes to see some day a complete reconstructed skeleton of this animal at the Musée d'Anthropologie de Monaco. He considers it to be the ancestor of the Alpine goat of to-day.

This most interesting and valuable volume will thus be seen to confirm the opinion which has slowly but surely ripened to a conclusion that there has been no sudden or complete break in the evolution or history of the fauna of western Europe from Palæolithic to Neolithic times. There has further been little if any natural organic evolution in the larger mammalia from the earliest Pleistocene to the present day. Some of the animals of the Pleistocene have disappeared through changes in climatic conditions or under the

[1] "Les Grottes de Grimaldi" (Baoussé Raoussé). Tome i., Fascicule iii., Géologie et Paléontologie (suite), by Prof. M. Boule. Pp. 157-236+plates xiv-xxix. (Monaco, 1910.)

unrelenting hand of man; others have deteriorated in size and vigour as they have gradually come under the yoke. The horse, however, forms a notable exception, having from obvious reasons improved in physique and gained in strength. Such minor changes, changes of degree rather than of kind, are all that evolution can lay claim to have effected in these stubborn mammalia within the compass of some thousands of years during which Mentone has known the two extremes of climate and temperature.

Another great assistance rendered by the work of M. Boule is that he has enabled us with more certitude than was possible before to reconstruct the milieu of certain of our Palæolithic ancestors; for, from the fauna it is not difficult to realise the nature of the flora or the conditions of the climate. With the information thus obtained we can apprach the stone and bone implements which the man of that remote date has left, and deduce more confidently what were the purposes they served. A knowledge of the fauna is thus seen to be the key which will most successfully unlock many of the sealed chambers of man's past. Apart, however, from all this, the study of the extinct Pleistocene fauna possesses in itself great and abiding interest, and dull must be the archæologist or anthropologist who does not desire further knowledge concerning these early companions of man whose bones lie commingled with his in river drift and cave floor.

The book is a most valuable contribution to science, and reflects the greatest credit on everyone concerned.

WILLIAM WRIGHT.

THE TYPES OF WATER WAVES.[1]

DR. CORNISH has produced an attractive and valuable book. The volume is not the less valuable in that it is primarily descriptive, and in that the author shows great caution and reserve as regards speculative explanations. This caution is indeed amply warranted. The mathematical theory of water waves, successful as it is up to a certain point, is limited in its application by the fact that it contemplates only specially simplified conditions. In particular, owing to the restriction to *small* amplitudes, it can at present offer little in the way of explanation of various important natural phenomena, where what is technically called "turbulent" motion comes into play. Laboratory experiments, on the other hand, require elaborate and costly arrangements, which are only provided with difficulty even when a definite practical problem is in view; and in some respects the mere question of scale would impair their relevancy. There remain only observations in the open, such as the author has recorded in the present book. The extreme difficulty of these, from a quantitative point of view, is well illustrated by his discussion of storm-waves at sea.

FIG. 1.—Wave-track of Steamer on Thunersee, showing thwart-ship and diverging waves. From "Waves of the Sea and other Water Waves."

The book is made very readable by the fact that the author's interest in his subject is evidently æsthetic as well as practical or scientific. He is fascinated by the extraordinarily beautiful and varied types of wave motion which are presented by nature, and has recorded a number of these, observed at sea or on land in many parts of the world, in a series of remarkable photographs.

[1] "Waves of the Sea and other Water Waves." By Dr. Vaughan Cornish. Pp. 374. (London: T. Fisher Unwin, 1910.) Price 10*s*. net.

The book consists of three parts. In the first of these, treating of deep-sea waves, the evidence of various writers as to the dimensions of storm-waves in different ocean basins is collated, and supplemented by the author's own observations. Accurate measurements are from the nature of the case very difficult, but it appears that there is a limit to the height (from crest to trough), which different observers concur in placing at about 40 feet, whilst the limit to the length is somewhere about 600 feet. The waves are longer and higher the longer the "fetch," *i.e.* the extent of water to windward, where the waves are generated. As to the mode in which waves grow under the influence of wind in a storm, we have at present little beyond general indications. Another subject here referred to is that of the much longer and lower waves which constitute the "swell" of the ocean. To the eye this is often scarcely perceptible at sea, and the only method of accurate observations consists in timing the waves as they break on the shore, where they are exaggerated by the shoaling of the water. In this way some inferences can be made, as pointed out by Stokes, as to the distance of the seat of the original disturbance to which the swell is due.

FIG. 2.—Stationary waves caused by a weir on the River Aare, Switzerland. From "Waves of the Sea and other Water Waves."

The second part of the treatise deals with the action of sea-waves in transporting shingle, sand, and mud. This is of enormous practical importance, and can be dealt with to some extent experimentally. From a theoretical point of view it is very difficult, and we shall not attempt here to discuss the contribution which the author makes to speculation on this subject.

The concluding section gives an interesting account, with admirable illustrations, of the "bore" or abrupt tidal wave observed in the Severn and other rivers, and of the stationary waves in flowing water due to fixed obstacles. Finally, the remarkable configuration of "ship-waves," first elucidated by Lord Kelvin, is exhibited in some beautiful photographs. These show clearly the system of "transverse" waves, which were (we believe) unnoticed in the earliest tank experiments until their existence had been pointed out by theory.

FIVE-HUNDREDTH ANNIVERSARY OF THE UNIVERSITY OF ST. ANDREWS.

FROM September 12–15 next, inclusive, this celebration will be held in the ancient ecclesiastical capital of Scotland, with all the ceremony it is possible to have in the circumstances. Though the university was not founded until 1411, yet St. Andrews for centuries previously had various teaching institutions in connection with the learned religious bodies in the monasteries of the Culdees and other sects concentrated in the ancient city, the preceptors of which had been trained in the English or Continental universities, especially those of France and Italy. Steps, indeed, had been taken before this period to further the interests of the Scottish students by the founding of the Scotch College (Balliol) at Oxford by Lady Devorguill, the wife of John Baliol; whilst the good Bishop of Moray had instituted in 1326 the Scotch College in Paris. No university, however, existed in Scotland, so that her students had to study for degrees elsewhere, and in the unsettled state of the times had not infrequently to encounter difficulties and hardships—even to the occasional capture by their then hostile neighbours, the English—on their way to other countries. Such was the condition of things when Henry Wardlaw was appointed to the bishopric of St. Andrews, and as he was a man distinguished for his wide culture, munificence, and great influence, it was not long before he found an opportunity. Eight years after his appointment to St. Andrews, viz., in 1411, the thoughts which doubtless had been revolving in his mind for a long time took shape and were put in action. A *Studium Generale* was at once commenced with the aid of a staff of able teachers in the faculties of law, divinity, and arts. He drew up a foundation-charter of the university, and forwarded it by envoys to the Pope (Benedict XIII.), who endowed it by means of papal bulls with all the powers of a university in 1413—to teach science, philosophy, and medicine, and this was subsequently confirmed by King James, who was throughout a staunch benefactor to the young institution. Thus the Scottish youth were no longer compelled to seek higher instruction out of their own country.

At the celebration in September will assemble noblemen, one of whom, the Marquis of Ailsa, is the lineal descendant of Bishop Kennedy (grandson of Robert III.), the founder of St. Salvator's College, whose elaborately carved tomb is one of the sights of the college chapel; delegates from the universities of Britain, and all her Colonies and Dependencies; from America, Austria-Hungary, Belgium, Denmark, France, Germany, Greece, Holland, Italy, Japan, Norway, Portugal, Russia, Finland, Sweden, Switzerland, Spain, and Turkey. Besides others distinguished in science and literature, representatives of the various learned societies in Great Britain and her Colonies, of almost all the foreign countries mentioned, official persons connected with all the churches in Britain, officials of the College of Justice, naval and military authorities, parliamentary leaders and members, sheriffs and heads of various departments, will grace the ceremony, together with former teachers, graduates, and students of the university, and the present staff both of St. Andrews and Dundee.

The programme of the proceedings, as at present arranged, will comprise a reception by the Chancellor of the University, Lord Balfour of Burleigh, in the large temporary hall, St. Andrews, a students' torchlight procession, and a students' symposium on the evening of Tuesday, September 12. On Wednesday, September 13, a procession will be formed in the college quadrangle, and will proceed to the Church of the Holy Trinity, where a religious service will be held. Then, after an interval, the presentation of addresses will be made in the temporary hall, and thereafter an address will be given by the Chancellor. In the evening historical tableaux in the Great Hall, an illumination of the city, and a procession will take place. Lastly, a second students' symposium will conclude the proceedings of the day. On Thursday, September 14, a graduation ceremonial will be held in the Temporary Hall, at which a large number of distinguished honorary graduates in law (LL.D.) and divinity (D.D.) will be capped. Thereafter the rector, Lord Rosebery, who represents the students, and who will be escorted by a guard of honour formed of the Officers Training Corps of the university, will be installed, and will deliver his address. In the afternoon garden-parties will be held at Mount Melville, at St. Leonard's School for Girls, and probably also at the Gatty Marine Laboratory. In the evening a banquet will take place in the Bell Pettigrew Museum, which will likewise be declared open. Contemporaneous receptions by the ladies of the university will further occur, both in St. Andrews and in Dundee the same evening, so as to include all guests and hosts, and especially ladies and students. Friday, September 15, will be mainly devoted to Dundee, commencing with a reception and addresses at University College, followed by a reception by the Corporation of Dundee, and a luncheon in the Art Galleries of the Albert Institute. Thereafter, excursions to Glamis Castle, Rossie Priory, and a sail to Perth, as well as visits to places of interest in Dundee, will occupy the afternoon. The day will be concluded by a graduates' and students' dinner in the Bell Pettigrew Museum, in St. Andrews, and a students' ball in the Temporary Hall.

The fine old ruins, so full of stirring historical associations, in St. Andrews, its old Tower of St. Regulus, usually called the Square Tower, one of the oldest buildings in the land, the home of Sir David Brewster, the most renowned principal of the university, the earliest Marine Laboratory in Britain, the fine Chemical Research Laboratory, the extensive stretch of sand—east and west—with the fringe of rocks, so full of interest to the geologist as well as to the zoologist, the zoological and botanical riches of the well-known bay, and the prominent part it has taken in initiating scientific fisheries' research—all combine to render the old cathedral city, where many Scotch parliaments were held, one of great interest. The unique silver maces, and the archery medals won by the young Scotch nobles who attended the university in the olden time, and many of whom afterwards became famous in the history of the country, are other features (not to allude to the splendid golf links) of interest to the distinguished visitors to the celebration of the 500th anniversary of the university in September.

W. C. M.

NATIONAL ASSOCIATION FOR THE PREVENTION OF CONSUMPTION.

Conference on Tuberculosis.

The conference on tuberculosis, held on July 19-21, organised in connection with the exhibition sent round the country by the National Association for the Prevention of Consumption, stationed at the Caxton Hall, Westminster, was as successful as those held during the past couple of years at Edinburgh, Cambridge, Oxford, and other centres throughout the country. Indeed, in certain respects the conference, recently brought to a conclusion, was more interesting and attracted greater attention than any one of its predecessors. The announced object of the conference was to discuss Mr. Lloyd George's Insurance Bill, or rather those sections and clauses of the Bill dealing with the prevention and treatment of tuberculosis; and at the opening meeting the members had the advantage of listening to an able address given by the President of the Local Government Board, who, as he himself put it, has, amongst his numerous and multifarious interests, specialised somewhat in tuberculosis and infant mortality.

Mr. Burns set himself to describe what has been done to bring down the mortality from tuberculosis during the last few years. As is usual with him, he illustrated his points by telling examples, of which two may be taken as likely to impress those interested in this subject even to the slightest extent. The first of these he drew from military life. A little more than thirty years ago the Guards were a body of eight thousand men—none finer or so fine in the world, maintained Mr. Burns—healthy, picked men, of fine physique, yet the death-rate from tuberculosis was a fraction above twenty. To-day what do we find? A little common-sense sanitation, better ventilation, and greater sobriety amongst the men together have brought down the death-rate from tuberculosis to 3·1. As Surgeon-General Evatt insists: what has been done in the barracks it should be possible to do in civil life. Not so quickly, perhaps, but certainly in the long run.

Coming down to later times, Mr. Burns points out that to-day in London only two persons succumb to tuberculosis where twenty years ago three lives constituted the toll to this disease. Again, for every two lives so lost in London, Berlin loses three and Paris five. This is a serious matter for our French friends, and "gives one furiously to think." How can this be accounted for? Certainly not by a single factor; but Mr. Burns makes a suggestion and gives certain figures that are well worthy of consideration.

During the last ten years the fall in the mortality from consumption has been, in Great Britain, 19; Scotland, 24; Ireland, 24; Germany, 18; London, 30; Berlin, 24; Paris, 3. This period synchronises with that during which the National Association for the Prevention of Consumption has been at work—also with Mr. Burns's term of office at the head of the Local Government Board; but during the same period the drink bill per head of the population in this country has fallen from 4*l.* 12*s.* to 3*l.* 0*s.* 8*d.* In Paris, on the other hand, no such fall has been recorded. Whether this be a cause or a symptom merely, this aspect of the question must receive careful and respectful consideration. Other points were brought forward during the conference, often with great force and wealth of argument. One thing which stamped this conference as something out of the common run of such meetings was the fact that enthusiastically as each man spoke of the special branch of the subject on which he was engaged, there was none of the "pushing of wares" to the exclusion of everything else that has sometimes characterised such meetings.

The optimistic note struck by the President of the Local Government Board in his opening address was sounded again and again by later speakers, the most hopeful of whom looked forward to the extermination of tuberculosis from cattle and man alike within the next thirty-five or fifty years, maintaining that this could readily be effected if a proper apportionment of the resources at the command of those who are dealing with the disease can be arranged. The credit of the sanatorium treatment has suffered in certain quarters from the fact that careless advocates have assigned to it functions that it was not fitted to perform, whilst others, opponents, equally careless and uninformed, have not taken into account the educational function of the well-governed and properly directed sanatorium. All are agreed, of course, that it is impracticable to submit all tuberculous patients to ordinary sanatorium treatment, and that the dispensary system must be brought into play to assist and supplement the work of the sanatorium. This dispensary system has many earnest advocates, and with certain extensions and linking up with the sanatoria on one hand and the hospital on the other there lie within it great potentialities.

In connection with the section of preventive work the optimistic spirit that manifested itself throughout threw into strong relief the feeling that far more might be done in the provision of open-air shelters, for tuberculous patients attending dispensaries and continuing at work, than has yet been done. Several speakers directed attention to the luxurious sanatoria that have been erected in various parts of the kingdom, where, owing to the enormous initial cost and the great expense of administration, the charges must necessarily be prohibitive except to those well endowed with this world's goods. Are these costly buildings necessary or even desirable? they ask. If tuberculosis is to be eradicated within the next thirty or forty years, to what use can such large and solid buildings be put when they have served their primary purpose? Moreover, would not the process of eradication of tuberculosis go on much more quickly if the money spent on these palatial buildings could be directed to the provision of a large number of open-air shelters, in some cases grouped around more solidly constructed administrative blocks, in others placed at the disposal of the dispensaries for the accommodation of single patients at or near their own homes? These shelters might be very inexpensive, and, in many cases, might be destroyed as soon as they had served their purpose. More substantial and comfortable buildings for the reception of patients in the later stages of the disease, where there is little to be hoped for from treatment except alleviation of pain—buildings from which should be dissociated all names and terms likely to depress the patient may well be provided, even at somewhat substantial outlay, especially as after they have served the purpose for which they are designed they may be converted into hospitals for the reception of other classes of patients.

The question of different methods of medication is not one to be discussed at a public conference, and, very judiciously, was not taken up. Some of the speakers, however, referred to the necessity for the continuance of experimental work. Here the prophecies of the President of the Local Government Board should have some weight in determining the nature of the efforts to be made and the character and mode of financing these efforts. It is certainly unnecessary to make provision for permanent endowments for the carrying on of this work. An immediate liberal subsidy will be of far greater value in ensuring the desired results than a large sum set aside of which only the interest can be used.

As in the case of shelters, &c., the money available should be utilised to cover as much ground as possible and *at once*. Extensive and immediate treatment, both curative and preventive, and well-devised experiments carried out as promptly and on as large a scale as possible, will do far more to stamp out tuberculosis than will efforts extending over a longer period, and in the long run far more costly.

The National Association for the Prevention of Consumption has been working away quietly and systematically for some time; much of its work in the earlier days of its existence was spadework of a very unobtrusive character, and certain critics, perhaps not very kindly disposed, have from time to time been prone to grumble at what they were pleased to call its inertness. For several years past, however, such criticism has been seen to be very much beside the mark, and the London conference, which was the last of a long series, has supplied ample evidence of the valuable work that has been done by the Association, demonstrating to those most directly concerned "what they shall do to be saved" from the white plague. With the facilities now offered by Mr. Lloyd George for putting into force some of the methods recommended by the conference, with a united effort made in matters on which all are agreed, such a shrewd blow may be struck at tuberculosis as it has not received since Koch made the announcement of his epoch-making discovery—the discovery of the tubercle bacillus.

DR. JOHN BEDDOE, F.R.S.

We regret to have to record that Dr. John Beddoe, the distinguished anthropologist, died on July 19 at Bradford-on-Avon.

Dr. Beddoe, who was born at Bewdley in 1826, was the first to make exact observations on the physical characters of living races over wide areas, and he will always be regarded as the founder of our knowledge of the physical anthropology of the living populations of Europe.

So early as 1846 he began to make observations on hair and eye colours in the West of England, and though he found his first system unsatisfactory and abandoned it he resumed the work, on the occasion of a visit to Orkney in 1852, and continued these observations to the end of his active life whenever his travels brought him in contact with new peoples.

Owing to his delicate health in childhood and youth, he was cut off from outdoor games and sports, but made good use of his time indoors by devoting it to a course of wide and solid reading. The effect of this is seen in the numerous and illuminating historical and other allusions in his anthropological books and memoirs.

Abandoning the study of the law, for which he was at first destined, he found a much more congenial study in medicine. He commenced his medical studies at University College, London, and completed them at Edinburgh University, where he took his M.D. in 1853. He was house physician at the Edinburgh Infirmary for fifteen months under the direction of such distinguished physicians as Christison, Simpson, and Syme.

In 1854 the Crimean War offered him the opportunity of visiting eastern Europe as a member of a civil medical staff sent out by the War Office to supplement the work of the military staff. Here he made good use of spare time to make observations on the Turks and other Eastern races he came in contact with.

On his return from the Crimea he resolved to spend a winter of study in the Vienna hospitals, and in his journeyings to and from Vienna he collected a great deal of anthropological material in Holland, Germany, Austria, Hungary, and Italy.

In 1867 he was awarded by the Council of the Welsh National Eisteddfod a prize of a hundred guineas for the best essay on the origin of the English nation. His essay was afterwards expanded into his well-known book, "The Races of Britain."

In 1868 Dr. Beddoe was president of the Anthropological at the same time that Huxley was president of the older Ethnological Society. The amalgamation of these two rival societies into a single society, the Anthropological Institute (now the Royal Anthropological Institute), which has done so much to promote the study of anthropology in this country, was due to a great extent to the efforts of Beddoe. He also took an important part in the movement which led to the constitution of anthropology as an independent section at the British Association.

Dr. Beddoe was president of the Anthropological Institute in 1889. In 1890 he delivered the Rhind Lectures on "The Anthropological History of Europe," a work which shows his unique knowledge of the physical characters, the migrations, and evolution of the peoples of Europe. In 1905 he delivered the Huxley lecture of the Royal Anthropological Institute, and quite lately he was appointed honorary professor of anthropology in the Bristol University.

When we consider that the large amount of anthropological research done by Beddoe was carried out during the intervals of leisure in a busy professional life, we cannot help being astonished at the amount of very valuable work he has done, nor withhold our admiration for the devotion to science which enabled him to persist in it through so many years. Beddoe was a pioneer in a new line of scientific investigation, and his example has been powerful in stimulating other investigators to carry out similar work. The great survey of the hair and eye colours of the school children of Germany carried out by Virchow was without doubt due to the stimulus of Beddoe's pioneer work, and a great deal of similar work has since been carried out by other investigators. The name of John Beddoe will always occupy an honourable place in the history of anthropology.

DR. H. TIMBRELL BULSTRODE.

DR. H. TIMBRELL BULSTRODE, who died suddenly from heart failure on July 22, was one of the senior medical inspectors of the Local Government Board, having been appointed to that office by Mr. Ritchie in 1892. His death was unexpected and will be widely regretted.

Dr. Bulstrode obtained his medical education at Cambridge University and St. Thomas's Hospital. Since his appointment to the Local Government Board he had, in addition to the more routine work of the medical inspectorate, been engaged under three successive medical officers in work of a more special nature implying exceptional skill in epidemiological investigation. It is in regard to this work that his high reputation was made. Three of his reports to the Local Government Board have been presented to Parliament as command papers. Of the subjects at which he worked, that of the relationship of contaminated shellfish to the prevalence of illness, and especially to enteric fever, is particularly important. Early in the nineties of last century the attention of the Local Government Board was directed to the possible causation of outbreaks of enteric fever, as well as of cholera, by the consumption of contaminated oysters, and Dr. Bulstrode was commissioned to make a comprehensive investigation into the subject. He visited all the districts in England and Wales in which there were oyster layings, and collected all the known literature on the subject of his inquiry. His report, which was presented to Parliament in 1894, was illustrated by a series of charts which indicated the position of all the principal oyster layings in England and Wales, and the positions of sewers in their neighbourhood. The issue of this report necessarily and properly caused much damage to the trade in oysters as then carried on. Its more permanent effect has been to improve the conditions under which a very large proportion of the total oysters in this country are grown and fattened.

Dr. Bulstrode's next investigated several deaths and a considerable number of cases of enteric fever which occurred after mayoral banquets at Winchester and Southampton, and clearly traced these to the consumption of contaminated oysters. Early in the current year a report by Dr. Bulstrode was presented to Parliament dealing with shellfish other than oysters in relation to disease. This report, which is a comprehensive one, brings up to date epidemiology in association with oysters, and contains a detailed account of the principal shellfish beds of mussels and cockles. The volume, like its predecessor on oysters, is illustrated by a valuable series of charts showing the topography of the beds in relation to sewage pollution. Dr. Bulstrode attended many meetings of the Royal Commission on Sewage Disposal which had the oyster and other shellfish difficulties under consideration.

Another public health question with which Dr. Bulstrode was particularly concerned is that of tuberculosis. In 1903 he gave the Milroy lectures at the Royal College of Physicians, choosing the subject of tuberculosis. In 1905 he was associated with Dr. Theodore Williams as a representative of the British Government at the International Congress on Tuberculosis at Paris. In 1908 Dr. Bulstrode's report on sanatoria for consumption was issued and presented to Parliament. This extremely valuable work on sanatoria in England and Wales was republished by H.M. Stationery Office in a cheaper edition, the demand for it having been large.

Dr. Bulstrode, at the time of his death, was engaged in an inquiry, as a representative of the Local

Government Board, with officers of the Home Office into cases of phthisis which had been attributed to "kissing the shuttle," a practice in the cotton mills in Lancashire. His recent report on plague in East Suffolk was a further piece of excellent work, set out with characteristic detail and exactitude. All his reports will remain for a long time valuable works of reference for investigators and examples of laborious and exact inquiry.

Dr. Bulstrode's death in his fifty-third year removes from the medical staff of the Local Government Board not only a very able and conscientious public official, but a colleague who had endeared himself to the officials of his own department, and was held in high repute by local officials in England and Wales with whom his investigations had brought him in contact.

THE PROMOTION OF SCIENTIFIC RESEARCH BY THE DEVELOPMENT COMMISSIONERS.

THE appointment of the Development Commissioners marks a remarkable change in the attitude of the British Government towards research. Not only is the old *laissez-faire* policy thrown over, for the commissioners are charged with the duty of fostering decaying rural industries and trying to promote new, but they are also specifically instructed to promote scientific research and experiment so far as it bears upon agriculture. The funds placed at their disposal are considerable—a capital sum of two and a half million pounds, with an annual grant of 400,000*l.* for the five years for which provision is made in the Act—and though the big grants will be chiefly wanted for such purposes as the improvement of harbours and inland navigation, the reclamation of land, rural transport, and similar works, there should yet be a very considerable margin available for investigation and education in its widest sense.

The first report, which the Development Commissioners have just issued, shows that although they have been at work for less than a year, they have set scientific matters in the forefront of their programme; indeed, they indicate that until they have dealt with research and education they intend to postpone the consideration of projects aiming at the direct creation of employment, such as the reclamation of land, canals and light railways, and afforestation of waste land. Our deficiencies in the scientific direction and control of agriculture and other cognate industries, *e.g.* sea-fishing, are both patent and pressing. In this direction the foundations have to be laid for the future; and, moreover, there can be very little doubt but that the expenditure wil be recouped a thousandfold, because it will take effect upon the mind of the men who have to live by the industry, whereas in the case of works the expenditure is greater and the ultimate benefits to the industry as a whole more doubtful.

The commissioners have already made certain grants for research to institutions like Cambridge University (4,000*l.*), the Rothamsted Experimental Station (2,000*l.*), the Royal Veterinary College (1,390*l.*), Bristol, and other university colleges possessing agricultural departments; but they indicate that these are only interim grants for the maintenance of certain work already going on pending the framing of a general scheme of research applicable to the whole kingdom and intended to secure that every part of the wide field shall receive adequate attention. The commissioners report that they are negotiating with the Board of Agriculture for the preparation of such a scheme, and that they propose to devote about 40,000*l.* a year to carrying it out. In other directions the scientific aspect of the question seems to have been well before the commissioners, for example in the scheme for the improvement of the breeding of light horses; they have insisted that "definite provision should be made for watching and supervising its operation and so far as possible making experiments from the point of view of scientific research in eugenics as applied to horses." Again, in attacking the problem of increasing the variety of production, they "have appointed two gentlemen of scientific training to investigate by inquiry at home and abroad" the cultivation and management of the tobacco, flax, and hemp crops; and, as regards forestry, they report that education and research ought to precede any action in the direction of afforestation on a large scale.

This recognition of the foundation of all development of industries like agriculture, forestry, and fishing upon scientific knowledge and research is very welcome, and must be applauded as a most promising departure from the spirit and methods that have hitherto prevailed in English official circles. We may compare the 40,000*l.* the commissioners propose to spend with the few hundreds a year which represented all the Board of Agriculture was able to devote to the same purpose.

In this connection the British Science Guild may well be congratulated upon its action. A few years back the guild appointed an agricultural committee, which, after making many inquiries and collecting a great deal of information, produced a report showing what Great Britain did in the way of agricultural research in comparison with foreign countries and our own colonies, and giving some examples of the returns which had accrued to the industry from the application of particular investigations. This report was widely and influentially signed and presented to the Government; and the guild may be well content with the manner in which its representations have now been translated into action. Subjoined are a number of extracts from the commissioners' report.

The Development Commissioners were appointed by the King on May 12, 1910, by Royal Warrant. The commissioners include Lord Richard Frederick Cavendish (chairman), Sir Francis Hopwood, K.C.B., and Messrs. Saint-Hill Eardley-Wilmot, H. J. Davies, M. A. Ennis, W. S. Haldane, A. D. Hall, F.R.S., and Sidney Webb. At the beginning of this year the commissioners entered, with the Road Board, into the occupation of permanent offices at Queen Anne's Chambers, Broadway, Westminster.

Since their appointment, the commissioners had held nine official meetings up to March 31 last, and it is with the work done at these meetings and the preliminary business transacted by the commissioners that their first report[1] deals.

General Principles of the Commissioners' Action.

The commissioners are informed that during the period under review about 170 applications for advances from the Development Fund were made to the Treasury. Of these, twenty-four reached the commissioners officially under the Act, so that they could take formal cognisance of them.

It may be useful if they offer some general remarks on the duties entrusted to them by the Act of 1909, and the principles at which they have arrived in considering how best to carry out those duties.

Their prime duty is to consider and report to the Treasury on applications referred to them for advances from the Development Fund. All applications must in the first instance be made to the Treasury. The Act directs that when an application reaches the Treasury it is to be dealt with in different ways, according to its source. If it is from a Government department, the Treasury are to send it direct to the commissioners for examination; if it

[1] First Report of the Proceedings of the Development Commissioners for the Period from May 12, 191 . to March 31, 1911. Pp. 60. (Wyman and Sons, Ltd.) Price 3*d*.

is not from a Government department, the Treasury are to send it to the Government department concerned with the subject-matter of the application, who are required to forward it in due course with their report to the commissioners. When the application reaches the commissioners they have to consider it and state their opinion to the Treasury, with whom rests the responsibility of finally deciding whether to give effect or not to the commissioners' recommendation if it is favourable. If the Treasury approve, the money is advanced as required to the applicant—direct, if the applicant be a Government department; if the applicant be some other body or association, through the department concerned, who are then responsible for supervising the actual expenditure.

From this procedure, as laid down by the Act of 1909, three main results follow. In the first place, the commissioners themselves have no power to make grants or loans from the Development Fund; like other Royal commissions, they can only recommend expenditure, which must be finally authorised by the Government. Treasury approval is required for every penny spent from the fund. Secondly (again like other Royal commissions, or the majority of them), they have no executive power; the schemes recommended by the commissioners must be carried out either by a Government department or by some other body under the supervision of a department. Thirdly, they have no formal and official cognisance of applications from bodies other than Government departments, and cannot report to the Treasury on them, until the applications have been examined by and passed through the departments concerned with their subject-matter.

Such being in general terms the position assigned to the commissioners by the Act, it became incumbent on them to settle at an early stage of their proceedings the main principles by which they would be guided in considering, amending, and framing schemes for expenditure from the Development Fund.

The first of these principles is that, to deal satisfactorily with many of the purposes mentioned in the Act of 1909, it is absolutely necessary to work on a comprehensive policy, which shall provide for and take account of the whole of at least one of the three main administrative divisions of the United Kingdom (viz. England and Wales, Scotland, and Ireland), and shall wherever possible be based on a survey of the position and needs of the whole kingdom in relation to that particular subject. Take, for instance, the very important question of research in agricultural science. Numerous applications for advances from the Development Fund for different branches of research and pieces of research work were expected, and have, in fact, been made by bodies, institutions, and associations all over the kingdom. It seemed to the commissioners that there would inevitably be waste of energy and money if these applications were simply taken one by one as they arrived, and advances recommended to those institutions which made out a good case for themselves, irrespective of other institutions and the work done by them. It is probably neither desirable nor possible to prevent all overlapping and duplication of work, and the commissioners realise that individual investigators and institutions cannot and ought not to be dragooned into uncongenial tasks. But looking to the vast amount of work still to be done, they think that any advances from the fund for this purpose should be made on a coherent and comprehensive scheme, covering as wide an area as possible.

Agricultural research has been taken as an example, but it will be obvious that similar considerations apply to other purposes for which advances may be made from the fund. The commissioners do not lay it down as a hard-and-fast rule that in no circumstances, however special, will they recommend an advance from the Development Fund apart from an examination of all possible or probable applications of the same nature, or apart from a general scheme applicable to the whole country or a large part of it; and the necessity of such a scheme varies with the purpose for which advances are desired. But for the reasons briefly indicated above, they feel that as a rule an application should be considered not simply and entirely as a disconnected unit, but in the light of a policy which takes account of the requirements of a wider area than a single district or institution.

From the adoption of this attitude, certain practical consequences follow. In the first place, it is impossible to deal with individual applications as quickly as if they were taken one by one, without reference to general considerations. To recommend even a large number of disconnected advances is obviously a very different thing from working out or examining in detail a coherent and organised scheme which is meant to be applicable to the whole country or a large part of it—a scheme in which existing bodies and institutions would each find a place consistent with its possible contribution to the general advancement.

It follows, secondly, that the relations of the commissioners with Government departments must necessarily be of the closest nature. In any event they must be close, for all applications come either from or through a department, and all advances from the fund must be made either to or through a department. But the commissioners' policy of proceeding by general schemes necessarily means that they welcome such applications as the departments themselves may make; and for reasons similar to those which have influenced the commissioners, the departments, when confronted with the duty of reporting on a large number of disconnected applications, have perhaps felt that they would best discharge that duty by themselves putting forward a general scheme which would cover and include so far as possible the schemes of the individual applicants. The commissioners cannot consistently with their statutory duty accept such schemes without consideration, and it is not a matter for surprise if they do not always find themselves in entire agreement with the applying department. In such cases, discussion between the two bodies is the only way of settling a scheme: for on the one hand it cannot be financed without the commissioners' recommendation, and on the other (the commissioners having no executive authority) it cannot be executed apart from the department. The commissioners are happy to say that they have hitherto encountered no difficulties with public departments which full discussion has proved unable to solve.

In the third place, procedure by general schemes involving large advances to Government departments brings into clear view the difficulties and delays caused by the inevitable complication of the administrative machinery of the United Kingdom. The nature of some subjects is such as to permit of their being considered separately for separate parts of the country; yet even with such subjects more than one department may be concerned—for instance, agricultural education (as distinct from scientific research) is in different branches within the purview of both the Board of Education and the Board of Agriculture. With some subjects, on the other hand, the commissioners might wish to deal, if possible, on a scheme or schemes taking account of all parts of the United Kingdom; and in that case they might be concerned at the same time with one or perhaps two authorities for England and Wales, another for Scotland, and another one or two for Ireland.

It will not escape observation that the one case (viz. the encouragement of horse-breeding) in which during the first few months of the commissioners' existence Government departments were able to submit, and the commissioners to recommend, comprehensive schemes, is precisely a case in which some of the difficulties mentioned have been absent. There is only one authority for the whole of Great Britain. The Irish scheme had been in existence for some years, and by common consent worked well, needing only money for its extension; and the British scheme followed, generally, similar lines.

The other principles on which the commissioners proceed may be explained more briefly. In the first place, they do not think that it would be consistent with their duty to recommend an advance from the Development Fund until a fairly detailed scheme for the expenditure of the money is framed and approved.

Secondly, they do not propose, as a general rule, and subject in certain cases to considerations of practical convenience, to recommend advances from the Development Fund in relief of existing expenditure, whether from Parliamentary votes, local rates, or other sources. In their view, it was the intention of Parliament that the fund should be used to promote new work, so to speak, not to pay for work already financed from other quarters.

Thirdly, the commissioners will, in general, recommend advances only by way of loan for schemes which are expected to be directly remunerative sooner or later.

Fourthly, the commissioners take note of the provision in the Act of 1909 (s. 18) which directs that in approving, executing, or making advances in respect of the execution of any work under the Act involving the employment of labour on a considerable scale, regard shall be had, so far as is reasonably practicable, to the general state and prospects of employment.

Last, and by no means least important, the commissioners feel it incumbent on them to ensure, so far as it lies in their power, that the fund shall not go into the pockets of private individuals, and they propose to recommend no applications or schemes likely to have that effect.

Policy in regard to Agricultural Development and Forestry.

The main lines of the policy by which they propose to be governed in considering schemes for two of the most important purposes mentioned in the Act, viz., first, the development of agriculture and rural industries, and secondly, forestry and afforestation.

Having regard to the amount of the Development Fund, they propose to deal with the first of these problems by devoting their attention principally to three lines of action. They aim first at increasing the amount and quality of the product of agriculture by assisting the extension of a system of scientific investigation and research, and with it of a system of education which will, so far as possible, ensure that the results of investigation and research are known and utilised in practice; and, secondly, they aim at increasing the variety of production by placing the cultivator in a position to know whether he can add certain new crops and industries to the existing number with a reasonable probability of profit. Finally, looking at the problem from a rather different and more strictly commercial point of view, they propose to encourage, in particular, the organisation of cooperation—a subject which is expressly named in the Act.

Nothing has impressed the commissioners more than the clearness with which the fact has appeared that the first condition of any considerable progress in these ways is the creation of a trained staff. It is useless to expect that immediate results of real value can be obtained on a large scale merely by expenditure. One example is sufficient: the number of men really qualified to conduct agricultural research in this country is at present exceedingly small, and it obviously cannot be increased at a moment's notice.

The problem of increasing the variety of production is likely to raise difficult questions both of principle and practice. It is enough at this early stage to name flax, hemp, tobacco, and beet as particular crops to which the commissioners propose to give attention with the view of ascertaining whether they can be grown in this country on a commercial basis, and to possible schemes for advances from the Development Fund for that purpose. They have appointed two gentlemen of scientific training to investigate by inquiry at home and abroad, and to systematise for their use the information available in regard to the first three of these crops. In regard to beet, they propose to consider in consultation with the Government departments concerned the question whether it is possible to make an experiment on a fairly large scale designed to show, not whether beet of good quality can be grown in this country (a point which they think may be regarded as settled), but whether it can be grown at a profit.

On the subject of forestry development, the commissioners have formulated for their guidance in considering British schemes and applications the following principles:—

(a) That the first requirement for such development is effective education in forestry at suitable centres, regulated by organised research and demonstration.

(b) That no scheme of State afforestation on a large scale can be considered until investigation has shown where State forests might be economically and remuneratively provided (regard being had to the interests of other rural industries), and until a trained body of foresters has become available.

(c) That for the present applications for grants for the above purposes should include provision for the creation and maintenance of such staff as may be necessary to give practical advice and assistance to those who desire to undertake afforestation or to develop existing afforested areas.

It will be gathered that in considering their action in this, as in other directions, the commissioners have been faced at the outset with the difficulty that the number of trained men in this country capable of directing forestry operations on any large scale is at present very small. Before all else they think it necessary that this difficulty should be overcome.

Applications and Schemes.

The twenty-four applications which reached the commissioners contemplated an expenditure of 210,829*l.* annually and 208,030*l.* capital sums. Among the applications, which have been grouped by subjects, may be mentioned:—

AGRICULTURAL RESEARCH AND EDUCATION.

I.—*England and Wales.*

The Treasury forwarded to the Development Commissioners on September 2, 1910, an application by the Board of Agriculture and Fisheries for an advance of 50,000*l.* per annum for the organisation of a system to aid and develop agriculture by the provision of technical advice for farmers and by promoting scientific research and experiments in the science, methods, and practice of agriculture.

The commissioners decided to recommend that the following grants, or such proportion as might be required for the financial year, should be paid to the Board for the benefit of the institutions named below, and for the purposes indicated:—

	£
Cambridge University.—Research work	4000
Bristol University.—(1) Bio-chemical investigations on cheese; (2) Investigations on teart land... ...	500
Yorkshire Council for Agricultural Education (Leeds University).—Investigations of atmospheric impurities	210
University College, Reading.—General work on (1) Microflora of cheese; (2) Cereal selection	250
South-Eastern Agricultural College, Wye.—(1) Investigations on tobacco; (2) Mycological Department; (3) Entomological Department; (4) Investigations on hop resins	350
University College of Wales, Aberystwyth.—Botanical survey of Aberystwyth, and subsidiary inquiries ...	156
Harper Adams Agricultural College.—Research on wart disease, and finger and toe	190
Royal Veterinary College.—Investigations in respect of vaccination	1390
The Incorporated Society for Extending the Rothamstead Experiments	2000
The British Dairy Institute, Reading	60
Woburn Experimental Station	600

The commissioners further intimated to the Board that they would be prepared to recommend additional interim grants, not exceeding in the aggregate a sum of 3000*l.*, to such other of the institutions as had applied for grants, but had not at that time been dealt with by the Board. They also informed the Board that they would be ready to recommend a grant of 1000*l.* to make provision for scholarships during the financial year so soon as they were favoured with a scheme embodying the conditions under which the Board proposed the scholarships should be given. The commissioners further contemplated recommending a grant of 1000*l.* for expenses of administration when the heads of estimated expenditure, and the amounts required under each head, were supplied to them.

It may be added that the commissioners have stated to the Board that they are willing to contemplate an expenditure of 40,000*l.* per annum for research alone, apart from advisory and other work.

II.—*Scotland.*

The Scotch Education Department forwarded to the commissioners on November 14, 1910, applications from each of the three agricultural colleges in Scotland for capital grants amounting in all to 137,425*l.*, made up as follows:—

Edinburgh:		£
College buildings	... ...	35,000
Farm	... ...	12,500
Forest garden	... .	1,225
		48,725
Glasgow:		£
College buildings	. ...	35,000
Farm	... ...	15,000
Research	... ...	2,500
Forest areas	... ...	5,200
		57,700
Aberdeen:		£
Purchase of estate	... ...	18,500
Alterations for farm purposes	... ...	6,000
Forest garden	... ...	1,500
Research (buildings, &c.)	... .	5,000
		31,000

On March 2, 1911, they informed the Department that they would be prepared to recommend the Treasury to grant a capital sum not exceeding 60,000*l.* on the following conditions:—

(1) That only one half of the expenditure ultimately approved is defrayed from the Development Fund, the other half being met by fresh contributions of local authorities and persons interested, and by a contribution from the Education (Scotland) Fund (one quarter from each source).

(2) That a revised scheme and estimates of expenditure relating to each individual college should be placed before the commissioners for consideration before they report to the Treasury.

They also informed the Department that they would be prepared to recommend an annual grant of one half of the excess of the expenditure of the colleges on what may be called "extension" work (*i.e.* instruction to agriculturists in the colleges' provinces by such means as lectures, visits, &c., and similar work), over the corresponding expenditure of the year 1908–9, on the following conditions:—

(*a*) That the grant from the Development Fund shall not in any year exceed the total contributions to the colleges from the Education (Scotland) Fund.

(*b*) That it shall not in any case exceed 5000*l.*

(*c*) That the commissioners are satisfied, when the formal application is made, as to the nature and scope of the work proposed; that it comes within the terms of the Development and Road Improvement Funds Act, 1909; and that it will be properly carried out.

III.—*Ireland.*

The commissioners received on July 18, 1910, an application by the Department of Agriculture and Technical Instruction for Ireland for a grant of 15,000*l.* a year for five years for the establishment and maintenance of an agricultural station for a system of general investigation and scientific research in Ireland.

It was proposed that the station should be established in the vicinity of Dublin, the capital expenditure being estimated at 20,000*l.* and maintenance at 15,000*l.* a year.

The commissioners determined to intimate to the Department that they would be prepared to consider schemes based on an expenditure of—

(*a*) 4000*l.* per annum for a central institution for investigations and technical advice of a local character.

(*b*) 5000*l.* per annum for scientific research in animal breeding or some other subject undertaken in Ireland as part of a general scheme of scientific research for the United Kingdom.

At the end of the year the commissioners were awaiting an amended application on the terms thus indicated.

Horse and Livestock Breeding.

The commissioners received on July 26, 1910, an application by the Board of Agriculture and Fisheries for a grant of 50,000*l.* per annum, of which 5000*l.* was to be devoted to livestock other than horses, and 45,000*l.* to the encouragement of light-horse breeding in Great Britain. On November 23 the commissioners recommended the Treasury to advance 36,000*l.* for one year to the Board by way of grant, to be expended generally as follows:—

	£
(*a*) Payment of premiums to the owners of stallions	13,000
(*b*) Encouragement of the keeping of brood mares	10,000
(*c*) Free nominations for the service of mares by premium stallions	3,000
(*d*) Purchase of stallions	5,000
(*e*) Registration of stallions	5,000

The report recommended advances not exceeding 3800*l.* to cover travelling expenses, the expenses of local committees, payment of local secretaries, &c., and not exceeding 1250*l.* to cover other administrative expenses up to March 31, when the sum previously voted by Parliament to the Royal Commission on Horse-breeding was expected to become available for the Board.

As regards horse-breeding in Ireland, the commissioners received on July 18, 1910, an application from the Department of Agriculture and Technical Instruction for Ireland for a grant of 10,000*l.* per annum for five years for the extension of the Department's existing schemes. On October 29, 1910, they reported to the Treasury, recommending a grant of 10,000*l.*, to be expended roughly in the following proportions:—two-fifths on the extension of the existing schemes for the registration and purchase of stallions, two-fifths on the extension of the existing schemes of service nominations to mares, and one-fifth on a new scheme to encourage the keeping and breeding of better mares of the Irish draught type.

Forestry.

It is provided in section 1 (*b*) of the Act that forestry, as one of the purposes for which the commissioners may recommend advances, shall include:—

(1) The conducting of inquiries, experiments, and research for the purpose of promoting forestry and the teaching of methods of afforestation.

(2) The purchase and planting of land found after inquiry to be suitable for afforestation.

Believing that forestry is one of the purposes of the Act which require to be dealt with on comprehensive and national lines, the commissioners at an early stage appointed four of their number to report on the broad principles to be applied to all applications bearing on the subject.

Various schemes and applications were considered, and the situation on March 31 is summed up as follows:—

In regard to England and Wales, the commissioners have just received a comprehensive scheme from the Board of Agriculture and Fisheries.

In regard to Scotland, they have agreed to the provision of a central demonstration area—for the acquisition of which preliminary steps are being taken—and of a forestry school in connection with it, and also to the provision of small forest gardens for the local use of the agricultural colleges.

In regard to Ireland, they have agreed to advances of 25,000*l.* or 30,000*l.* for the purchase of land, and to further advances, so soon as formal and definite applications are made under the Act, for additions to staff and for the maintenance and management of small woodlands in the hands of county councils.

The Development and Improvement of Fisheries.

Among the applications from the Department of Agriculture and Technical Instruction for Ireland which the commissioners received on July 18, 1910, one dealt with the development and improvement of fisheries. For this purpose the Department asked for a sum of 50,000*l.*, made up as follows:—

	£
For the development of six specified harbours	32,500
Removal of wrecks	1,000
Motor boats	5,000
Inland towns—supply of fish	1,000
Dredger	8,500
Shell-fish	2,000
	50,000

An interim application was considered by the commissioners at their meeting held on March 15, when it was resolved:—

(a) To recommend an advance of a sum not exceeding 4000*l.* for the purchase of a dredger, on the production of satisfactory tenders for the approval of the commissioners.

(b) To postpone consideration of the application in respect of Ballinagoul until the next meeting, for the production of plans of the proposed works.

Summary and Conclusion.

It will be gathered from this brief review of their action that during the first nine months of their operations the commissioners (and also, they believe, the Government departments most concerned with the Development Fund) have been largely occupied in necessary preliminary work. Although they have received under the Act but a small proportion of the applications actually made to the Treasury, yet it must be remembered that the settlement of a comprehensive scheme for such a purpose as agricultural research is in practice equivalent to disposing of many individual applications; and for reasons already stated, that procedure, though apparently slow, is, in the commissioners' view, the only ultimately satisfactory method of dealing with schemes for several at least of the purposes mentioned in the Act.

The sums of which the commissioners have either recommended the allocation, or agreed to recommend it so soon as satisfactory schemes are framed, amount roughly to 165,000*l.* per annum, and 100,000*l.* non-recurring advances. By far the larger proportion of this expenditure, if ultimately approved by the Treasury, will go in agricultural research and instruction, viz. England and Wales 105,000*l.* per annum, Scotland a lump sum of 60,000*l.* and 5000*l.* per annum, Ireland 9000*l.* per annum.

These figures do not take account of the considerable sums, of which no definite estimate can yet be given, but for which schemes were either being prepared or were under examination by the commissioners at the close of the year, *e.g.* forestry in England and Wales, the purchase of a demonstration area in Scotland and the establishment there of a central school of forestry, the development of Irish fisheries and fishery harbours, and the encouragement of the organisation of cooperation throughout the United Kingdom. Nor do they take account of applications which had not reached the commissioners, though known as having been made, or about to be made, to the Treasury—as, for instance, schemes for the development and improvement of British fisheries and of Scotch harbours; nor, again, of possible expenditure on such projects as the revival of the flax and hemp industries, the encouragement of tobacco and beet cultivation, or the establishment of an institution for the study of rural economics.

In the first nine months of their work the commissioners, so far as they are concerned, have allocated and, as they think, rightly allocated, one-third of the annual income guaranteed to the Development Fund for five years. Out of the two-thirds which now remain they hope to provide during the coming year for considerable annual expenditure on such purposes as forestry and forestry instruction and the organisation of cooperation; and it cannot be supposed that expenditure on the purposes with which they have already dealt ought to or will remain stationary at the amounts provisionally fixed. Looking to these facts, they cannot but feel some apprehension that unless Parliament comes to the aid of the fund its position in a very few years will not be a strong one. They will, however, be far more able to form an opinion on this important question at the end of the financial year 1911–12, by which time they hope that all the applications hitherto made to the Treasury will have reached them from the Government departments, that considerable schemes known to be in preparation will have been submitted, and that the inquiries which they are making into such subjects as flax, hemp, and tobacco cultivation will have been completed, or be on the point of completion.

NOTES.

ON Saturday last, July 22, nineteen aëroplanes started from Brooklands, near Weybridge, in a race for which a prize of 10,000*l.* was offered by *The Daily Mail*. The specified route was a circuit of Great Britain, with a number of landing-places, or control stations, at each of which a descent had to be made; these places, with their distances in miles from one another, were:—Brooklands to Hendon, 20; Hendon to Harrogate, 182; Harrogate to Newcastle, 68; Newcastle to Edinburgh, 93; Edinburgh to Stirling, 31; Stirling to Glasgow, 22; Glasgow to Carlisle, 86; Carlisle to Manchester, 103; Manchester to Bristol, 141; Bristol to Exeter, 65; Exeter to Salisbury Plain, 83; Salisbury Plain to Brighton, 76; Brighton to Brooklands, 40; total distance, 1010 miles. The first section of the race was covered by J. Védrines in 19m. 48s., and ten other airmen accomplished the journey in less than half an hour. On Monday morning the following machines and pilots started from Hendon for Edinburgh, with official control descents at Harrogate and Newcastle:—J. Védrines, Morane-Borel monoplane; Lieut. Conneau ("Beaumont"), Blériot monoplane; J. Valentine, Deperdussin monoplane; G. W. Hamel, Blériot monoplane; S. F. Cody, Cody biplane; H. J. D. Astley, Birdling monoplane; C. Howard Pixton, Bristol biplane; Lieut. R. A. Cammell, R.E., Blériot monoplane; O. de Montalent, Bréguet biplane; C. T. Weymann, Nieuport monoplane; C. P. Pizey, Bristol biplane; G. Blanchet, Bréguet biplane; B. C. Hucks, Blackburn monoplane; Lieut. H. Bier (and passenger), Etrich monoplane; Lieut. H. R. P. Reynolds, R.E., Howard Wright biplane; E. Audemars, Blériot monoplane.

YESTERDAY afternoon, when we went to press, two airmen, namely, "Beaumont" and Védrines, had reached Brooklands, having completed the circuit, and it was announced that the prize had been awarded to "Beaumont." The race was a severe test of the efficiency of aëroplanes and their control by the pilots. The circuit of 1010 miles had to be completed without any airman changing his engine or aëroplane. Five parts in each aëroplane and five in each engine were stamped, and at least two parts in each case had to be in place at the end of the race, the object of the contest being to encourage the construction of trustworthy and enduring flying machines. That it should be possible for airmen to travel over such an extended course of strange country with nothing but maps and compasses to direct them is, however, a remarkable achievement, independent of the capabilities of the aëroplanes. No doubt much experimental data and mathematical investigations will be required before aëroplane architecture can reach the position of naval architecture, but meanwhile aviation engineers and pilots are bringing us nearer that conquest of the air which will be the distinguishing characteristic of the present century; and one of the historic events of this era of aërial navigation will be the trying contest which has just been concluded.

WE gather from a circular lately received that a testimonial is contemplated in honour of Sir Patrick Manson, K.C.M.G., F.R.S. The international memorial was an inception by Prof. Blanchard, of the Faculty of Medicine, Paris, and with him are associated the names of men best known in tropical medicine. It was felt, however, that it would ill become Sir Patrick's British *confrères* did they not come forward and show their special appreciation of the work he has done in the field of tropical medicine. The international testimonial is proposed to take the form of a plaquette in gold to be presented to Sir Patrick, and bronze plaquettes to subscribers, to bear an impression of Sir Patrick by a well-known artist. The British testimonial is in the first place to be the presentation of a portrait in oils, of which each subscriber of one guinea and over will receive a black-and-white reproduction; but it is hoped that, in addition, a Manson prize will be founded for bestowal as a reward for good work accomplished in the sphere of tropical medicine and hygiene. Of the success of these testimonials there should be no doubt, for the benefits conferred upon mankind by Sir Patrick Manson as the "father" of modern tropical medicine is incalculable. A new field of scientific investigation has been opened by him; the formulation of the mosquito-malaria theory has had consequences which have extended far beyond even the widely flung malaria, and opened up new channels of thought in every direction. Knowledge of the part played by vermin in the spread of disease is being extended daily as the result of Manson's work, and a new school of thought, giving a fresh direction and impetus to inquiry, has advanced science generally, and will go on bearing fruit so long as time extends.

THE organising committee of the Fourth International Conference of Genetics, to be held in Paris on September 18–23, met recently under the presidency of Dr. Viger. M. Philippe de Vilmorin, secretary of the committee, reported what had been done up to that day in preparation for the conference. Not counting the names of the principal French biologists who are members of the committee, the secretary was able to give the names of the following foreigners who have subscribed:—Baur, Giesenhagen, Goldschmidt, Pfitzer, Poll, &c. (for Germany); Agar, Bateson, Darbishire, Gregory, Miss Durham, Hartog, Laxton, Lynch, Nettleship, Paton, Punnett, Miss Saunders, Staples-Browne, Sutton, Miss Wheldale, &c. (for Great Britain); Bradley (for Australia); Fruwirth, Strakosh, Tchermak, &c. (for Austria); W. and Chs. Saunders (for Canada); Johannsen (Denmark); Balls (Egypt); Davenport, Hays, Howard, Swingle, Tower, &c. (United States); Hagedoorn, Houwink, Lotsy, Noordnijn (for Holland); Leake (for India); Strampeli (for Italy); Nilsson-Ehle, Rosenberg (for Sweden); Chodat (Switzerland); Boris de Fedtschenko (Russia); and Arechavaleta (Uruguay). Many universities and scientific societies will be officially represented. Numerous communications have been promised; short descriptions of them will be published before the meeting of the conference, and they will be published in full in the proceedings, a copy of which will be sent to each subscriber. The meetings of the conference will depend upon the number of the communications, but it seems probable that five sittings will be sufficient. The remaining time will be devoted to visits to the Museum of Natural History, the Pasteur Institute at Garches, to Verrières, the laboratories of the Sorbonne, &c. Probably there will be a reception by the French National Society of Horticulture on September 18, and one at the Hôtel de Ville on September 23.

IT has been decided to publish from the Sleeping Sickness Bureau a quarterly bulletin dealing with the Leishmania group of diseases. Dr. C. M. Wenyon, protozoologist to the London School of Tropical Medicine, will undertake this part of the work. A list of references is now in preparation and will form the first number.

REUTER's correspondent at Washington announces that on July 24 the Senate ratified the agreement between the United States, Great Britain, and Russia for the suspension of pelagic sealing for fifteen years. An article upon the fur-seal and the convention, which has now been accepted by the United States Senate, appeared in NATURE of July 13.

WE learn from *Science* that the earthquake of July 1 is reported to have done considerable damage at Lick Observatory, on Mount Hamilton. The 36-inch telescope is said to have been moved three-quarters of an inch out of place on its concrete pier, but was restored without trouble. The case of the Riefler clock was wrecked, and minor damage was done to the working parts. The chimneys of the observatory buildings were injured, and a brick structure which houses a number of astronomers was cracked so as to be unsafe for occupancy.

IN the obituary notice of the late Dr. H. Bolus in NATURE of June 8, reference was made to "his generous support of the Cape University, which owes to him the foundation of its chair of botany." Prof. H. H. W. Pearson writes to point out that though the establishment of the "Harry Bolus chair of botany in the South African College in 1903 was due in a large measure to the munificent support which Dr. Bolus gave it, there is no botanical chair in the Cape University, which is not a teaching institution."

REFERRING to the inauguration of a fund to honour the memory of the late M. J. Joubert, to which attention was directed in our last issue (p. 101), we are able to state that an influential committee has been formed, including representatives of the Pasteur Institute, the French Physical Society, and the International Society of Electricians. Joubert's collaboration with Pasteur, his work for the French Physical Society, of which he was once president and for ten years general secretary, and his researches and writings, have all made his name widely known and respected. The idea of founding a Joubert scholarship should appeal to all old colleagues, pupils, and friends of Joubert. Subscriptions may be sent, as has been stated, to M. Gauthier-Villars, 55 quai des Grands-Augustins, Paris.

THE present month is establishing a record both for the long and persistent drought and also for its high temperature. In London, July 25 was the twelfth day during the month with the thermometer above 80°, and on two days, July 21 and 22, the temperature exceeded 90°. There has been no temperature in London so high as 90° in July since 1900, and none at any period of the summer since 1906. At some places in the east and south-east of England the thermometer rose higher than in London. In France and Germany the temperature has also been excessive, shade readings of 100° being reported in places. The month was absolutely rainless in London and over the southern portion of England until July 24, when slight rain was experienced, which was followed by a thunderstorm on July 26; so long a period of drought has not occurred in July since 1887.

THE recorder of Section C (Geology) of the British Association sends the following statement of the provisional programme for the Portsmouth meeting:—Joint meetings have been arranged with Sections E (Geography) and K (Botany). The subject for discussion with Section E is "The Former Connection of the Isle of Wight with the Mainland," and with Section K, "The Relation of the Present Plant Population of the British Isles to the Glacial Period." Presidential address by Mr. Alfred Harker, F.R.S. The address on the local geology will be delivered by Mr. Clement Reid, F.R.S. The following papers have already been promised:—"On the Discovery of Remains of *Iguanodon bernissartensis* in the Wealden Beds of Brightstone Bay, I. of W., and the adaptation of the pelvic girdle to an erect position and bipedal progression,"

R. W. Hooley. (1) "Siliceous Oolites and other concretionary structures in the vicinity of State College, Pennsylvania," (2) "On the Pre-Cambrian Beds of Ontario," Prof. E. S. Moore, of State College, Pennsylvania. "Further Work in the Silurian Rocks of the Eastern Mendips," Prof. S. H. Reynolds. (1) "On some New Rhætic Fossils from Glen Parva, Leics," (2) "On the Shell-layer in Mollusca," A. R. Horwood.

In *The Times* of July 12 Mr. W. E. Roth, now Commissioner of the Pomeroon district, British Guiana, discusses modern men of the Stone age in New Guinea and North Australia. From a comparison of Mr. Goodbody's account of the strange race found in the hitherto unknown interior of Dutch New Guinea with the natives of North Australia, Mr. Roth comes to the conclusion that the latter are "undoubtedly the more primitive, in that they are nomadic and ignorant of any native fermented drink. They are certainly on a level with regard to the treatment of their women and in their eating human flesh; this, however, can hardly be regarded as true cannibalism, in that all the cases that I have met with in North Queensland were due rather to sentiment and affection, nor, indeed, did I come across a single instance where the individual—man, woman, or child—was purposely killed to be eaten."

Artists and students of anatomy will welcome the elaborate paper entitled "Les proportions du corps pendant la croissance de 13 ans ½ jusqu'à 17 ans ½ ainsi qu'à la naissance, à 6 ans ½ et à 23 ans ½ représentées en milliémes de la taille," published in parts iv.–v., for 1910, of *Bulletins et mémoires de la Société d'anthropologie de Paris*. These series of elaborate measurements of the relations of different parts of the human body are illustrated by statistical diagrams. The memoir is a fine example of the best class of anthropometrical work in which French *savants* have gained a well-merited reputation. Another similar memoir, contributed to the same journal by Drs. Chaillou and Léon Mac-Auliffe, entitled "Le type musculaire," starts with the examination of cerebral characteristics, and passes on to the consideration of living types and sexual variations. The paper deserves study by all who are interested in physical culture. After pointing out the diseases due to the sedentary life, the authors arrive at the conclusion that its hygiene resolves itself into two words—exercise and rest.

In the July issue of *Man*, Messrs. N. F. Robarts and H. C. Collyer continue their report on the excavation of the British camp at Wallington. The numerous loose unbroken flints found on the inner side of the ditch seem to have been used as missiles, and round Tertiary pebbles were employed as sling-stones. A large collection of implements used in the preparation of food was made, the most common, probably because they were the most indestructible, being saddle-back mealing stones, made of the Lower Greensand sandstone. Many tiles, resembling those from the Swiss Lake dwellings, were discovered. Though there were many flakes and cores, stone implements were scanty in number. A broken axe of diorite indicates foreign commerce. Further exploration of the large remaining portion of the ditch will doubtless provide many other similar articles, but the specimens already unearthed are sufficient to give a tolerably clear idea of the civilisation, arts, and industries of the inhabitants of this Surrey town in the first or second century B.C.

We have received a copy of No. 3 of the *Nature Photographer*, which contains excellent photographs of a merlin and her young, and of a group of the tree-fungus known as the "oyster of the woods."

The first part has reached us of a "Lepidopterorum Catalogus," edited by C. Aurivillius and H. Wagner, and published by W. Junk, of Berlin. The catalogue, of which this part deals with the Chrysopolomidæ, purports to give the name of every genus and species, with references.

After financing a natural history collecting expedition to Alaska, Miss A. M. Alexander recently supplied funds for a similar undertaking in Humboldt County, Nevada, which was duly accomplished in the summer of 1909. The results, so far as mammals are concerned, are recorded by Mr. W. P. Taylor in a report issued as No. 7 of the seventh volume of the University of California Zoological Publications. One short-tailed field-mouse is described as new.

Among the more important papers recently published in the Proceedings of the Academy of Natural Sciences of Philadelphia, reference may be made to the third portion of Mr. J. P. Moore's account of the polychætous annelids, dredged off southern California by the *Albatross*, which appeared in the April issue. The number of new forms described indicates the richness of the fauna. Later on in the same issue Messrs. Brown and Pilsbry describe the molluscs of the Tertiary Gatun beds, Isthmus of Panama.

In describing a batch of fourteen newly-born young of an electric ray (*Narcine brasiliensis*) from Florida, Messrs. Bean and Weed point out, in No. 1816 of the Proceedings of the U.S. National Museum, that these differ in colouring from their parents. The young, as shown in a striking plate, are spotted as conspicuously as a leopard, whereas in the adult the spots are much less distinct, and in some cases are formed by the agglomeration of pin-like dots. In No. 1824 of the publication cited, the same authors reclassify the so-called freshwater American sunfishes of the genus Lepomis, belonging to the peccoid family Centrarchidæ. The pharyngeal bones and teeth are largely taken as the basis of classification, and a number of examples of this part of the skeleton are figured.

In an article on the Morocco-Algerian frontier, contributed to the *Field* of July 15, Sir H. H. Johnston reproduces two outline figures of the extinct north African buffalo (*Bos* [*Bubalus*] *antiquus*), incised on rock-faces near Tiout, southern Algeria. The sketches, the age of which is unknown, appear to have been made by a people related to the modern Berbers, but living under conditions similar to those prevalent during the Neolithic or early Metal age in Europe. The horns of the buffalo seem to be of the type of those of the Indian, as distinct from the African, species, and are of immense size. On the other hand, it has been stated that the skeleton, apart from the skull, is more like that of the African buffalo; and the nasal bones appear to be of the short type distinctive of the latter. Sir Harry Johnston states that he was informed by one of the professors at the University of Algiers that other rock-pictures show this buffalo domesticated by a tribe acquainted with the use of metal; a circumstance which renders it all the more remarkable that the species should have become extinct before the time of Carthaginian and Roman history. It may be added that the intermediate characters presented by the extinct Algerian species tend to show that the proposal to separate generically (or subgenerically) the African from the Indian buffalo is unnecessary.

Systematic contributions to the *Kew Bulletin* (No. 5) comprise a list of Balsaminaceæ from the State of Chitral determined by Sir Joseph Hooker, a series of new African euphorbiaceous plants, including a new genus, Cyrtogonone, defined by Dr. Prain and a collection of new exotic fungi described by Mr. G. Massee; of the latter, two species of Balansia, *Æcidium osyridocarpi* and *Ustilago trichopterygis*, are figured, and *Æcidium cymbopogoni* is noted as a destructive pest on lemon grass in the botanic gardens at Entebbe. An article on persimmons, communicated by Mr. W. B. Hemsley, furnishes evidence for separating *Diospyros roxburghii*, a species native to east India and western China, from *Diospyros kaki*.

An appreciable supplement to what was considered to be a fairly complete list of plants for Monroe County in New York State and adjoining territories, published in 1896, has been issued in the Proceedings of the Rochester Academy of Science (vol. v.). The additions amount to more than two hundred species, of which two-thirds are native and one-third alien. No fewer than seventy-seven of the native species represent determinations made by Dr. Sargent for the genus Cratægus, as this county supplied him with a large number of critical forms; under Viola, eight new native species are scheduled. An alien that was expected and duly arrived along the railroad track is a variety of *Salsola kali*, that receives the name of Russian thistle. *Lysimachia nummularia* is noted as a weed growing on lawns.

The announcement is made in the May number of *The Indian Forester* that the responsibilities of editorship have been transferred to the president of the Research Institute at Dehra Dun, with whom, as heretofore, a board of management is associated. Among the contents is a concluding article on paper-pulp testing, contributed by Mr. W. Raitt. Dealing with grasses, two new sources are indicated as pulp prepared from "ulla," *Anthisteria gigantea*, and a Burmese consignment of "kaing" grass, *Phragmites karka*, both gave satisfactory results in the matter of colour, strength, and toughness; being in these respects superior to "bhabur," *Ischaemum angustifolium*, that is now worked in the factories. Summarising the prospects of the pulp industry in the United Provinces, the author is of opinion that large reserves of material exist, that ulla, bhabur, and spruce promise to yield the best material, while a number of trees, notably *Bombax malabaricum*, would furnish a pulp of inferior but serviceable quality.

Central America is following the excellent example set by the United States in agricultural education, and from Costa Rica we have received the first two numbers of the *Boletin de Fomento*, the organ of the Department of Agriculture. Hevea and coffee naturally come in for a good deal of attention, and sections are devoted to horticulture and agriculture; there is also a geological section. A list of Spanish works on water in relation to agriculture is given, which, though small in comparison with other lists, is much more extensive than one would have expected. The bulletins are well illustrated, and will, we hope, be found to serve a useful purpose.

The Agricultural Statistics of India for the years 1904–9 are now published in two volumes, vol. i. relating to British India and vol. ii. to the native States. The statistics are not discussed, but are given without comment; for the native States they are not always as accurate as might be desired, but the best available information has been used. For the historian and the administrator these records are invaluable, and all interested in Indian agriculture will find complete *data* as to crops, irrigated and unirrigated areas in the numerous districts, for each of the five years under consideration.

The growing importance of rice in India has necessitated a careful study of the numerous races cultivated by the natives, and as a preliminary these races have been enumerated in *The Agricultural Ledger* (1910, No. 1). The list is very extensive, and extends over two volumes, each of nearly 300 pages, but it is believed to be as complete as is at present possible. Under each variety is given a very brief description, together with references to papers or books where a fuller account may be found: thus the list is also a guide to the literature. An enormous amount of work has evidently been involved in its preparation, but the authors, Messrs. R. Abbey-Yates and E. F. Vieux, will have the satisfaction of knowing that they have saved subsequent workers much weary searching through literature that is not always easily accessible.

The report of the Egyptian Survey Department, dated July 3, states that the White and Blue Niles had been rising throughout June at a normal rate, but the level at Wadi Halfa was then 25 cms. below normal, owing to a check in the rains in Abyssinia. The forecast for the Nile flood indicated that it will probably be about 10 per cent. below the average.

The Cairo Scientific Journal for June contains two articles on the silt which is carried and deposited by the flood waters of the Nile, relating especially to the Ibrahimia Canal, one of the great artificial waterways which irrigate Middle Egypt to the north of Assiut. Samples were taken at varying depths, and seemed to show that the scour caused by a bridge unsuitably placed increases the silt which is deposited in the canal downstream of it to a considerable extent. The matter is one of great importance to irrigation in Egypt, and too little attention has hitherto been given to obtaining accurate results, so that the work of Messrs. Bury and Pollard is of definite value.

In the same number Mr. A. Lucas treats of "hashish," or Indian hemp, *Cannabis indica*, the forms in which it finds its way into Egypt; the manner in which it is consumed, and the methods of detecting it with certainty. Its introduction into Egypt is prohibited, and very large quantities (amounting to 23,000 kilog. in 1909) are seized every year by the Custom House officials and the coastguard officers, but the demand is widespread, and it is obtainable practically in every village. From the number of ways in which this injurious drug is prepared for consumption, in the form of sweetmeats or confections, and the large amount that is still introduced into the country, such investigations are of the highest importance, especially in a country where the adulteration of foods is not controlled, as in Europe.

In the July number of *Petermann's Mitteilungen*, Dr. Peucker gives an account of the proceedings of the International Aëronautical Conference, held at Brussels on May 26 and 27, in so far as they affected maps. Resolutions were passed in favour of the scale of 1 : 200,000 as far as possible, though in special circumstances other scales might be desirable; each sheet should include a degree square, and the sexagesimal system should be employed: geographical names should be in the language of the country represented. In the compilation of detail and employment of conventional signs full latitude was given, but some delegates expressed the desire that high-tension electric cables should be indicated.

The Hydrographer's report for 1910 has been issued, containing a brief summary of the surveys which have been carried out by the Admiralty during the year. Five ships were employed in home waters and seven abroad, off

British Columbia, Australia, Borneo, the west, south, and south-east coasts of Africa, the Straits Settlements and Australia, and off Newfoundland. Two ships of the Royal Indian Marine were employed on the Marine Survey of India, off Burma, and the west coast of India. Among much work classed as miscellaneous, a systematic determination of the magnetic variation in the North Sea was carried out in March by the officers of four cruisers, which resulted in obtaining good values at sixty-two positions. Considerable irregularity was also located near the Shetland Islands, and also near the coast of the British Isles. Further experiments were carried out at Chatham with the Field-Cust tide-recording apparatus for use at sea, and very satisfactory results were obtained.

THE Journal of the Meteorological Society of Japan for May contains, in addition to several articles in Japanese on interesting subjects (*e.g.*, "Fogs on the Korean Coast," "Variation of Barometric Pressure in Japan," &c.), original articles in other languages. One of the latter is on "Wireless Telegraphy in the Service of Japanese Meteorology," by Mr. T. Saki. Japan is frequently visited by typhoons, and the most dangerous are those which originate in the Pacific. By arrangements made since May, 1910, the central office at Tokio receives ordinary and special codified radiograms from men-of-war and vessels of the great Japanese shipping companies, from distances even as far off as 180° E. longitude (40° E. of Tokio), and dispatches warning telegrams to ships at sea. These messages will be of great value both for storm-warning purposes and for improving our knowledge of the behaviour of those destructive storms.

IN *Climatological Service* of the U.S. Weather Bureau (District No. 11, California), Prof. A. G. McAdie publishes a paper on forecasting the supply of water for the summer from the depth of snow, which is of considerable interest to engineers, farmers, and others. Observations of the depth of snow and of rainfall have been made since 1870 at Summit, a station on the Southern Pacific Railway, at a height of 7017 feet, where 86 per cent. of the precipitation falls as snow. The average depth of snow (mean of ten seasons), the average rate of its melting, and the depth for the present season, are shown by a diagram. A model (shown in the paper) is also made use of for comparing the actual curve of melting snow for any given season with the mean curve. By means of this design and the tables, the probable date of the snow's disappearance, and the consequent cessation of water supply from this source may be determined. The author points out that the wind is probably the greatest factor in reducing the depth of snow, and he refers to the difficulty of determining the water equivalent for given depths. The "packing" process plays an important part; samples taken near the top and bottom of a snow bank give very different results.

DR. H. A. MIERS, F.R.S., principal of London University, delivered the eighteenth Robert Boyle lecture before the Oxford University Junior Scientific Society on May 20, and selected as his subject the growth of a crystal. The lecture has just been issued by Mr. Henry Frowde, price 1*s*. net. To the elucidation of the problem of crystallisation nearly the whole of the researches which Dr. Miers had carried on with the aid of a small but zealous band of students during his tenure of the Waynflete chair of mineralogy at Oxford had been devoted, and his lecture, therefore, took largely the form of a valedictory address, in which he recounted the nature of those researches and summed up the progress made in our comprehension of the constitution of crystallised matter as the result of them. Dr. Miers had early realised that mere idle speculation was futile, and that it was of primary importance to observe a crystal while actually growing, and had devised for the purpose apparatus which he brought with him to Oxford; with it he made the interesting discovery that the layer immediately in contact with the crystal is denser than the liquid as a whole. In conjunction with Miss Isaac he investigated the conditions governing crystallisation from a saturated solution, and at his instigation Mr. Barker studied the growth of one crystallised substance on another, and found that congruence of molecular structure was the factor that determined parallelism of growth. Dr. Miers referred to Prof. Lehmann's discovery of liquid crystals, and to the theory of crystal structure put forward by Mr. Barlow and Prof. Pope, and, in conclusion, pointed out that advance in a subject such as crystallisation, which lay near the confines of several branches of science, depended to no small extent upon the assistance of other workers beyond the fence.

UNDER the title "Men of Note in Aëronautics," the July issue of *Aëronautics* gives a biographic notice of Mr. R. F. Macfie which should do much good in bringing home to English readers the side of aviation to which little attention is given in daily papers. The extracts from Mr. Macfie's diary will, indeed, be a revelation to the uninitiated reader of the difficulties encountered by the early pioneers of artificial flight, which include destruction of aëroplanes, repeated interviews with War Office officials, followed by refusal of permission to fly, delays of three days at Custom houses, permission refused at Pau after having previously been granted, interviews with municipal authorities resulting in further refusals, loss of machine in transit, its recovery in a terrible state of ruin, delay in sending engines, short flights, then permission withdrawn, machine damaged by bad weather, then partially burnt. In spite of the present popular enthusiasm, there are many workers in aviation who not only do not receive the recognition they deserve, but are, on the contrary, handicapped by every kind of discouragement.

THE Circolo Matematico di Palermo is a society which during the twenty-seven years that have elapsed since its foundation in 1884, has gradually developed into an international mathematical society. It is interesting to note how different nationalities were represented at the time when its last report, for 1910, was drawn up. Out of a total of 745 members, we find that the countries contributing not fewer than 10 members may be classified as follows:—Italy, 275; United States, 119; Germany, 111; France and colonies, 54; Austro-Hungary, 49; Russia, 24; Great Britain and Ireland, 17; Sweden, 16; Denmark, 13; Belgium and Switzerland, each 11. The membership for the whole British Empire, including India, only numbers 24, the same as for Russia. It need scarcely be pointed out that the large preponderance of Italian members is in great measure attributable to the local character of the society, but leaving the figures for Italy out of account, the remaining statistics may afford some indications of the relative importance attached by different countries to an international movement for the advancement of higher mathematics.

THE annual report of the Royal Prussian Meteorological Institute ("Bericht über die Tätigkeit des königlich Preussischen Meteorologisches Instituts, 1910") has been issued. The administrative report shows that satisfactory progress has been maintained with routine work both at the institute and at the Potsdam Observatory. A number of scientific papers by members of the staff or by observers in connection with the institute are printed as appendices. Several of these deal with questions of thermometer and rain-gauge exposure. Among the remaining papers we may mention a detailed summary of the observations of cloud motion over Hildesheim, extending over the period 1904–8, by Th. Bötel, observer at Hildesheim, and a report by W. König of the heavy rainfall experienced in Germany during the first few days of August, 1910. Appendix xi. reports on the comparison of the standard barometers and magnetic instruments of Potsdam Observatory with those of de Bilt, Paris, Val Joyeux, and Pavlovsk, carried out by Dr. W. Kühl in conformity with resolutions of the International Meteorological Committee. Further papers on magnetic comparisons are contributed by Prof. Ad. Schmidt and Dr. O. Venske. Prof. Schmidt also contributes a paper on the detailed magnetic survey of east Prussia, a region of great magnetic disturbance. This is accompanied by a chart of isogonic lines for the epoch 1911·0

IF the collimator and telescope of a spectrometer are so placed that their axes coincide, and a block of plane parallel glass is placed between the collimator lens and the telescope lens, no deviation of the image of the collimator slit is produced. If the upper part of the glass block is provided with a prism-shaped cavity which contains a liquid having an index of refraction which differs from that of the block, the upper part of the image of the slit will be deviated by an amount proportional to the difference of the two indices of refraction. Now the deviation of a narrow pencil of homogeneous light on passing through a lens is proportional to the distance of the point of the lens on which the pencil falls from the axis of the lens. By making the light which has passed through the liquid pass through a lens at the proper distance from the axis, the deviation due to the liquid may therefore be compensated. It is on this principle that the Féry refractometer is constructed. The block of glass containing the prism-shaped hollow for the liquid the index of refraction of which is required, is enclosed in a small water tank the sides of which are plane convex lenses. The tank and contents can be moved horizontally across the field by means of a screw, and the distance through which they have to be moved to make the resultant deviation zero, is found to be proportional to the difference of refractive indices of glass and liquid. In the instrument as constructed by Messrs. Hilger, the range of refractive index is from 1·3300 to 1·6700, with a degree of accuracy of nearly 0·0001. The reading is direct, and by heating the water in the tank to different temperatures the effect of temperature on the index of the liquid may be determined. A measurement can be obtained with 1 c.c. of liquid.

THE second issue of *Le Monde*, which is described as a monthly illustrated encyclopædia, being an anthology of the reviews of all countries, has reached us. Copies may be obtained in this country from Messrs. Nilsson and Co., 16 and 18 Wardour Street, London, W., at the price of three francs. Among other contributions to this issue we notice translations into French of Mr. H. H. Suplee's article in *Cassier's Magazine* on the determination of altitudes reached by aëroplanes, and an article from *The Times* on the great ocean liners which now connect Europe and America.

WE have received from Prof. C. Ulpiani a reprint of a paper from the *Atti della Società Italiana per il Progresso delle Scienze*, 1910, discussing the work of the United States Bureau of Soils, especially the applications of physical chemistry to the soil.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES FOR AUGUST:—

Aug. 1. 7h. 11m. Jupiter in conjunction with the Moon (Jupiter 1° 13′ N.).
7. 22h. 46m. Uranus in conjunction with the Moon (Uranus 4° 28′ N.).
8. 18h. 0m. Mars at quadrature to the Sun.
10. 1h. 0m. Venus at greatest brilliancy.
10–12. Maximum of the Perseid Meteors.
12. 21h. 0m. Mercury at greatest elongation E.
13. 6h. 0m. Saturn at quadrature to the Sun.
16. 15h. 53m. Mars in conjunction with Saturn (Mars 0° 21′ N.).
16. 20h. 2m. Saturn in conjunction with the Moon (Saturn 4° 2′ S.).
16. 20h. 12m. Mars in conjunction with the Moon (Mars 3° 40′ S.).
19. 19h. 0m. Venus in Aphelion.
21. 1h. 20m. Neptune in conjunction with the Moon (Neptune 5° 36′ S.).
22. 14h. 0m. Venus stationary.
25. 11h. 50m. Venus in conjunction with the Moon (Venus 10° 23′ S.).
28. 22h. 0m. Jupiter in conjunction with the Moon (Jupiter 1° 41′ N.).

DISCOVERY OF ANOTHER COMET (1911*c*).—A telegram from the Kiel Centralstelle announces the discovery of a comet at the Geneva Observatory (U.S.A.) on July 20. At 9h. 52m. (Geneva M.T.) the comet's position was

R.A. 22h. 13·6m., dec. 20° 57′ N.,

and it was moving in a north-westerly direction. A second observation was made on July 21 at the Lick Observatory, and at 9h. 53·1m. (Lick M.T.) the position was

R.A. 22h. 13m., dec. 21° 34′ 40″ N.

This position precedes the Great Square, and forms, roughly, an equilateral triangle with α and β Pegasi; it transits at about 1 a.m. According to the Lick observers, the comet was of about the tenth magnitude, and was moving in a N.N.W. direction.

THE KIESS COMET, 1911*b*.—A number of observations of comet 1911*b* appear in No. 4512 of the *Astronomische Nachrichten*, where the magnitude is variously recorded with values varying from 4·0 to 8·5. The object is blue or green, and has a faint tail, which on a photograph taken at Simeïs on July 9 was 0·5° long, in position angle 285°.

Later observations have made it possible for Dr. Kobold to improve his elements and obtain an ephemeris which practically agrees with the observations; these he publishes in a supplement to No. 4513 of the *Astronomische Nachrichten*.

Ephemeris (12h. M.T. Berlin).

1911	α (true) h. m.	δ (true) ° ′	log r	log Δ	mag.
July 26	4 15·0	+30 3·3			
,, 28	4 9·9	+28 57·7	9·9515	9·8582	5·8
,, 30	4 4·2	+27 40·2			
Aug. 1	3 57·5	+26 3·5	9·9755	9·7742	5·4
,, 3	3 49·7	+24 5·6			

Perihelion occurred on June 30, so that the comet is now receding from the sun; but it is approaching the earth, and later, in August, will come within 0·2 of an astronomical unit. It should then provide a striking spectacle, especially to those situated in the southern hemisphere, in the early morning sky. At present its calculated magnitude is about 6·0, but when nearest the earth the comet should increase in brightness to about magnitude 3·5. The present position lies about half-way between ι Aurigæ and the Pleiades, and on August 3–4 the comet should be very near to the latter asterism.

WOLF'S COMET, 1911*a*.—Observations of this faint comet are recorded in No. 4512 of the *Astronomische Nachrichten*. M. Javelle, observing at Nice on July 5, found it to be a star-like object of less than magnitude 14·0, having a faint nebulosity about it. M. Kamensky finds that the correction to his ephemeris is about −0·5s. and −6·3″, and asks observers to communicate their positions to him.

THE RADIAL VELOCITY OF THE SUN, AND DOPPLER'S PRINCIPLE.—In No. 5, vol. xxxiii., of *The Astrophysical Journal* Mr. A. Cotton has a paper dealing with the legitimacy of applying Doppler's principle, purely and simply, to determine the radial velocity of the sun's parts from the measured displacements of the lines in the solar spectrum. He shows that the fact that the sun is surrounded by an extensive, turbulent atmosphere, in which densities and thermic qualities of vastly different magnitudes coexist, is sufficient to call for prudence when applying a simple, single interpretation to the displacements.

PECULIAR STELLAR SPECTRA AND SELECTIVE ABSORPTION IN INTERSTELLAR SPACE.—We have just received No. 51 of the Lowell Observatory Bulletins, in which Dr. Slipher discusses evidence for the existence of some material in interstellar space which differentially absorbs star radiations.

A spectrum of β Scorpii displayed a sharp K line, whereas all the other lines in this "Orion"-type spectrum were diffuse and broad; and while the latter show a Doppler displacement equivalent to a range of 240 km., the K line gives no sign of shift.

Further research indicated that σ, δ, and π Scorpii exhibit the same phenomena, and in this are like δ Orionis, ζ Ophiuchi, ι and η Orionis, o Persei, and other binaries. Apparently the matter wherein this calcium absorption takes place is, in each case, independent of the star, and the theory at once suggests itself that it takes place in an absorbing medium lying between us and the stars. Evidence for this accumulates in other directions; and the matter is one of fundamental importance to which the attention of astrophysicists must soon be directed. Dr. Slipher asks for cooperation; as a preliminary, the examination of all the spectra of "Orion"-type stars in existence would indicate those in which the independent behaviour of the calcium, and maybe the sodium, lines was marked.

FRENCH ASTRONOMICAL WORKS.—Readers of French will find that "Quelques Heures dans le Ciel," a franc "paper back," by the Abbé Th. Moreux, gives a very complete, lucid, and well-illustrated *résumé* of present-day astronomy. The chatty freedom with which the various points are explained will attract the beginner, and the illustrations will considerably assist his comprehension.

Those who wish to practise astronomy will find the Commandant Ch. Henrionnet's "Petit traité d'Astronomie pratique" a useful summary and guide. The author describes the books and the instruments used, the simpler methods employed, and gives a brief statement of the interesting things in various constellations. Gauthier-Villars publish the book at 1.75 francs.

THE MANCHESTER MEETING OF THE INTERNATIONAL ASSOCIATION OF SEISMOLOGY.

THE meeting of this association, which was held in Manchester on July 18–22, proved to be one of considerable interest and importance. The time spent on business and administration was less than at preceding meetings, so that more was left for original communications and discussions.

On the opening day, the Vice-Chancellor of the University of Manchester received the delegates in the Whitworth Hall, and during the day a telegram was received from the President of the Board of Education in the following terms:—

"His Majesty's Government heartily welcome your association, and wish success to their deliberations. They rejoice to see the attempt to organise seismology internationally, which was initiated by the British Association under the influence of Dr. Milne, bearing fruit, through your proceedings on British soil."

Amongst the communications received, probably the most important was the description by Prince Galitzin of his new instrument for measuring the vertical component of the motion of the soil. The instrument shown at the meeting has been acquired for the observatory at Eskdalemuir, where it will be set up as soon as a proper foundation can be built.

Mr. Oddone showed an ingenious and simple apparatus for measuring the elasticity of rocks, and Mr. Wiechert's communication on the constitution of the interior of the earth gave rise to an interesting discussion.

An instrument was also shown at the meeting constructed by the Cambridge Scientific Instrument Company, with which it is intended to count the number of waves which strike the shore in a given time in order to test whether the period of these waves is the same as the period of the microseismic disturbances. This instrument has already been taking records on the coast of Northumberland, under the superintendence of Mr. Morris Airey.

There was a reception in the Town Hall on one of the days of meeting, which was well attended, and a dinner was given by the university on the last evening.

Saturday, July 22, was given up to excursions, and at the invitation of the director of the Meteorological Office and of Mr. and Mrs. J. Walker, nearly twenty foreign delegates visited the new magnetic and meteorological observatory at Eskdalemuir.

The foreign delegates both privately and publicly expressed their gratification at the presence of Dr. Milne, and, in addition, British men of science were well represented, amongst others by Sir George Darwin, Profs. Lamb, Love, Knott, Mr. Oldham, and Dr. Shaw.

Prince Galitzin was elected president, and Mr. Lecointe vice-president, for the next period of three years, dating from April, 1912.

The opening address delivered by Prof. Schuster on July 18 is subjoined.

Some Problems of Seismology.

Since our last meeting important changes have taken place in our Central Bureau. Increasing age has compelled Prof. Gerland, to whose strenuous efforts the foundation of this association is mainly due, to resign the directorship of the seismological station at Strassburg. Prof. O. Hecker, who has been appointed in his place, has thereby become the director of the Central Bureau, and you will agree with me that no better choice could have been made. The excellence of his work is well known to you, and since he has entered into his new office he has with characteristic energy already done much to make the bureau more efficient for its international work. You will have an opportunity of showing your confidence in him when we decide on the locality of the Central Bureau for the next period of four years, as though we have no official voice in the choice of the director, it lies in our power to move the seat of the Central Bureau at any meeting of the general assembly if such a course seems desirable in the interests of our work.

Our association primarily deals with the study of the causes of earthquakes and of their effects, but the interest which the public shows in our investigations is mainly due to the sympathy roused by the human suffering which follows the trail of these seismic catastrophes. At present we feel helpless, though perhaps not altogether hopeless, in the face of the destructive convulsions of the earth. The problem of constructing buildings which can withstand shocks of earthquakes does not enter into our programme, but it has been asked, and the question will be raised during the present meeting, whether there are any preliminary indications which would allow us to predict the occurrence of a dislocation of the soil and take precautions to mitigate to some extent its power of destruction. Remembering how meteorologists have succeeded in preventing loss of life at sea by predicting the course of cyclones in the Indian Ocean or the Gulf of Mexico, we might be tempted to hope that similar warnings may help us to fight the dangers of an earthquake. I am afraid that the cases are not quite analogous, and even if our knowledge should allow us in the future to form predictions of equal certainty, the dangers accompanying such predictions may overbalance its benefits. The precautions which can be taken in a harbour against an approaching storm are of a comparatively simple character, and the meteorologist is therefore justified in warning us against a probable storm which does not appear; but would the seismologist be justified in creating a panic and dislocating trade by predicting an earthquake which failed to take place? We can easily forgive the meteorologist who forecasts the weather as "fine to doubtful and stormy"; but should we forgive the seismologist when he forecasts the approaching seismic condition of our town as "calm to unstable and collapsing"? Perhaps it may seem to you that I am wandering beyond the range of practical science even in alluding to this subject; nevertheless, the fear of creating panics by premature forecast is one which has already cast its shadows in advance, and I am informed that insurance companies in this country have shown some irritation by the early publication of the indications of a destructive earthquake which has taken place in a distant part of the world.

To the man in the street the question whether a thing is large or small is all-important; to the scientific man it matters not at all; and a great part of our deliberations will deal, not with catastrophes, but with microscopic movements of the soil, movements so small that the vibrations due to the traffic in a city compare with it as the waves of the ocean with the ripples on a pool. At the last meeting of the general assembly, four years ago, you appointed a committee to investigate these microseisms. I need not remind you that there are two types of short waves which are frequently observed. One of them has independently been traced in different countries, and by several observers, to the action of the wind, which seems to create waves over an extended land surface just as it does over the ocean. The second type of vibration, which occurs in periods of from five to ten seconds, is more difficult to trace. It has been suggested that the vibrations are due to the impact of waves on the shore against which the wave strikes. For the purpose of testing this hypothesis, an instrument has been set up on the coast of Northumberland (partly paid for by the funds of this association) which automatically counts the number of waves which in a given time strike the shore. The instrument, which was designed by the Cambridge Scientific Instrument Company, Ltd., will be exhibited at this meeting. It has been set up and looked after with great ability by Mr. Morris Airey, and we are already able to say that it will fulfil its object, though the observations at present are too few to allow us to draw any conclusions.

While we rightly attach much value to the systematic investigation of minute disturbances, we must not forget to keep in mind the source and origin of all dislocations of the soil. The recent advances in physical science render it imperative to review our position with regard to this fundamental question.

In our youth we were taught that the earth, once a molten and fiery globe, had gradually cooled down, leaving the inside still hot, but gradually cooling and contracting. This contraction of the nucleus was looked upon as the primary cause of geological dislocations. But now do we stand at present? In the breaking up of radio-active products we find a source of heat which—if the amount of radium and thorium in the interior of the earth is not decidedly less than that which is found near the surface—would not only balance the earth's loss of heat by radiation, but actually increase its average temperature. Though reasons may easily be found why the surface layer of the earth may be richer in radio-active products than the core, I think that we are nevertheless driven to the conclusion that the earth is now, and has been for a long time, in thermal equilibrium, and that shrinkage by cooling does not account for any of the more recent displacements. Why, then, should not the earth long ago have settled for itself all seismic questions, and have come to rest in a comfortable state of equilibrium? After the four or five million years which it has had to calm down, we might have expected that everything should be quietly arranged in uniform layers round the centre of the earth. Instead of this regular distribution of matter, we have not only mountain chains, but also the depressions and elevations which cause the distribution of land and water over the globe.

The causes of these inequalities have long interested geologists and mathematicians, but the wider discussion of the stability of the whole structure on which we live has only recently come into prominence. The subject is a most difficult and intricate one, and a most important contribution towards its elucidation has appeared within the last few weeks. In an essay to which the Adams prize of the Cambridge University has been adjudged, and which, I think, will become a classical guide to all who intend to pursue the subject, Prof. Love has treated the problems of geophysics with masterly ability and lucidity. I wish it had been possible to arrange—perhaps it is still possible—for Prof. Love to give you an account of his investigations, and in his presence it would be impertinent in me to explain, as otherwise I might have been tempted to do, the main conclusions at which he has arrived. I must therefore content myself with directing attention to the great importance of this work, and alluding to one suggestion contained in it which more particularly touches a subject with which this meeting is concerned.

The important work of Prof. Hecker, confirmed since by others, has allowed us to trace the tidal deformation of the earth, and has brought to light the curious result that the earth appears to resist a change of shape less in the north and south than in the east and west direction.

Prof. Love, having failed to account satisfactorily for the effect in other ways, suggests that the want of symmetry in the rigidity is apparent only, and that the observed effects are caused by the attraction of the tide wave in the North Atlantic and its accompanying excess pressure on the sea bottom. In the investigation of the tidal deformation of the earth, our work overlaps that of the International Geodetic Association, and a communication from that body will have to be considered by us. In other directions our work closely touches that of the geologist, and there may be points of contact with other parts of geophysics, such as meteorology and terrestrial magnetism. This interdependence of different branches of science will force us before long to consider our relationship to other international associations.

The extreme specialisation which finds expression in the formation of so many different societies and associations is an evil which may be a temporary necessity, but which we should try to mitigate so far as possible. There ought to be a connecting link which draws us away from the minute elaboration of detail and towards the great problems that ought never to leave the mind of a man of science. But what is this connecting link to be, and what are the bonds which are to unite it to bodies of such varied interests and constitutions? I have formed my own opinion, but I am afraid on this occasion to enter on to ground which may be controversial.

In concluding these few words of introduction, I feel that I express your wishes by thanking the Vice-Chancellor, who has found time among his many heavy duties to come here to welcome you.

THE PROGRESS OF CANCER RESEARCH.

THE tenth annual meeting of the Imperial Cancer Research Fund was held on July 20 at the Royal College of Surgeons, the Duke of Bedford presiding. The presidents of the Royal Colleges of Physicians and Surgeons, Sir Wm. Church, Sir Douglas Powell, Sir John McFadyean, Sir Henry Morris, Sir John Tweedy, Dr. Sidney Martin, Mrs. Bischoffsheim, and many other supporters of the fund were present. Sir Wm. Church, in moving the adoption of the annual report, gave an outline of Dr. Bashford's statement of the progress of knowledge of cancer, from which we give some extracts below. In seconding the resolution, Sir Henry Morris directed attention to the widespread influence exercised by the investigations of the scientific staff. This was evidenced in one way by the number of distinguished voluntary workers attracted to the laboratory from abroad, not only from all European countries, but also from America, Australia, and Japan, and in another way by the number of learned societies at home and abroad which invited the director to address them. Thus Dr. Bashford had visited, among other centres, Berlin, Heidelberg, Toronto, Paris, Budapest, Christiania, and Utrecht. Its influence was felt in a third way by the large increase in the number of centres engaged in the investigation of cancer in the laboratory. The other business was purely formal.

A feature of this year's work is the extension of experimental investigation to rabbits, in which animal a carcinoma of the mamma and a sarcoma of the subcutaneous tissue have been discovered, the latter being capable of propagation.

Statistics.

It will be remembered that the policy pursued in regard to the statistical investigation of cancer has been to supplement the national statistics, and, if possible, to add to their utility by special inquiries, but not to endeavour to overlap or in any way to replace them. This collaboration and coordination, which does not exist in the case of organisations for the investigation of cancer in other countries, where independent statistical inquiries have been undertaken with the voluntary assistance of the medical profession, has been of the greatest importance in England and Wales by preventing profitless overlapping, and in effecting real advances in the accurate statistical knowledge of the incidence of cancer.

The application of the law of age-incidence for cancer to short-lived as well as to long-lived animals reinforced the other reasons for obtaining it, and suggested that knowledge would be advanced by more detailed information about the age-incidence of cancer in the several organs of man as distinct from its dependence on the age-distribution of persons. The tabulation of the new data for the years 1901–9 brings out the fact that the increase during this period is referable to certain anatomical regions and not to others. Thus, for males, the main increase falls on the alimentary tract, especially the stomach. The liver and gall-bladder and the skin show no, or only a slight, increase. For females, the increase, although it falls mainly on the alimentary tract (stomach and intestines), affects also the mamma, while the uterus, ovary, liver and gall-bladder, rectum and skin, show little or no increase. It is also of importance that the recorded mortality from cancer of the generative organs has not increased at the same rate as that for other organs, and that most of the increases affect the higher age-periods predominantly. For the first time it is fully demonstrated that it is wrong to make statements of a disquieting nature about the increase of cancer in general. While it is evident that several of the differences brought out by the figures can be explained by more accurate diagnosis and by transference of the seat of the disease from the secondary to the primary situations, as illustrated, *e.g.*, by the relation revealed between cancer of the liver and gall-bladder and the alimentary tract, this may not account fully for other features. In particular, the increase recorded for the mamma in women and the tongue in men requires further study and elucidation.

The analysis also shows that the incidence is very unequally distributed among the several situations, and, indeed, that the whole curve of incidence may be different for different organs. A progressive increase up to the highest age-periods is characteristic of the face, lip, mouth, bladder, urethra, and breast only. The other organs show a distinct diminution in the highest age-periods; but it is not yet possible to determine whether this curve indicates a liability rising to a maximum followed by a diminution, or is merely the result of deaths being still ascribed to other causes in the case of cancer of internal organs in aged people. The proportion of total deaths ascribed to the ill-defined cause of old age is 65·6 per 1000 as compared with 65·7 for cancer, and it must be borne in mind that the increases recorded for cancer affect principally the higher age-periods, and that the average age of the population is increasing.

The study of the occurrence of cancer in mankind and in domesticated animals in widely separated parts of the globe has shown that the practice of peculiar customs (involving the subjection of particular parts of the body to chronic irritation), provokes the disease in situations and organs from which it is absent when these customs do not obtain. It is reasonable to suppose that the frequency of cancer would be diminished if such practices as the use of the kangri in Kashmir, the chewing of betel-nut, the eating of very hot rice in China, were discontinued. It is also reasonable to assume that the introduction into England of these exotic customs would greatly increase the frequency of cancer in this country. So definite is the evidence of the mediate causation of certain forms of cancer by chronic irritants, that the possibility of variations in the cancer death-rate must be admitted as regards particular organs and regions of the body. The possibility of a variation of the main incidence of cancer in conformity with changes in certain customs must also be admitted. That irritation is really an important causative factor of cancer is an assumption which is justifiable only for certain forms of cancer occurring in particular regions. The knowledge of the irritants to which different species of animals and the individual tissues of the same animal are susceptible is of very considerable importance. The acquisition of this knowledge will doubtless require extensive study, and it is advisable to approach this study in man statistically, and advisable to have data of the incidence of cancer in persons pursuing different occupations. This information will be embodied in the next decennial supplement to the reports of the Registrar-General.

Heredity.

The breeding experiments which have been in progress for many years have been alluded to in several earlier reports. They have now yielded upwards of 2000 mice of known ancestry and age. 562 females were available for a study of the influence of heredity on the development of cancer of the mamma when an analysis was made on October 24, 1910. The investigations show that heredity plays a part in the development of cancer of the breast in mice. At all age-periods the disease is more frequent when the mother, or either grandmother, or all three had died from cancer of this organ.

Apart from its bearing upon heredity, the obtaining of such mice was most important for furthering the experimental investigation of the genesis, nature, and, should it be necessary, artificial production of cancer, and for attempting to define the reasons for its apparently greater frequency in some geographical areas than in others.

While it is at present impossible to explain how the liability is transmitted, it can be averred with certainty that it does not consist in the inheritance of a soil more suitable for the growth of cancer in general. It can only be inferred, with some probability, that it is a local or circumscribed tissue predisposition, in virtue of which the mammary tissue is prone to pass from mere proliferative reaction into continuous or cancerous proliferation. Further, hereditary predisposition is only one of the factors in play, for it has been found that chronic inflammatory changes are remarkably frequent in the mammæ of female mice of the laboratory. Other factors still unrecognised may exist.

Individuality and Cancer.

The study of the parallel behaviour of normal and cancer tissue, both as regards absence of continued growth and the nature of the immunity reactions induced, when cancer is transferred from one animal to another of a strange species, showed that cancer had all the properties which distinguish the normal tissues of one species from those of another species. Recent experiment has carried knowledge much further. The fact that transplantable tumours grow in normal animals as well as they do in spontaneously affected animals shows that the latter do not present a soil for the growth of cancer substantially different from that presented by normal animals. When this result is contrasted with the almost invariable success of transplanting a portion of its spontaneous tumour into the animal so affected, and the almost invariable failure of implantation of any spontaneous tumour into other spontaneously affected animals, the demonstration is complete that each tumour is peculiarly and genetically related to the individual in which it arises. This conclusion is drawn from studying the growth of tumours under the different conditions just enumerated, and is supported by the results of elaborate experiments on inducing resistance or immunity to the inoculation of cancer-cells under these different conditions. The results of these two lines of inquiry agree also with the fact that resistance has not been induced either with an animal's own tumour or its own normal tissue. The individuality of cancer would thus appear to have been placed at last beyond all further discussion. It has long been maintained in various forms on the basis of deductions drawn from histological (microscopical) examination of the tissues at the site of the primary lesion, and from the nature of dissemination, but this interpretation of the findings has been as vehemently combated. The combination of the results arrived at by microscopical investigation and experimental study appears to terminate any need for further discussion. A long step has thus been taken in defining the direction in which the future investigation of cancer is alone likely to be profitable.

The Nature of Cancer.

It follows from the argument pursued in the preceding paragraphs that a closer definition of the nature of cancer will involve an analysis of the relation obtaining between the individual developing cancer and the tumour.

In all previous reports guarded reference has been made to the mediate relation obtaining between chronic irritation and certain forms of cancer. The indefiniteness in the way of directing attention to the relationship has been deliberate. In the first place, it is due to an effort to elucidate those forms of cancer with which irritation is most constantly associated without considering other forms in which the particular irritants concerned do not play a part. In the second place, it is due to the fact, already frequently emphasised, that these irritants have nothing in common beyond their association with cancer. The varied investigations of the past nine years have added a knowledge of new forms of irritation. It has become more and more evident that irritation, effective in one case, may be, and often is, quite ineffective in another.

It has been ascertained that every fresh transplantation effects a disturbance of the cancer cells. They are thrown into a state equivalent to regeneration from which they tend to recover, as analogous as possible to reactive proliferation when naturally occurring.

Ever since the beginning of these investigations it has been maintained that the mere cultivation of cancer had important, if only indirect, bearings upon its nature and genesis. Thirty-five of the tumour-strains have now been growing for more than three years, *i.e.* for longer than a mouse lives, while fifty other strains have been grown for extended periods. The one feature all these tumour-strains have in common is the power of continuous growth which they possess, in spite of the most divergent structure, and of extremes in the rate of growth varying from an almost explosive rapidity to one much inferior to that of embryonic tissue, as determined by weighing experiments.

It can be shown that there is a constancy in the behaviour of a tumour-strain and a variability which is individual. The variations which occur are similar to those which distinguish the eighty-five different strains from one another. They are not mainly induced by the environment, but arise spontaneously; otherwise all strains would approach a common type, which they do not. The demonstration of the occurrence of these variations under artificial conditions permits of the inference that they could also occur under natural conditions, and yields objective evidence of the validity of the conclusion that the cancer-cell is a biological modification of the normal cell endowed with many inherent properties of the latter. The objection at once suggests itself that these variations during prolonged propagation are secondary, and do not necessarily indicate corresponding primary changes as responsible for genesis; but this objection cannot be maintained against the facts that the potentiality for variation has been demonstrated, as has also the tenacity with which the several varieties are adhered to.

Immunity and Therapeutic Investigations.

The dissemination of cancer has been studied experimentally both by injecting cancer-cells directly into the blood-stream and by implanting them in internal organs. It has been found possible to produce the lesions of dissemination in these ways both in the absence and in the presence of a primary growth, and what is more important also, to prevent them. Problems difficult of solution in the mouse, because of its small size and the short duration of its life, can now be studied in the more favourable circumstances obtaining in the rabbit, the extension of experiments to this animal being a new feature made possible by the successful propagation of a sarcoma from rabbit to rabbit.

Nothing but harm can result from the premature application to the treatment of the human subject of methods found to modify the growth of propagated cancer in animals. The methods which induce an *active* immunity to propagated cancer have been tested on thirty-three mice with natural cancer, and have given no evidence of powers either to hinder growth and dissemination or to prevent recurrence of spontaneous cancer after surgical removal.

The successful treatment of animals bearing propagated cancer by means employed to induce *passive* immunity has been described by other investigators. Some of these methods have been tested in the laboratory, but have not yielded positive results. It becomes increasingly evident that the therapeutical treatment of cancer is not to be sought for along these lines.

A considerable number of cases of natural healing of spontaneous malignant new growths have now been observed in mice affected with spontaneous cancer. The changes leading to natural cure appear to depend, as in propagated cancer, on an altered condition of the cell and its contents rather than on an alteration in the general condition or constitution of the affected animal. Means must be devised for elucidating the nature of the change in the cell before curative measures can be discovered.

Since these investigations were first contemplated by those responsible for their inauguration, the provisions made for the investigation of cancer have greatly altered in this country. Whereas nine years ago, apart from special provision for treatment being supplied by a number of hospitals, there existed for the investigation of the disease only one other laboratory in addition to the Imperial organisation contemplated by the founders of this fund. To-day a number of other laboratories exist throughout the country, both in London and the provinces. England and Scotland are now provided with a greater number than any other country in comparison with their size and population. Whenever an opportunity has occurred of furthering the particular investigations upon which these institutions have been engaged, assistance has been rendered by supplying material from the laboratory and by the Imperial Cancer Research Fund in many other ways. The responsibilities thrown upon the workers of the Imperial Cancer Research Fund are not diminished, but rather increased, by the multiplication of institutions engaged in the investigation of cancer.

THE BOARD OF EDUCATION'S SCIENCE EXAMINATIONS AND GROUPED COURSE CERTIFICATES.[1]

As is well known, the Board of Education for some time past has been considering the reorganisation of the existing system of science examinations conducted by the Board, in the hope of lessening the somewhat heavy cost of these examinations and of securing greater educational efficiency. The conclusions arrived at by the Board have recently been published in a circular, accompanied by a covering letter from Sir Robert Morant, in which is summarised the principal changes which the Board has decided to bring into operation in the session 1911–12.

The general principles governing the action of the Board in respect to the proposed alterations are given in the following extract from Sir Robert Morant's letter:—

"The examinations were instituted in circumstances widely different from those of the present, at a time when no other machinery for promoting scientific or technical instruction was generally available; and they have in the past contributed greatly to the diffusion of scientific and technical knowledge throughout the country. But during recent years there has been a great development in the teaching of the subjects covered by the examinations in evening and technical schools, the organisation of which is necessarily affected by the nature of the examination tests available; and the Board have had to consider under what conditions a system of science examinations, conducted not by the teachers of the schools but by an external body, has any claim to continued existence, and how the working of the system so far as it is retained can best be coordinated with and made to supplement the work of the teaching institutions themselves."

It is evident that the Board recognises the very great difference between the general educational conditions in

[1] "Science Examination and Grouped Course Certificates." Board of Education Circular, No. 776, June 20.

force when the examination system was initiated and the conditions prevailing at the present time, and that extensive changes are necessary in order to bring these examinations into harmony with modern developments of educational thought and practice. The Board clearly realises that the annual examination must not be the dominant factor in education. The examination must be subordinate to the teaching. Further, the yearly test, to be of any value, must be mainly an "internal" one, in which the teacher plays an important part. At the present time, the examinations conducted by the Board are purely "external" examinations, carried out by an outside body which is out of touch with the teacher and the students, and necessarily unacquainted with the actual conditions under which the educational work is carried out.

The Board, however, is not yet prepared, "as regards all students, to hand over entirely to the teaching staffs . . . the functions which the Board at present discharge in regard to the testing and certification of the attainments of individual students, although a partial transfer of such responsibility has now become possible." In the future, the Board will leave the examination of, and the issue of diplomas to, full-time day technical institution students to the teachers concerned, subject to regulations to be previously submitted to and approved by the Board. Full-time day students will not in general be permitted to attend the evening science examinations. The examination of all first stage evening or part-time students is also handed over to the institutions. Further, "the Board intend to invite the assistance of some teachers in technical schools as members of the examining boards to be constituted for the reorganised examinations."

Coming to the examinations themselves, the principal changes enumerated in the circular are the following:—

(*a*) A number of the examinations formerly held by the Board will be discontinued. These examinations are mainly in subjects which have attracted comparatively few candidates in the past (*e.g.* nautical astronomy), and in certain branches of natural science, such as botany and biology, which have usually been taken only by candidates reading for university degrees. The examinations to be retained by the Board are divided into five groups as follows:—

(1) *Group A.*—Pure and Applied Mathematics:—Practical plane and solid geometry, pure mathematics, practical mathematics, theoretical mechanics (solids), and theoretical mechanics (fluids).

(2) *Group B.*—Engineering:—Machine construction and drawing, applied mechanics (materials and structures), applied mechanics (machines and hydraulics), heat engines, building construction, and naval architecture.

(3) *Group C.*—Physics:—Heat, magnetism, and electricity.

(4) *Group D.*—Chemistry:—Inorganic chemistry and organic chemistry.

(5) *Group E.*—Mining and metallurgy:—Coal mining, metallurgy.

It may, perhaps, be regretted that the Board proposes to cease its examinations in subjects such as agriculture, hygiene, and physiology, in view of the national importance of these subjects, the rapid development of public interest in them, the increasing provision of facilities for instruction, and the absence of any generally recognised and easily accessible system of examinations in these subjects if the Board's examinations be withdrawn.

(*b*) Up to the present the Board has held four examinations in each subject, arranged as follows: 1st stage, 2nd stage, 3rd stage, and Honours. In the future, the Board will not conduct elementary examinations corresponding to the first stage, as it is felt that these examinations are now unnecessary, the "inspection" by the officials of the Board on their visits to the classes being sufficient to test the efficiency of the teaching. The Board will only hold two examinations in each subject, termed "Lower" and "Higher" examinations respectively. The standard of the Lower examination will be approximately equal to that of the present Stage II., while that of the "Higher" examination will be intermediate between Stage III. and Honours.

The main objections which may be urged against the withdrawal of the Stage I. examinations are:—(1) The present Stage I. syllabuses are a valuable guide to many teachers, especially perhaps to those interested in the more directly technical subjects and to those employed in the smaller, isolated technical schools; (2) the lack of uniformity in the elementary stages of technical instruction caused by the absence of syllabuses followed by schools all over the country, thus hindering the transfer of students from one institution to another. These obvious disadvantages may probably be best overcome by consultation between the representatives of the teachers and the Board of Education inspectorial staff, with a view to arrive at a common measure of agreement respecting courses, curricula, and the standard of work to be aimed at, especially in the earlier years of a student's work.

(*c*) Practical examinations, such as those in chemistry and metallurgy, will be discontinued, but candidates for admission to the Higher examination in subjects other than practical geometry, mechanics, &c., "will be required to furnish a certificate of having completed a satisfactory amount of laboratory work, and to submit his laboratory note-books signed and certified by the teacher."

Elaborate regulations, which will probably be found somewhat burdensome in actual practice, are outlined in the circular with regard to "grouped course certificates and diplomas, and conditions of endorsements." The Board will not, in general, issue certificates to students who have passed a given single examination. The Board will, however, endorse certificates or diplomas granted by school authorities upon the satisfactory conclusion of well-balanced courses of study, and "they trust that a certificate or diploma, endorsed by the Board under the prescribed conditions, will be recognised by all concerned as having at least a definite minimum value and standard."

"Grouped courses" are classified by the Board into two main classes: (1) evening or part-time day courses, (2) full-time day courses. Each of these is again subdivided into three groups: (*a*) junior courses (14 years to 16 years of age), (*b*) senior courses (16 years to 18 years), (*c*) advanced courses (18 years to 20 years).

Generally speaking, the proposed regulations as outlined in the circular mark a distinct advance upon the arrangements in force at present. In the main, the alterations are in the direction of freedom for the teachers, a greater elasticity permitting more modifications to suit local educational and industrial requirements, and the placing of examinations in a relatively less important position. The circular holds out to technical teachers the promise of speedy action by the Board of Education in regard to two important matters which they have long pressed upon the attention of the authorities at Whitehall, namely, the cooperation of the teachers in the drawing up of syllabuses and the conduct of examinations, and the improved organisation and coordination of all grades of technical education.

J. WILSON.

THE BRIGHTON CONFERENCE OF THE MUSEUMS ASSOCIATION.

THE attendance at the Brighton meeting of the Museums Association, held on July 10–15, was large and representative, delegates being present from forty-two museums at home, as well as from the American Museum of Natural History (New York), the Australian Museum (Sydney), and the Deseret Museum (Salt Lake City, Utah). The presidential chair was occupied by Mr. H. M. Platnauer, of York. Mr. Platnauer was one of the original founders of the Museums Association, which was inaugurated at York twenty-two years ago.

In his presidential address Mr. Platnauer strove to answer the question "What is a museum?" and showed by his remarks that he conceived all museums, whether of science, art, or history, to have a broad and educational function. He deprecated the idea that a provincial museum should be purely local, would not agree that the function of an art museum is merely to make a pleasurable appeal to the emotions, and suggested that museum arrangements should convey the facts of natural evolution and human progress by exhibits arranged in more than one dimension of space.

Mr. H. S. Toms had prepared an account of the Brighton Museum, with special reference to developments since the last meeting of the association in Brighton twelve years ago. It was plainly indicative of great progress, and embodied some very useful practical hints on the care of collections.

Mr. J. A. Charlton Deas introduced the subject of national art loans to municipal museums, pointing out the great and growing need for making the artistic treasures of the nation more accessible to the dwellers in the provinces.

The value of museum guides, catalogues, and other publications was dealt with by Mr. Thomas Sheppard under the title "Pastimes for Curators." He described the manner in which the eighty or more publications issued by the Hull Museum had been prepared, and showed how they kept public interest in the collections alive and frequently led to desirable acquisitions.

Dr. J. A. Clubb read a paper on the purpose and arrangement of an index museum, in which the idea was elaborated of making the entrance hall of the museum a philosophic introduction to those fields of human knowledge covered by the museum collections. The validity of the word "index" in this connection came in for some criticism, but it was generally agreed that some form of introductory collection, broad in conception and treatment, is an absolute necessity in all large museums. By the multiplicity of their collections and specimens such institutions bewilder the uninitiated visitor, who should be enabled to get a clear grasp of what the institution is aiming at by some lucidly sketched outline.

As a new departure in the work of the association, a public lecture was given during the conference. The lecturer was Dr. F. A. Bather, F.R.S., who took for his subject "Open-air Folk Museums." The lecture consisted chiefly of a description of the open-air museum founded at Skansen, Stockholm, by Arthur Hazelius. Dr. Bather gave an outline of the object of such museums, and emphasised the urgent need for promoting some such scheme in Sussex, and thus preserving the fast disappearing relics of its extremely picturesque past.

A further paper by Mr. W. Ruskin Butterfield on folk museums dealt specially with the material at present available in Sussex, and showed how rich Sussex still is in picturesque old dwellings, involving much delightful folklore.

Mr. Arthur Smith showed how collections of photographs might serve the purpose of recording the history and progress of the surrounding district. Many places have collections of photographs and prints secured merely for the purpose of what may be called a survey, but Mr. Smith emphasised the fact that this is not sufficient. Photographs ought to be taken so as to show clearly, for instance, the original and altered condition of a street or building, so that a person looking at them may realise the nature and extent of the change which has taken place.

Evolution in archæology was dealt with by Mr. R. A. Smith, of the British Museum, who described the succession of developmental characters exhibited by such articles of human manufacture as stone implements, pottery, brooches, and primitive British coinage in a lucid and informing manner. He strongly advocated the arrangement of antiquities on evolutionary lines wherever possible.

The evolution of English pottery during the eighteenth century was the subject of a paper by Mr. H. Stuart Page. He argued that the adoption of an intelligent system of classification on lines which he set out in some detail would enable the involved story of English pottery to be illustrated by a carefully selected series of examples showing the gradual development in materials, processes, and technique. It was a matter for speculation how long the English potters would have continued contentedly in their antiquated methods of producing coarse heavy ware but for the introduction of Oriental china, brought into the country by tea-drinking habits. The beauty of this ware —all the more emphasised by the rudeness of the English production—created a remarkable infatuation, and the English potters sought to rival it. Their history then becomes one of laborious costly experiment, absorbing lives and fortunes. Ignorant of chemistry, they were, in fact, groping in the dark. The eventual result, however, was the acquisition of a technical skill which, whatever be the artistic quality, holds its own among the ceramic productions of the world.

Mr. E. Rimbault Dibdin read a paper on the functions and scope of a municipal art museum, in which he showed that there exists in England a very confused idea of the way in which to make an art museum of value. He urged that special efforts should be made to attract curators and directors of art institutions, and to assign a special day to the discussion of the questions of function, scope, conservation, arrangement, lighting, and the hundred and one other practical problems which face the administrator of art collections.

A small trade exhibition organised in connection with the conference was of considerable practical interest to curators.

During the meeting visits were paid to the Worthing Museum and Library, to the Booth Museum, to Hastings Museum, to Sedlescombe Museum, and to Battle Abbey. The association concluded its business by accepting the invitation of the Board of Agriculture and Technical Instruction for Ireland to meet in Dublin in 1912, and by unanimously electing Count Plunkett, director of the Irish National Museum, through whom the invitation was conveyed, to the presidential chair for the ensuing year.

THE FRENCH AEROTECHNICAL INSTITUTE.

ON July 6 the Aërotechnical Institute of the University of Paris, which has been founded by the generosity of M. Henry Deutsch de la Meurthe, was inaugurated at St. Cyr. Its object is entirely scientific, and is to study all problems of aviation and aërostation relative to the support of bodies in the air, both at rest and motion, from the double point of view of theory and practice. Under the presidency of the vice-rector of the Paris University, with M. Deutsch de la Meurthe and the dean of the faculty of sciences of the Paris University as vice-presidents, the council includes all the famous names in French aëronautics, as follows: MM. Armengaud, Barthou, Baumès, Blériot, Bouttieaux, Cailletet, Carpentier, Eiffel, Estienne, Hugon, Janet, Jouguet, Kapferer, Kœnigs, Le Cornu, Loreau, Maurain, Marchis, Painlevé, Picard, Sauvage, Soreau, Surcouf, Urbain, Voisin, Weiss.

The area occupied by the buildings and grounds is 72,000 square metres, of which the principal part has been reserved for building purposes. The remainder includes a strip 25 metres by 900 metres, with an additional piece of some 462 metres in length, which has been conceded by the Minister of War. Moreover, 4000 metres have been set apart for the erection of aëroplane sheds, workmen's houses, &c.

In the central hall are the following:—

(1) A large fan, two metres in diameter, fitted with various adjustments, and an aërodynamical balance for measuring wind-pressures on surfaces.

(2) A wind tunnel furnished with a fan for the study of the reaction of the air on surfaces, the air-current being capable of maintaining a uniform speed of 20 metres a second.

(3) An aërodynamical balance.

(4) A wind tunnel similar to that built by Col. Renard for studying the stability of model hulls or planes.

(5) An apparatus for measuring the friction of various surfaces moving through air of various pressures at gradually increasing speeds.

(6) A dynamometrical installation for measuring the thrust of stationary propellers.

(7) An installation for the study of helicopters.

(8) A protected chamber for testing the resistance of propellers at very high speeds. (Although it would be difficult to attain to bursting speed, it will be possible to run them at a considerably higher rate of revolution than the normal.)

(9) A test bench for motors.

In the chemical laboratories researches will be made in the study of light gases, of fabrics for balloon envelopes and aëroplane coverings, and of varnishes.

The physical laboratories will be concerned with the improvement and application of instruments used in aërial navigation, and the physical properties of light gases.

The photographical section will be occupied in obtaining records of experiments made; a special department will test all materials used in the construction of flying-machines and dirigibles; and the usual meteorological instruments are provided.

The power-house contains two compound vertical steam engines, one of 120–150 horse-power, and the other of 30–40 horse-power, driving dynamos of 200–300 amperes and 160 amperes respectively.

In the grounds is an experimental track 1400 metres long, quite straight, and perfectly flat save for 80 metres at one end which has a slope of 10 mm. in the metre to facilitate the start of the rolling platforms, and a rise of 5 mm. in the metre at the other end to assist stopping and returning them.

The rails are 12 metres in length, welded two together by an aluminothermal process so as to give 24 metres without a joint. The current is conveyed to the carriage by live rails raised on oak standards about 0·7 metre high on each side of the track, the return being made through the track-rails themselves.

Four rolling platforms are to be provided, each designed and fitted for its special work. The first measures the vertical and horizontal components of air-pressure on planes and curves, both simple and compound, and determines the position of the centre of pressure at various angles of incidence. This has been already built. The others under construction are to comprise two for propeller testing (one for large dirigible propellers and the other for aëroplane propellers to obtain their thrust, speed of rotation, the power absorbed, and their mechanical efficiency), and one for measuring the resistance of the different parts.

Platform No. 1 weighs, including the motor of 1100 kgs., 4900 kgs. The iron chassis is 6·12 metres long, 2 metres wide, and is rounded in front. The motor-bed is carried in the centre. Two axles 3·60 metres apart carry the chassis, which projects 1·86 metres in front and 0·66 metres in rear. This inequality is for the purpose of putting additional weight on the front axle, which tends to be lifted during experiments with large horizontal surfaces. For the same reason the axis of the motor is nearer the front axle than the back axle. The wheels of cast steel are one metre in diameter. The steering swivels run in ball-bearings, and special arrangements are used to prevent lateral play. A system of brakes engaging additional rails at the end of the track brings the platform to a standstill. All the platforms are to be fitted with the following instruments:—

(1) A registering chronograph for the number of turns of the axles.

(2) A registering cinemometer, giving the speed at every point along the course.

(3) Dynamometers.

(4) A wattmeter registering the motive power at every point.

The platform at present in use can easily obtain a speed of 33 metres a second.

As open-air experiments are not always desirable or possible, a whirling table has been installed in a circular building 38 metres in diameter. The axis of the planes or propellers tested on the end of the arm will be 16 metres from the centre, thus describing a circle 100 metres in circumference. There are two motors, one of 20 horse-power, which turns the arm, and another of 25–30 horse-power, which is connected up with any propeller undergoing tests.

There only remains to mention the library, on behalf of which an appeal is made for gifts of books, pamphlets, and prints, and the bulletin of the institution, in which will be published from time to time the results of the work accomplished.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

GLASGOW.—At its last meeting for the session, the University Court, with the concurrence of the Senatus, resolved to increase the teaching power of the University by the institution of the following:—a third lectureship in engineering; a second lectureship in zoology, with special reference to protozoology; a new assistantship and a new assistant demonstratorship in physiology; two new assistant demonstratorships in geology; and a new demonstratorship in physical chemistry and radio-activity.

The resignation by Captain Lyons, F.R.S., of his lectureship in geography was accepted with regret. It was agreed to intimate the vacancy, and to take steps for the appointment of a new lecturer before the beginning of next session.

The resignation by Sir Robert Wright of the office of principal and professor of the West of Scotland Agricultural College brings into operation a provision by which the University and the College, through a joint committee, take part in the appointment of the new professor. The committee will meet for the purpose during the summer.

Professorships of medicine, surgery, obstetrics, and pathology in connection with the Royal Infirmary, and in addition to the existing chairs, have been sanctioned by his Majesty in Council, and will be filled up in time for next session.

THE Nevada State University, says *Science*, has received 50,000*l*. from Mr. Clarence Mackay, of New York City, and several of his friends, for the construction of a library and administration building.

THE annual meeting of the Midland Agricultural and Dairy College, Kingston, Derby, will be held at the college on Monday, July 31, when the report on the year's work will be presented, and the Duke of Devonshire will address the meeting and present the diplomas and certificates awarded to students during the past session.

IT is stated in *Science* that all the qualified men in this year's graduating class in the College of Agriculture of the University of Wisconsin have secured positions, and the requests for teachers are still coming in. The demand is especially strong from agricultural high schools both in Wisconsin and other States. Many of the requests are for men who have been brought up on farms, have had some teaching experience, and also have had a thorough course in agriculture. The demand for such instructors in agriculture for high schools is very much greater than the supply. Even as early as four weeks ago most of the seniors had accepted positions as farm managers, as research assistants, or as teachers of agriculture in colleges and secondary schools. The average salary of the men who will teach next year in agricultural schools is 250*l*.

IN referring, in the issue of NATURE for March 2 (vol. lxxxvi., p. 30), to the centenary of the University of Christiania, which was founded by King Frederic IV. in 1811, we were able to give the important items of the interesting programme of events which has been arranged for the occasion. The following representatives of British universities and other institutions had, up to July 13, been chosen to attend the celebration, which begins on September 4 and lasts until September 8:—University of Bristol, Prof. I. Walker Hall; University of Cambridge and the Cambridge Philosophical Society, Sir George Darwin, K.C.B., F.R.S.; University of Durham, Rev. H. Gee; University of London, Dr. H. A. Miers, F.R.S.; the Royal Society, Sir J. Rose Bradford, Sec.R.S.; the British Academy, Prof. W. Paton Ker; the Royal Institution, Prof. H. E. Armstrong, F.R.S.; the Victoria Institute, Dr. J. W. Thirtle; Victoria University of Manchester, Prof. C. H. Herford and Sir William J. Sinclair; University of Oxford, Prof. W. J. Sollas, F.R.S.; University of Aberdeen, Prof. D. W. Finlay; University of St. Andrews, Dr. H. M. Kyle; University of Edinburgh, Lord Edward T. Salvesen, K.C.; the Royal Society of Edinburgh, Mr. James Currie; University of Glasgow, Prof. J. Ferguson; Queen's University of Belfast, Prof. J. Symington, F.R.S.; University of Dublin, Rev. T. B. Willson; the Royal Irish Academy, Prof. C. Marstrander.

LORD HALDANE distributed the prizes at Mill Hill School on July 22 and delivered an address. He said the British nation is now taking a wider view of education. A great deal has been learnt from the Continent and from hard experience. "For two years and a half," said Lord Haldane, "I have been chairman of a Royal Commission on University Education. How much longer we shall have to sit before we have dealt with the whole of the material we have to survey I do not know." The Commission has shown two things—first, that the nation is waking up about education, and that very great advances are being made; and, secondly, that those advances have come none too soon, because other nations have been making advances. This nation has come to learn that education is one and indivisible. Organisation is the order of the day, and without it nothing can be done. Schoolmasters are functionaries of a very important order; they have to mould the national life of the generation that is coming on. The world is moving forward. There used to be a tradition, said Lord Haldane later, that our great public schools were very much behind the great secondary schools of the Continent, but as schools of character English public schools are not to be beaten.

UPON the recommendation of the Development Commissioners, the Treasury has decided to make an advance from the Development Fund to the Board of Education to enable the Board to make additional grants in aid of farm institutes. Such an institute should serve as the headquarters for the miscellaneous and itinerant work of the county agricultural staff, and should also provide accommodation for central courses of instruction in agriculture and kindred subjects and for demonstration. These central courses might include, for example, (1) a sixteen or twenty weeks' winter agricultural course for the sons of small farmers who have acquired some practical experience on the land since leaving elementary schools; (2) shorter courses in dairy work, poultry-keeping, and the like during spring and summer; and (3) vacation courses for teachers of rural subjects in local continuation courses. The grant in aid of the provision or enlargement of a farm institute will not exceed 75 per cent. of the total cost, while the grant for maintenance will be limited to 50 per cent. of the total cost. On educational grounds, the Board regard it as essential that there should be a farm and garden in connection with the institute, which should not only be used for the internal teaching, but should also serve as an object-lesson to the farmers and gardeners of the county. In some cases a small holding might be added. These should be conducted on business principles, but some annual deficiency will generally be entailed by their use for educational purposes. The grants are not to have the effect of reducing the amount of any expenditure at present incurred by a local education authority out of the rates or other local resources upon work of the type to be aided, or the amount of any contribution by the authority to the educational work conducted by the agricultural colleges.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, July 17.—M. Armand Gautier in the chair.—A. **Haller** and Ed. **Bauer**: Syntheses of substituted β-diketones, of ketonic ether-salts, and of enolic ethers by means of the sodium derivatives of ketones. The interaction of the sodium derivative of isopropylphenyl-ketone with benzoyl chloride gives two isomeric benzoyl compounds, one, the diketone dibenzyl-dimethyl-methane, from which a monoxime is readily prepared, and the other the enolic form, not combining with hydroxylamine. Other examples of similar reactions have been worked out. Chlorine and iodine compounds give different reactions in some cases.—A. **Lacroix**: The alkaline rocks of Nosy komba (Madagascar).—Ch. Ed. **Guillaume**: The modifications undergone by nickel steels after prolonged heating and on the action of the time. These measurements show the necessity of a preliminary tempering of nickel steels used in the construction of instruments of precision, and the possibility of calculating by extrapolation during a period of several years the length of a standard invar bar maintained between certain limits of temperature.—Paul **Sabatier** and A. **Mailhe**: Some new preparations of the benzylamines and of hexahydrobenzylamine. The general method employed consists in acting with ammonia gas upon the vapour of an alcohol at 300° C. to 350° C. in presence of a catalytic oxide, such as thoria. With benzyl alcohol the chief products of this reaction are benzylamine and dibenzylamine. Pure benzylamine, obtained by this method, treated with hydrogen at 170° C. to 180° C. in presence of a very active nickel gives ammonia, toluene, and hexahydrobenzylamine. The latter base was isolated, and its properties are described.—M. **Bernstein** was elected a correspondant in the section of medicine and surgery in the place of the late M. Engelmann.—M. **Borrelly**: Observations of the Kiess comet (1911*b*) made at Marseilles Observatory with the comet finder. Observations of the comet and comparison stars are given for July 9, 12, 13, 14, and 15. The comet appeared as a globular nebula with a condensation at its centre, and was about the 8th or 9th magnitude.—M. **Esmiol**: Observations of the Kiess comet made at the Marseilles Observatory with the Eichens 26 cm. equatorial. Observations given for July 13 and 15.—Ernest **Esclangon**: Observations of the Kiess comet (1911*b*) made with the large equatorial of the Observatory of Bordeaux. Positions of the comet and comparison stars given for July 10 and 11. The comet appeared as a nearly round nebulosity of about 2′ diameter.—Observations of the Kiess comet (1911*b*) made at the Observatory of Besançon with the 33 cm. bent equatorial. Positions given for July 10, 11, 12, and 13.—A. **Petot**: The extension to geodesic lines of a kinematic property of the right line.—Ruben **Mallton**: The construction of integral functions of irregular growth.—A. **Korn**: An important class of asymmetrical nuclei in the theory of integral equations.—H. **Vergne**: A theorem in hydrodynamics.—MM. **Melchissedec** and **Frossard**: The mechanical theory of some tubes producing sound.—A. **Leduc**: Internal pressure in gases. Formulæ of state and the law of molecular attraction.—M. **Hanriot** and F. **Raoult**: The magnetisation coefficients of gold. A comparison of the magnetic properties of the brown gold (previously described by the authors) and ordinary gold into which the brown gold is converted by heating shows that they are distinct varieties of the same metal.—G. **Chavanne**: Isopyromucic acid. Its behaviour towards oxidising agents. Dibromomaleic and bromoxymaleic dialdehydes. Dibromomaleic aldehyde,

$$OCH—CBr=CBr—CHO,$$

is obtained by acting with bromine upon monobromisopyromucic acid, and treatment of the bromine addition compound thus obtained with bromine and water.—Ph. **Barbier** and R. **Locquin**: The transformation of some substituted paraconic acids into the isomeric cyclopropanedicarboxylic acids. This transformation is effected by the action of thionyl chloride upon the dry acid dissolved in one and a half times its weight of benzene, and maintained at the temperature of the water-bath for twelve hours. This new reaction will be studied with other lactones.—G. de **Gironcourt**: The cheeses of Touareg. This native cheese is remarkable for the small proportion of water it contains. It keeps well for long periods of time, and can be carried great distances without change.—MM. **Vermorel** and E. **Dantony**: Sulphur capable of being moistened. A method of treating sulphur for agricultural purposes.—A. de **Varenne**: The destruction of Cochlyis of the vine.—Pierre **Lesage**: The characters acquired by plants watered with solutions of common salt. The addition of the salt causes a reduction in the size, a yellowish coloration, and a reduction in the duration of the cycle of growth.—G. **Perrin**: The prothallus of Equisetum.—A. **Guilliermond**: The mitochondria of plant cells.—C. L. **Gatin**: The influence of the tarring of roads on the growth of the trees of the Bois de Boulogne. In certain cases only, where the road is much exposed to the sun and where the traffic is heavy, could the tarring of the road be proved to have a marked deleterious effect on the trees.—Edmond **Perrier**: Remarks on the preceding communication, pointing out the serious damage done to the trees in the Jardin des Plantes by the adjacent tarred road.—B. **Roussy**: The existence of a very simple geometrical law of the body surface of a man of given dimensions, demonstrated by a new method. Detailed instructions are given (with two diagrams) for determining two magnitudes called by the author the mean perimeter and the total mean peripheral height. The surface of the skin is shown to be equal to the product of these two quantities.—Raphael **Dubois**: Fluorescence in luminous insects.—L. **Mercier** and R. de **Drouin de Bouville**: The disease of the crayfish of the lake of Nantua: a criticism of the views of M. Dubois.—F. **Rogoziuski**: Researches on the glycogenic property of glucosamine.—A. **Daniel-Brunet** and C. **Rolland**: The influence of sex and of castration upon the quantity of lipoids in the bile of cattle.—Stanislas **Meunier**: An example of pluvial decalcification realised in the course of the lower Tertiary epoch.—Louis **Laurent**: The presence of the genus Atriplex in the Tertiary flora of Menat (Puy-de-Dôme).

CAPE TOWN.

Royal Society of South Africa, May 19.—Mr. S. S. Hough, F.R.S., vice-president, in the chair.—R. **Marloth**: Some new South African succulents and other plants. Among the plants described in this paper are three species of special interest, viz., one of Cytinus, one of Borbonia, and one of Anacampseros. The Cytinus is noteworthy as it constitutes a second species of Rafflesiaceæ for South Africa; the Borbonia is of economic importance, being the source of a colonial tea, viz., "rooibosch-tea," and the Anacampseros is another example of mimicry-plant, of which eight species were described in previous papers.—Miss D. L. **Bleek**: Note on the language of Bushmen tribes north of the Orange River. All words and sentences taken down from Bushmen south of the Orange River show that they spoke one language, with dialectical variations. North of the Orange River, however, in the Langeberg and adjoining Southern Kalahari, we find a different language, that of II n Bushmen, closely allied to that of I Xam Bushmen (those south of the river); the difference in the vocabulary, and still more in the grammar, of these two tribes is too great to be called a mere dialectical variation. In the Northern Kalahari the so-called Masarwa are found, people living exactly as Bushmen do, though said to be mixed in type. The South African Museum has a series of gramophone records taken from pure Masarwa, in the heart of the Kalahari region, which the author has transcribed, and which, in spite of the instrument not having recorded clicks clearly, gave valuable evidence that the language belongs to the Bushman family.—L. **Péringuey**: Note on the result of investigation of a Strand Looper rock-shelter, with exhibition of the objects found. The cave which it was decided to excavate is, properly speaking, a rock-shelter, filled with an accumulation of kitchen refuge, blown sand, &c. The excavation was carried through a depth of nearly 14 feet of this material, when it was found necessary to stop, owing to the dampness of the detritus. The cave was originally discovered by Mr. C. J. Whitcher, who carried on some excavation first, and very kindly allowed the museum to proceed with further exploration work. This cave proves to have been a necropolis, a considerable number of skeletons having been found at different depths. In the pelvic bone of a young child (or female) was found embedded a small stone chip, part of the point of an arrow, probably poisoned. Most of the skeletons are in a greatly advanced stage of decay. Some are plainly Strand Loopers, but others were found which are not Strand Loopers; they are of greater and more robust stature, and would appear to be half-bred, or perhaps Kaffirs, yet the mode of burial is the same, but the skulls of this "larger race" are not entire, nor could all the fragments be found. A feature of the hitherto unrecorded burial rites is the placing of flat stones, occasionally painted, on the hunched-up body resting on its side. One of these stones has polychrome paintings of the Bushman type, but unlike any of these paintings, in this one the eye, and an attempt at facial delineation is noticeable. The evidence of the bone and stone implements found in this sepulture not only indicates that the two industries prevailed simultaneously, but that implements of palæolithic and neolithic type were also coeval. It can now be said that in South Africa the hiatus which in Europe, or in the Palæarctic region, separates the palæolithic from the neolithic, is now proved not to have existed.—T. **Burtt-Davy**: Observations on the inheritance of character in Zea Mays. In Red Cuzco and some other breeds of red maize, the red colouring matter is confined to the pericarp, and is therefore a fruit character; it does not appear in the first cross between a white male and a red female. In a red dent breed the red pigment occurs in the aleurone layer; it is therefore a seed character; it is dominant to whiteness. When this breed is crossed with a white sugar breed the results in the second generation are approximately:—Red: starchy, 56·25 per cent.; sugary, 18·75 per cent. = 75 per cent. White: starchy, 18·75 per cent.; sugary, 6·25 per cent. = 25 per cent. A single grain has been seen, in which the starchy character appears in one half, the sugary character in the other. The number of rows on a maize ear, within certain limits, is subject to fluctuating variations, which may perhaps be affected by season or food supply, or both. When an 8-row type is crossed with an 18-row type, both characters disappear in the heterozygous form, and an intermediate type is produced, in which there are 10, 12, or 14 rows, 12 rows greatly predominating. A white-cobbed breed crossed with a red-cobbed produces a red-cob in the first filial generation. Result of reciprocal cross is the same.—E. **Nevill**: The early Babylonian eclipses of the sun. On the fourteenth line of Tablet No. 35968 of the British Museum Collection, Mr. King has deciphered the record:—"On the twenty-sixth day of the month Sivan in the seventh year the day was turned into night and fire in the midst of heaven. . . ." From collateral evidence contained on the tablet, the author supports Mr. King's contention that the phenomenon referred to is a total eclipse of the sun, but differs from Dr. Cowell, who has identified it with the eclipse of B.C. 1062, July 31. The author has examined the features of some seventy eclipses which occurred between B.C. 1250 and B.C. 950, the extreme limits of date which seems to be compatible with the inscription, and finds that three of these only appear to satisfy the prescribed conditions of having been visible from the neighbourhood of Babylon at a time of year corresponding with the twenty-sixth day of the month Sivan, viz., those of —1217 June 5, —1123 May 18, and —956 May 31. The identification of this eclipse is of importance as bearing on the theory of the moon's motion, as well as in relation to doubtful points concerning the chronology of the earlier kings of Babylon.—T. **Muir**: Sylvester's axisymmetric unisignants.

CONTENTS.

THURSDAY, AUGUST 3, 1911.

ZOOGEOGRAPHY.

Bartholomew's Physical Atlas, vol. v., Atlas of Zoogeography: a Series of Maps Illustrating the Distribution of over Seven Hundred Families, Genera, and Species of Existing Animals. Prepared by Dr. J. G. Bartholomew, W. Eagle Clarke, and P. H. Grimshaw. Pp. viii+67+36 plates+xi. (Edinburgh: J. Bartholomew and Co., 1911.) Price *2l. 12s. 6d.* net.

THE fifth volume of "Bartholomew's Physical Atlas" is devoted to "Zoogeography"—that is, as the word clearly indicates, the science of the distribution of animal-life over the world's surface. Little was known and still less was understood about this branch of zoology in former years. But when the "Origin of Species" began to be discussed it was quickly perceived how closely the localities of animals and plants are connected with their affinities, and how important "zoogeography" is to the student of animal and vegetable life. Linnæus and his immediate followers did not understand this. They thought that such terms as "East Indies" or "Brazil" were quite sufficient indications of the locality of an animal. But, as the science of zoology advanced, authors became gradually more particular as to their localities, and nowadays unless the place of origin is exactly known a specimen loses at least half its value. In early days the faunal character of each geographical area was supposed to depend entirely on its climatic and physical peculiarities. This idea, however, has been abundantly proved to be incorrect. In many cases tracts of the world's surface exactly similar in climate and in other physical conditions can be shown to be entirely different as regards their animal life. It was not until the theory that the descent of animals is accompanied by modifications of their structure became appreciated that any correct views were put forward on the laws of their geographical distribution. The authors of the present work describe the commencement of this new period as follows:—

"The first attempt to map out a set of zoogeographical regions, based upon the actual distribution of species, and apart altogether from purely geographical considerations, was made by Dr. P. L. Sclater. This eminent zoologist, who is, fortunately, still living, read a paper before the Linnean Society of London, in June, 1857, entitled 'On the General Geographical Distribution of the Members of the Class Aves.' Taking as his basis the Passerine, or 'Perching' Birds, he proposed the division of the earth into six great regions, which he defined geographically, and whose area in square miles he roughly estimated. At the same time, he furnished a tabulated statement of the number of species found in each region, and gave an indication of the peculiar and characteristic genera. As this paper was an epoch-making one, and as its divisions correspond very closely with the main regions adopted in most of the schemes since proposed, it is perhaps desirable to quote the main features before proceeding further."

The authors then proceed to enumerate the six great "regions" into which Dr. Sclater had proposed to divide the earth's surface for zoological purposes, adding in each case a short description of their boundaries and estimated areas, also a rough calculation of the number of species of birds then known to be found in each of them. These six regions were as follows:—(1) The Palæarctic region (embracing Europe and North Asia, and the northern part of North Africa); (2) the Ethiopian region (Africa, except the portion north of the Sahara); (3) the Indian region (southern Asia and the adjacent islands); (4) the Australian region (Australia and the Pacific Islands); (5) the Nearctic region (North America); and (6) the Neotropical region (South and Central America).

The publication of Dr. Sclater's article induced many other zoologists to state their views on the subject. Günther, Blanford, Huxley, Heilprin, and Blyth were among the number. Many of them agreed more or less with Dr. Sclater's proposals, but offered criticisms on particular points, and suggested emendations of his nomenclature. But in 1876 appeared Dr. Wallace's classical and important work, "On the Geographical Distribution of Animals," which combined all that had been previously known on the subject with the knowledge acquired by the travels and experiences of this great naturalist. In this work Dr. Wallace absolutely adopted Dr. Sclater's division of the world into six great regions and his nomenclature, only suggesting that the name of the "Indian" region should be changed to the "Oriental" region, an improvement which subsequent authors have been generally willing to agree to.

Dr. Wallace, after fully considering the question, states decisively his reasons for adopting the six zoological regions proposed by Dr. Sclater as follows:—

"So that we do not violate any clear affinities or produce any glaring irregularities, it is a positive, and by no means an unimportant advantage to have our regions approximately equal in size, and with easily defined, and therefore easily remembered, boundaries. All elaborate definitions of interpenetrating frontiers, as well as regions extending over three-fourths of the land-surface of the globe, and including places which are the antipodes of each other, would be most inconvenient, even if there were not such great differences of opinion about them. There can be little doubt, for example, that the most radical zoological division of the earth is made by separating the Australian region from the rest; but although it is something useful and definite to know that a group of animals is peculiar to Australia, it is exceedingly vague and unsatisfactory to say of any other group merely that it is extra-Australian. Neither can it be said that, from any point of view, these two divisions are of equal importance. The next great natural division that can be made is the separation of the 'Neotropical' region of Dr. Sclater from the rest of the world. We should thus have three primary divisions, which Prof. Huxley seems inclined to consider as of tolerably equal zoological importance. But a consideration of all the facts, zoological and palæontological, indicates that the great northern division (Arctogæa) is fully as much more important than either Australia or South America, as its four component parts are less important; and, if so, convenience requires us to adopt the smaller rather than the larger divisions."

Convinced by these weighty arguments, the authors of "Zoogeography" adopt the six Sclaterian regions without exception, and use them throughout their work, making only the change of the name of the "Indian" region into the "Oriental" region, as was suggested by Dr. Wallace. They take these six regions one after the other, and describe their extent, the best mode of their division into subregions, their most obvious physical features, and the chief zoological characteristics which distinguish them. One of the more difficult points to be considered is the relation of North America to the Palæarctic region. So similar in many respects are their faunas that Heilprin had proposed to unite them under one name as the "Holarctic" region, which has met with approval by Huxley, Newton, Lydekker, and other writers. But after discussing the question, our authors follow Wallace in rejecting Heilprin's proposal, and give good reasons for doing so.

The third and most important part of the present work is the zoological section, to which we must now direct attention. It is obvious that an exact knowledge of the general distribution of animal life must be based on a thorough acquaintance with the particular distribution of each species. But, as is well pointed out in the present work, the distribution of animal life in many areas "has not been investigated in sufficient detail to afford the necessary data, and in such cases it is impossible to define the range of species with precision." Moreover, in many groups of animal life, especially in the lower forms, the species are so multitudinous, and as yet so little known, that they cannot be used for such a purpose. But all the higher forms, such as mammals, birds, reptiles, and amphibians have been dealt with in this work, besides the more important families of fishes, and a selection of the better-known groups of insects and molluscs. The zoological portion of the letterpress of "Zoogeography" occupies some forty-four pages of two columns each, and seems to be very complete, though it involves a mass of details, which it must have been a hard task to put together and to arrange in order.

Following this portion of the work is a "bibliography," containing the titles of the separate books and the principal articles published in journals relating to zoological distribution. This, we think, though useful as it is, might have been improved by the addition of the names of the leading authorities on the faunas of each of the different parts of the world, something like that which was given by Dr. Sclater in his presidential address to the Biological Section of the British Association at Bristol in 1875. It must be admitted, however, that such a list, though of much value, would have somewhat inconveniently increased the bulk of the "bibliography."

We now come to the maps, the most important feature in the work, which have been planned to illustrate the distribution over the world's surface "of more than seven hundred families, genera, and species of existing animals." It is to be regretted that the extinct forms of animal life have been altogether unnoticed, as they serve to explain in some degree the anomalies of the present state of distribution. That the task of inserting them would have been serious it must be confessed. We observe that the dodos (Dididæ) have been mentioned. But we think that a few words might also have been devoted to the moas (Dinornithidæ) of New Zealand, the rocs (Æpyornithidæ) of Madagascar, and to other forms which have only recently become extinct. Taken as a whole the thirty-six plates of the atlas are excellent, and fully sustain the claim of the great firm which has produced this handsome volume to issue nothing but first-class work.

In books of this kind, accompanied by a large number of illustrations, there are often slight discrepancies between the plates and the descriptions of them in the text. We find nothing of this sort in the present work, in which it is obvious that the main object of the text has been the description and explanation of the illustrations. In fact, we consider that Mr. Bartholomew and his enterprising firm deserve the greatest credit for the production of the fifth volume of their "Physical Atlas," which, we are sure, will long remain the leading authority on "zoogeography."

CENTRAL ASIA.

L'Asia Centrale: noti di viaggio e studi di un Diplomatico giapponese. By Nisei Tocugiro (Nishi Tokujiro). Translated by L. Nocentini. Pp. xxx+317. (Turin: Unione Tipografico-Editrice Torinese, 1911.) Price 4.50 lire.

THE distinguished Sinologist, Prof. Lodovico Nocentini, has translated into Italian an interesting Japanese work on the geography, ethnography, and political conditions of Central Asia, which was written a quarter of a century ago by Mr. Nishi Tokujiro (or Tokujiro Nishi, as we should say), then First Secretary of the Ministerial Council at Tokyo. The translation, with additions and notes by the translator, which bring it up to date, has now been presented to the Italian Geographical Society, with a preface by the president of that body, Signor Cappelli. Mr. Nishi has been prevented by other work from adding new material to the book himself.

In 1880 Nishi Tokujiro, then attached to the Imperial Legation at St. Petersburg, left on his homeward journey by way of Central Asia, passing through Russia and Chinese Turkestan on the way, and this volume, produced in 1885, was the result of his *noti di viaggio* and general knowledge. When published it would, had it been translated promptly, have been of great interest, and even now, with the addition of Prof. Nocentini's notes, it is valuable as a general account of Central Asia. For non-Italian readers, however, its value is somewhat discounted by the unscientific transliteration of all names, whether Russian, Chinese, Turki, or what-not, into a guise which, though it may reproduce the correct sounds of the originals to an Italian reader, is confusing to those of other nations, who have to re-transliterate into the forms familiar to them. What English or German reader, to take instances, would at once recognise in "Coccienco" the Russian name Kochienko, in "I-'r O-scen" the Chinese Yi-erh Wo-shen, in "Cucia" or "Cuccia" the town of Kucha, or even in "Culgia" that of Kuldja? And ought the town of Piotr-Alexandrovsk to be literally translated into Italian as "Pietro-Alessandro"? In England we do not talk of "Coachienco," "Yee-erh, " "Cootcha," or "Peter-Alexander" (though we might have sixty years ago), and nowadays the strictly scientific "Kočyenko," "Kuldža," or "Kuča," would be perfectly well understood here. In this matter of transliteration the Italians (like the French in dealing with Arabic names) are half a century behind the times. This book will be read, out of Italy, only by those who have some knowledge of Central Asia and its languages, but do not necessarily know even enough Italian to recognise the name of the author of this book in its Italian form, "Nisci Tocugiro."

Mr. Nishi's work was a very complete description of the lands and peoples of Central Asia, so far as counting of heads goes, but not a particularly thorough one. Its historical sections are the best, but its great interest lies simply in the fact that it was the work of a Japanese so early as the eighteenth year of Meiji. Even then the relentless advance of Russia in Asia was being noted by the watching Japanese, and the resources and possibilities of her Asiatic dominion were being "sized up" by the unimportant traveller Nishi, who was significantly, on his return to Japan, attached to the general staff. Who knows but even then the Japanese were beginning to prepare for the inevitable struggle, which came twenty years later, just when the dominion of all Asia seemed about to fall irrevocably into Russian hands? Mr. Nishi had no great belief when he wrote in the ability of China or even England to stop Russia. He seems to shrug his shoulders over the vain English protests against the advance of the colossus of the north, which emanated in "Mervous" succession from our Foreign Office for twenty years, and ended with the "Penjdeh incident" (Signor Nocentini calls the place "Pange"), which seemed to make our weakness patent to all the world. The ally of 1902 did not seem very admirable to a Japanese in 1885. We have, however, got over our "mervousness" now that Russia is brought up short by the great mountain-barriers, and indeed it is not probable that we ever had any real justification in trying to stop her advance into Turkestan. Her taking of Merv was much more inevitable than our taking of Mandalay, and she only went beyond bounds when she took Penjdeh and the Kushk valley from Afghanistan. The real danger of war which then ensued was a signal to her to stop, for we know now, since Japan has shown us, that Russia's power is all "bluff"; she had no more wish for war with us in 1885 than with China over the question of Kuldja in 1880, or with Japan in 1903. In 1880 China met her bluff with greater bluff, and in 1903 Japan took her at her word, with the result that the history of Asia has entered on a new phase, incredible had it been, prophesied in 1885, even to the self-confident countrymen of Mr. Nishi.

Signor Nocentini brings the political part of the book fully up to date, even including an account of Dr. Stein's discoveries and the text of the Anglo-Russian agreement relative to Tibet. We see from this that the prohibition of the sending of scientific expeditions to Tibet by either Russia or England expired in 1910. But in view of the disturbed condition of Tibet owing to the Chinese invasion, it is not probable that any such expeditions will be sent there for some time yet.

The typographical and ethnological details have not been brought up to date. The mountains stand where they stood in 1885, and the Jaxartes has not yet again changed its course, while the ethnic peculiarities of Kirghiz, Uzbegs, Sarts, Eleuths, and Dungans remain the same, so this does not matter. But details of the population of the cities and of the dislocation of Russian troops in Asia in 1881 have now merely an antiquarian interest.

Nevertheless the book is a very interesting one, and is well worth persual by those who study the subject. What the future of this huge land will be, who can say? The Japanese war has probably put a stop to all Russian advance for many a year to come, unless a parliamentary China should foolishly (thinking herself, in Babu-wise, the equal of Japan) try to oust Russia from northern Manchuria. In that case China will lose much, while Japan will look benevolently, this time, upon Russia's chastisement of her. Then we English would be well advised to insist that Russia, whatever else she may take, shall leave Chinese Turkestan in Chinese hands. Otherwise a fresh attack of "mervousness" may arise, if Russia is in Kashgar and Khotan.

If there is no war between Russia and China within the next few years, the Russians will be able to devote their rather intermittent energies to the development of the enormous territory that is already theirs. Railways are a necessity to her military hold of Central Asia, and there are lines yet to be built which are of great strategic importance, though they may not "pay" for a century. A railway from Orenburg through Akmolinsk to Semipalatinsk is projected, and another line should run from Tashkend to Krasnoyarsk, by way of Aulië-ata, Vyernyi (where the recent earthquake took place), Sergiopol, Semipalatinsk, and Barnaul, with a branch to the Ili valley, and, if China will permit, on to Kuldja. This line would bind Turkestan to eastern Siberia, and enable troops to be railed from Samarkand to Irkutsk direct. But the country to be traversed is mostly steppe, and the immediate value of the line would only be military, as in the case of the existing Orenburg-Tashkend railway. So Russia will be condemned indefinitely to pour out millions of roubles into the wilderness (and the contractors' pockets), and only a century hence will the slow work of the present day bear fruit in a great and mighty country, the home of millions of peaceful and hard-working Russians—a new Canada.

The future of China, who can prophesy? But it is improbable that a century hence China will have allowed the Japanese to retain their control of southern Manchuria, or even Korea, and the islanders may be driven back to their home, even as we were expelled from France in the fifteenth century. History always repeats itself in similar cases. But Japan will have done her work well, and the notes made by Nishi Tokujiro in his journey twenty-five years ago would have shown us then, had we had ears to hear or eyes to see, that already Japan was studying the huge continent at her door, and weighing the possibilities that might come forth from it in the fulness of time.

It remains only to say that the book is "bound" only in paper covers, and falls to pieces directly it is cut. We presume that Italians send their books to the binders before they read them. L4.50 seems a high price for a book of 300 pages that has no binding and no illustrations. Unlike the French, the Italians understand the value of an index, and this book has a good one.

LUCIANI'S HUMAN PHYSIOLOGY.

Human Physiology. By Prof. L. Luciani. Translated by Frances A. Welby. Edited by Dr. M. Camis. With a preface by Prof. J. N. Langley, F.R.S. In two vols. Vol i., Circulation and Respiration. Pp. xiv+592. (London: Macmillan and Co., Ltd., 1911.) Price 18*s*. net.

THE rapid progress in the science of physiology makes it increasingly difficult for any single individual to give a comparatively complete presentation of the whole subject. In consequence of this fact, the larger text-books are usually written by several authors. While there are many advantages in this method, a loss of unity in the treatment of the subject inevitably results. Luciani's work gives a more detailed account of the subject than the majority of text-books of single authorship, and thus occupies a place intermediate between the larger works and those of moderate size.

The arduous labour of translation has been carried out very efficiently, the English version being clear, accurate, and eminently readable. The translator has also had the advantage of the assistance and advice of Dr. Aders-Plimmer on chemical subjects, and of Mr. W. L. Symes on many technical difficulties. The references to the literature of the subject appended to the various sections of the work form a very useful feature. The editor, Dr. M. Camis, has rendered these more complete by the addition of the chief recent English and American physiological papers. These references will undoubtedly offer valuable guidance to senior students of physiology desirous of extending their knowledge of physiology beyond the limits of their text-books.

The present volume, which extends to 600 pages, deals with the general physiology of living matter, the physiology of blood, the circulation, respiration, and lymph.

The introduction gives a brief but masterly account of the general objects and domain of physiology. The first three chapters deal with the structural features, the chemical and physical basis of living matter, its fundamental properties, and the conditions by which it is influenced. The third chapter closes with an interesting account of the hypotheses of Pflüger, Hering, and Verworn regarding the nature of the processes which take place in living substance.

The fourth chapter deals with the formed constituents of blood. The historical development of the subject is excellently epitomised. The general physico-chemical characters of the blood as a whole are next described. A brief account of the methods used in determining the rate of coagulation might have been added with advantage. The morphological elements of blood are then described. The plate showing absorption spectra is somewhat diagrammatic, methæmoglobin and acid hæmatin being represented as having identical spectra.

An excellent account of the chemical and physical properties of blood plasma, and of the theories of its coagulation, forms the main subject-matter of chapter v. The chapter concludes with an account of the effects of bleeding, transfusion, and the bactericidal and immunising properties of blood.

An exceptionally detailed account of the historical development of our knowledge of the circulation of the blood is given in chapter vi. The author ascribes the discovery of the true course of the circulation to Cesalpinus rather than to Harvey, differing in this respect from the large majority of physiologists. In the preface to this volume, Prof. Langley has given the chief reasons for critical caution in studying Prof. Luciani's views on this subject.

The mechanics of the heart and blood flow are fully discussed in chapters vii. and viii. The discussion of the myogenic and neurogenic theories of cardiac rhythm given in chapter ix. offers an excellent example of the author's skill and impartiality in presenting the evidence for and against rival views. The account given embodies the most recent work on the subject, including that of Carlson on *Limulus polyphemus*.

Chapter x. provides an excellent account of the vaso-motor nervous mechanism. Chapter xi. is devoted to the chemistry and physics of respiratory exchanges. A most interesting review of the historical development of the subject is given, both from the chemical and physiological points of view. A description of Haldane's method for determining the oxygen capacity of blood might have been appended to the account of the methods for the extraction of the gases of the blood.

The nervous and chemical control of respiratory rhythm form the subject-matter of chapter xiii. Some interesting recent observations by Italian workers, throwing new light on the mode of production of certain forms of polypnœa in muscular work, are recorded. A somewhat fuller discussion of recent views on the chemical regulation of respiration would have been welcome.

The present volume concludes with an excellent account of the physiology of lymph and lymphatic organs.

The book is singularly free from errors; yet in a text-book of this extent minor errata inevitably occur. The following may be mentioned with the view of aiding to some extent in the preparation of a table of errata. On p. 25 "cornea" is used instead of "stratum corneum"; on p. 109 "carbon bisulphide" should be replaced by "ammonium sulphide"; on p. 333 "afferent" by "efferent"; and on p. 415 "inspiratory" by "expiratory."

The present edition is a distinct advance on the earlier issues, the more recent additions to physiology being fully given. Such are some of the chief characteristics of this book. So brief a review as the foregoing necessarily leaves unmentioned many other important features. The book is a remarkable achievement, especially in view of the fact that it is the work of a single author, and appears to the reviewer to possess special qualities and merits, which entitle it to a high place amongst the existing English text-books of physiology. The issue of the remaining three volumes will be eagerly awaited by all who have studied the present volume.

ABBE'S THEORY OF IMAGE FORMATION IN THE MICROSCOPE.

Die Lehre von der Bildentstehung im Mikroskop von Ernst Abbe. Edited by Otto Lummer and Fritz Reiche. Pp. xii+108. (Braunschweig: F. Vieweg und Sohn, 1910.) Price 5 marks.

AN account of Abbe's theory of the microscope image given by so distinguished an optician as Prof. Lummer cannot fail to arouse a large amount of interest among all students of optical theory, as well as among workers with the microscope. It demands the more attention in that it is professedly a reproduction of Abbe's theories as propounded by himself. Lummer tells us that in the winter of 1887, in company, among others, with Winkelmann, Czapski, Rudolph, and Straubel, he attended a series of lectures given by Abbe in Jena, and it is clear that he enjoyed exceptional opportunities of becoming acquainted with Abbe's views and his manner of regarding microscope theory.

The work, we are told, is founded solely on the carefully preserved notes of these lectures. One question only, it was thought, needed to be reviewed from the modern point of view: Is the Fresnel-Huyghens secondary-wave interference theory a satisfactory basis for the discussion of the phenomena, or will the more modern theory of Kirchhoff and Maxwell lead to some modification of the conclusions arrived at? It may be answered at once that Lummer attacks the problem of image formation by limited beams from the latter point of view, and shows that it leads to identical results with the former.

The intrinsic interest of the book is very great, and the methods employed are most instructive, both in the establishment of general principles and in their application to the special cases which arise in microscope imagery when periodic structures are viewed by transmitted light. Thus, in the latter case, the determination of the distribution of light intensity in the image plane requires an integration over the plane of the structure viewed, and over that of the actual or virtual aperture. By variation of the order of integration the authors are able to bring out clearly the part played by the different "diffraction spectra" in the formation of the image. The same thing is shown in a different manner more fully, and still more clearly, in Lord Rayleigh's well-known paper of 1896, "On the Theory of Optical Images, with special reference to the Microscope."

The special cases here dealt with are those of a single luminous slit, two parallel slits, self-luminous or viewed by transmitted light, and a single slit of finite breadth, with or without phase difference; finally, in a separate chapter the case of a grating is considered, and the effect discussed of limiting the image-forming rays to certain of the grating maxima. In dealing with images formed by transmitted light, the case of oblique illumination is also treated. The source of light is supposed either at a finite or infinite distance, but, as might be anticipated, there is no special discussion of the case of "critical" illumination. Throughout, the treatment is not for a circular aperture, but an aperture of special form is assumed to simplify the integration.

The main interest of the volume, however, lies in the light it throws on the manner in which Abbe derived his well-known theory. From this point of view we must confess that we find the book a little disappointing. It is not easy to agree with Prof. Lummer as to the necessity, or even the desirability, in this book, of devoting space to showing how far the older theory is in agreement with more modern views, and this is not the only feature which tends to produce a sense of uncertainty as to how far the account given can be regarded as a direct reproduction of Abbe's presentation of the subject. What admirer's of Abbe's work would wish to have is a close and faithful transcript of Abbe's own development of the theory, with the minimum of variation from the line of argument he may have followed. The volume is, however, inspired by a true enthusiasm for Abbe's teaching, and a just appreciation of the value of his work, and the future historian of science will be indebted to Prof. Lummer for the trouble he has taken to present in a manner worthy of its origin the material at his disposal.

THE NUTRITION OF THE ALGÆ.

Die Ernährung der Algen. By O. Richter. Pp. viii+192. (Leipzig: Dr. W. Klinkhardt, 1911.) Price 12 marks.

SINCE the appearance in 1905 of the second part of Oltmann's work on the morphology and biology of the algæ, so large a number of memoirs on the nutrition of the algæ have appeared, that Dr. Richter has thought it worth while to collect them into a volume for the *International Review of Hydrobiology and Hydrography.* The references are grouped under three headings—(1) the significance of chemical elements and certain chemical compounds in the physiology of nutrition; (2) the influence of various chemical and physical factors of the nutrient substratum on the form and development of the algæ; and (3) an appendix on the influence of temperature and light on the algæ with reference to their culture.

It is not possible to give anything like an adequate account of the numerous investigations which are brought under review. After a brief discussion of the metallic elements which are of importance to the algæ, the non-metallic elements and compounds are considered. Reference is made to the evolution of oxygen in carbon dioxide assimilation and the various methods by which it can be quantitatively determined. Engelmann's well-known bacterial method and Beyerinck's method of using luminous bacteria are spoken of by the author as "two of the most elegant methods for the demonstration of the evolution of oxygen." Beyerinck found that luminous bacteria, when placed in contact with algal filaments, are phosphorescent when oxygen is being evolved, but cease to be luminous in its absence.

In reference to Bokorny's observations on Spirogyra and Zygnema in support of Baeyer's hypothesis that formaldehyde is the first product of carbon dioxide assimilation, the author concludes that, in view of their far-reaching scientific importance, it is necessary that these investigations should be repeated with absolutely pure cultures of algæ. This appears to be so much the more desirable as Treboux, working with pure cultures of some of the lower algæ, was unable to obtain starch formation either with formaldehyde or methylal. Dr. Richter very properly lays stress upon the great importance of pure cultures in these experiments in order to prevent the contamination with carbon dioxide produced by fungal or bacterial growths, which may completely vitiate the results. He fully discusses the results obtained by various observers upon the assimilation of organic nutrient substances, such as glycerine. Many algæ seem to prefer organic compounds containing nitrogen; others prefer carbohydrates. Among the former are diatoms, and indeed these organisms seem to have a preference for albuminoid food substances.

The second part of the book is taken up with a consideration of the papers dealing with the poisonous action of various chemical compounds, the influence of narcotics, the deleterious effects of different species of algæ upon one another, and the reactions of the nutrient material upon their growth and development. The poisonous action of minute traces of metals, termed by Naegeli oligodynamic, is illustrated by some interesting experiments made by the author to show the deleterious influence exerted by coins when placed in contact with diatom cultures on agar. In discussing the effects of light and temperature on the algæ, the author shows clearly that variation in intensity has a very marked effect on their growth and on the formation of various organs.

The book may be commended to students as a very useful summary of the important researches bearing upon algal nutrition and the various factors by which it is controlled. Very few of the problems, of course, are peculiar to algæ (they are problems of plant nutrition generally), and the book is to some extent lacking in completeness, because, in his desire to confine himself strictly to algæ, the author has neglected many papers dealing with plant nutrition, which are just as applicable to algæ as to other plants.

There is a very full index, both of subjects and of authors, together with a good table of contents and a list of nearly five hundred references.

H. W.

POPULAR ASTRONOMY.

(1) *Star-Lore for Teachers: Suggestions for the Teaching of Astronomy by direct Observation, Experiment, and Deduction.* By B. Lowerison. Pp. 67; interleaved for notes. (London: The Clarion Press, n.d.) Price 1s.

(2) *The Star Pocket-book; or, How to Find Your Way at Night by the Stars. A Simple Manual for the Use of Soldiers, Travellers, and other Landsmen.* By R. Weatherhead. With a foreword by Sir Robert Ball. Pp. 80. (London: Longmans, Green, and Co., 1911.) Price 1s. net.

(3) *Les Progrès Récents de l'Astronomie (III.—année 1909.)* By Prof. Paul Stroobant. Pp. 174. (Brussels: Hayez, Rue de Louvain, 1911.)

(1) IF the automatic response to the stimulus of the starry heavens has not forced a man to acquire enough astronomical knowledge to instruct his pupils intelligently in star-lore, that man has no business to be a teacher of the subject. Lacking the capacity or desire to observe and find out for themselves, we fear that such misplaced persons will gain little from this book.

The information is tabloidal, sometimes even awkwardly abbreviated, and the compilation bears internal evidence of the lack of that fuller knowledge so essential in anyone who professes to direct the teacher.

The motive is worthy, and as the book was written "for love" we should, perhaps, modify the criticisms that suggest themselves at once. But *gamma* is not the brightest star in Corona (p. 29), nor is Sirius a notable Algol variable, as might be deduced from p. 40; and objection may be taken to "astrology" as a translation of "L'Astronomie."

The children under the author's tuition probably enjoy their astronomy lessons immensely, and he is to be congratulated upon the modest but effective equipment so thoughtfully provided for them. We would that other teachers could be induced thus to recognise the wonderfully educative potentialities of astronomy, but we fear that, despite the excellent intention, this small book can do but little to further the recognition.

(2) As a practical naval instructor, Mr. Weatherhead was asked to lecture to a number of army officers on the use of the stars as guides in night marches, and he now gives the general public the benefit of his admirable notes. A brief introduction, directions as to how to identify the chief stars, and a key to the nomenclature of them, are followed by some excellently clear charts showing the brightest, most conspicuous groups. A few tables and examples make it clear how to find north or south by three of the simplest methods. All interested in the stars apart from their

physical features will find the pocket-book instructive and interesting.

(3) Dr. Stroobant's annual summaries of the most important results obtained in astronomical research each year are models of concise and careful compilation, in which the general reader, as well as the professional astronomer, will find much to interest and instruct.

Limitations of space forbid any extensive *résumé* or discussion of the various sections here, but, whether it be in solar physics or in astronomy of position, it would be difficult to point to any result of value that is not included. In the present volume, as one would naturally expect, Halley's comet is given a prominent place, the bringing together of the most important observations and results occupying about sixty pages; the history of the 1909–10 apparition is brought up to the end of July, 1910, and illustrated by several photographs and charts. W. E. R.

OUR BOOK SHELF.

Inorganic Chemistry for Schools. By W. M. Hootton. Pp. viii+408. (London: Edward Arnold, n.d.) Price 3*s.* 6*d.*

The author of this volume has exercised a considerable amount of ingenuity in illustrating his subject by reference to many of its most interesting technical applications. His own knowledge is evidently extensive and up-to-date, and it is therefore all the more to be regretted that he should have adopted a method of teaching which is radically bad and indefensible. As in so many other cases of the kind, he has evidently sacrificed sound method to the demands of those who require "a sufficient preparation for the London Matriculation (new syllabus), Northern Universities Matriculation, and Army Entrance Examinations in chemistry," compressed into a two years' course, and has adopted a system which approaches perilously near to "cramming" pure and simple.

Formulæ are introduced on p. 48, but the pupil has to take them as *ex cathedra* pronouncements until on p. 261, almost at the close of his course, he receives a faulty explanation of the way in which they may be deduced. In the meantime, he must be puzzled by being told, on p. 51, without any explanation, that "phosphorus pentoxide (P_4O_{10}) is a white powder easily soluble in water." It would scarcely be possible to conceive a more direct violation than this of the maxim which forms the opening words of the preface, that "It is demanded of a school course of chemistry that it shall train the reason"! The imperfections of his own reasoning is shown by a statement on p. 267 that "according to Avogadro's theory, the atomic weights of elementary gases are numerically equal to their densities." Such a statement, if reproduced by his pupils, and applied by them to mercury, sulphur, and phosphorus, should go a long way towards securing their failure in the examinations for which this book is intended to prepare them. Such errors would be impossible if the author had consulted the original papers or the "reprints" by which they are now rendered so easily available.

The same lack of accuracy and absence of all historic sense is shown in a very picturesque way on p. 46, Fig. 14, where Lavoisier is represented as heating mercury in a long-necked retort by means of coal-gas, and with the help of the burner invented several decades later by Bunsen. In a book so faultily designed and containing such errors, the inclusion of diagrams of electric furnaces for the manufacture of calcium, of carbide, and of carborundum, is a very inadequate compensation. Such a volume cannot be recommended.

East and West. Comparative Studies of Nature in Eastern and Western States. By S. D. Kirkham. Pp. x+280. (New York and London: G. P. Putnam's Sons, 1911.) Price 7*s.* 6*d.* net.

The title refers to the two horizons of the American continent so widely distant that there is the greatest difference in the scenery and organic life representative of the States situated on the Atlantic and Pacific slopes. Primarily it is the author's desire to interest his countrymen in the natural beauties of the land of their inheritance. He presents a dozen sketches of typical scenes or associations with which he is familiar. The descriptions are taken from localities in the States of New York or Massachusetts, on the east, and from the States of California and Arizona on the west, where the author has evidently spent some time in leisurely observation. Cape Ann, Long Island woods, Chaparral and Arizona gardens are sufficiently explanatory as to their situation; other localities described are the forest-clad waterways in the Adirondacks, the "finger-lakes"—so called on account of their configuration—in New York State, and the Elysian fields, situated in this case in the Santa Inez valley in California.

The sketches or impressions relate almost entirely to natural artistic effects, plant associations, or the habits of birds; they will appeal with special force to the traveller who has trodden paths remote from civilisation. To English readers many of the names of birds and plants will be a puzzle; chickadee, road-runner, phœbe, and vireo are strange; similarly madrona, bay berry, and hobble bush require translation. An appendix of scientific names would add materially to a better understanding of the text. It is evident that the author has found greater diversity and brilliancy in the plant- and bird-life in the western States, for which reason the later sketches are the more attractive and illustrative.

Columbia University Contributions to Anthropology. Edited by Franz Boas. Vol. ii., Kwakiutl Tales. By Franz Boas. Pp. viii+495. (New York: Columbia University Press; Leyden: E. J. Brill, Ltd., 1910.)

This volume is the first to appear of a projected annual series under the general editorship of Dr. Franz Boas, and forms, with tales previously published by him, a large mass of material for the study of the myths of the Kwakiutl, who live between River Inlet and Cape Madge, on the coast of British Columbia. There are here many interesting parallels to legends of Japan, Australia, and other distant lands, as well as racial and local tales, often humorous, of culture-heroes and sorcerers, and naïve explanations of the origins of dances and ceremonies, and of animals and natural objects. The usefulness of the collection could have been much increased, especially for readers not familiar with American-Indian lore, by multiplying the footnotes, and by an introduction such as Dr. Boas himself supplied to Teit's "Traditions of the Thompson River Indians," for, as pointed out by him elsewhere, the traditions and organisation of the tribe are mutually explanatory, and here we have the traditions only.

The first tale, for example, has no notes, and yet the general reader can scarcely be expected to know that the victor who takes unawares an adversary more powerful in magic is a tribal culture-hero, and that the double-headed serpents forming the belts and canoes of the rivals are each the dread sisiul, which has a horned snake's head at each end, and a two-horned human head in the middle. It is an unlucky mischance, in a volume otherwise so carefully produced, that four lines which should begin p. 451 are printed at the top of p. 452, and it is only appreciation of the great value for reference of a series for which we are heartily grateful to Dr. Boas and his university that prompts us to beg that no future volume shall, like this, be without an index.

A. R. WRIGHT.

LETTERS TO THE EDITOR.

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

The Nature of γ Rays.

DR. E. VON SCHWEIDLER pointed out in 1905 that an effect (such as ionisation by α rays) due to a finite number of independent events would be subject to fluctuations. The mathematical theory of the different experiments which have been made to exhibit this with light, α and β rays, has been developed by Mr. N. R. Campbell.

One of us began some preliminary experiments in 1908 at the Cavendish Laboratory to detect discontinuous effects with γ rays. Two forms of apparatus have been used in our experiments. In the first, two similar cylindrical ionisation vessels were placed close together with their axes directed to the source of the γ rays—some radium.

If the γ rays have a spherical wave front, the two similar vessels, being symmetrically placed with respect to the source, should be equally effected by the γ rays, though the resulting ionisation due to the equal effects may not be the same. If, on the other hand, the γ rays are any type of corpuscular radiation (in the Newtonian sense) made of a finite number of particles, the effect in the ionisation vessels would be unequal over short periods of time. To compare the number of ions produced in the two vessels, the electrodes were connected to an electrometer, one vessel being positively, the other negatively, charged. The positive and negative currents from the two cans were balanced as closely as possible for long periods of time, and so there was no large steady drift of the electrometer. The quartz fibre electrometer (Proc. Camp. Phil. Soc., xv., p. 106, 1909) showed fluctuations in the balance.

In the second apparatus a box-shaped ionisation can with a central plane electrode was used. The positive ions formed in one half of the can were received on one side of the flat electrode, the negative ions from the other half of the can on the other side of the electrode. Large fluctuations were observed when the source of γ rays was placed in the plane of the electrode outside the can. This experimental result would be explained if (1) the γ rays from radium are projected particles, or (2) if the number of ions produced in air by a constant source of γ rays is subject to fluctuations.

We are continuing the experiments with the view of determining what part each of these factors plays in producing the fluctuations observed.

T. H. LABY.
P. BURBIDGE.

The Physical Laboratory, Victoria College (University, N.Z.), Wellington, N.Z.

The Occurrence of a Fresh-water Medusa (Limnocnida) in Indian Streams.

MR. S. P. AGHARKAR, lecturer on biology in the Elphinstone College, Bombay, who has been kind enough to undertake the collection of fresh-water invertebrates on behalf of the Indian Museum, has recently sent me several specimens of a medusa from small streams in the Western Ghats. Although they were taken at so great a distance from the west coast of India, it is important to note that these specimens were obtained from a river-system which flows across the Indian Peninsula and reaches the sea more than 500 miles away on the shores of the Bay of Bengal. Mr. Agharkar writes as follows:—

"The Medusæ were collected in deep pools of the Koyna and Yenna rivers (tributaries of the Krishna). I was not able to get the hydroid form. I was told that the Medusæ (called flowers or wheels by people) occur regularly in these rivers every dry season. Probably they are present all the year round, only they are swept away by the current during the rainy season and a short time after that. During the dry season, when the stream becomes more or less a succession of deep pools, they become very marked."

In the structure of the manubrium and digestive system, the position of the gonads, the structure of the tentacles, and the form of the umbrella these medusæ agree precisely with *Limnocnida tanganyicae*. As regards generic identity, there can, indeed, be no doubt, and there is nothing in the specimens before me to suggest even a specific difference. They are not, however, in a particularly good state of preservation, having suffered somewhat in the post, and the question of specific identity may be left unanswered until after an examination of fresh specimens, which I anticipate no difficulty in obtaining at a suitable season. In the meantime, I should be extremely grateful for well-preserved specimens of Limnocnida from Africa in order that an actual comparison may be made.

N. ANNANDALE.

Indian Museum, Calcutta, July 7.

Standard Time in Portuguese Territories.

I BEG to inform you that Standard Time will be in use from January 1, 1912, throughout Portuguese territories, as follows:—

h.	m.	
8	0	E. Macao, Portuguese Timor.
5	0	E. Portuguese India (provisionally 5h. 30m. E.).
2	0	E. Portuguese East Africa.
1	0	E. Portuguese West Africa.
0	0	(Greenwich, or West Europe).—Portugal, St. Thomé and Principe Islands, Whydah.
1	0	W. Madeira, Portuguese Guinea.
2	0	W. Açores and Cape Verde Islands.

This observatory remains entrusted with the determination and the telegraphic transmission of Standard Time to the whole country, to the Lisbon time-ball, and to the time station at the Meteorological Observatory, Ponta Delgada (St. Miguel, Açores).

I take this opportunity to state also that the most trustworthy geographical latitude of this observatory is lat. N. 38° 42′ 30·5″ (prime vertical, meridian, and zenith telescope series of observations from 1872 to the present, printed or unprinted), and that the designation "*Lisbon, Tapada,*" is now the most suitable for it, being similar, for instance, to "Florence, Arcetri," or "Naples, Capodimonte."

For two years a new astronomical observatory has been in existence and at work at Lourenço Marques; the geographical coordinates are (transit pier):—

Lat. S. 25° 58′ 4·9″ ± 0·2″ (meridian observations by Captain Gago Coutinho).

Long. E. 32° 35′ 30·4″ ± 0·05″ (moon culminations, simultaneously here, and geodetic connection with the Cape).

Altitude (top of pier), 59 metres.

CAMPOS RODRIGUES.

Observatorio Astronomico de Lisboa, Tapada-Lisboa-Portugal, July 25.

Obsolete Botanical and Zoological Systems.

WOULD some naturalist with a taste for bibliography be so good as to mention books which contain tables of obsolete botanical and zoological systems? Agassiz's "Essay on Classification" and the article on Zoology in the "Encyclopædia Britannica," ninth edition, furnish useful examples, but more are desired.

L. C. M.

LOLO AND BORDER TRIBES OF WESTERN CHINA.[1]

THIS book deals mainly with the little-known Lolo and neighbouring tribes in western China, who are believed to represent some of the pre-Chinese aborigines of that empire. The journey into the steppes of Tibet, which gives the title to the book occupies less than a sixth part of the volume, and is based upon notes by the late Lieutenant J. W. Brooke, upon his journey along the well-known route from Koko Nor to Nagchuka. Foiled in his attempt to enter Central Tibet in 1907, Lieut. Brooke, on the advice of Mr. Fergusson, turned his attention to the Lolo country in western China to the north of the Yangtse, and the present volume is issued as a memoir of that adventurous young traveller, who met a tragic death at the hands of the wild Lolos. In Mr. Fergusson, the resident missionary of Chengtu, the capital of Szechuan, Lieut. Brooke has found a sympathetic and competent editor, whose own notes indeed form the most important part of the book, based as they are upon a long personal acquaintance with those regions.

FIG. 1.—Lolo Chief hostages. From "Adventure, Sport, and Travel, on the Tibetan Steppes."

The warlike Mantze tribes, now settled in China, preserve the tradition of having come from Tibet, and this is generally supported by their physical features, their language, customs, and religion, as they are professedly lamaists. The part of Tibet, however, to which they are assigned by Mr. Fergusson is not clearly evident. They are stated to be "emigrants from Gari, a place north of Siklim [*sic*], near Camba Dsung . . . on the upper slopes of the Brahmaputra." Possibly the deserted town of Ge, near Khamba Jong, to the north of Sikkim, may be intended. The Tibetan legend of its desertion has been recorded by Lieut.-Colonel Waddell in his "Among the Himalayas" (p. 196), and is in keeping with a possible emigration to China.

The Lolo tribe and its affinities are less well known. This tribe, or rather the series of tribes bearing this general title, occupies the more inaccessible mountains in western China, on both sides of the Yangtse, in the provinces of Szechuan and Yunnan. It is the former section of the tribe which is dealt with here. The aggressive turbulence of this wild tribe has prevented travellers from penetrating the country to any great distance, though it and its people are not so wholly unknown as is represented in this book. M. P. Vial, in his "Les Lolos" (Shanghai, 1898), Colborne Baber, T. de Lacouperie, Colquhoun, and latterly Dr. Logan Jackson, in his "Back Blocks of China," have contributed to advance our knowledge of the subject; but Mr. Fergusson now adds much that is both new and interesting. These wild Lolos have hitherto preserved their independence, though in order to repress to some extent their habitual bloody raids into settled Chinese territory, hostages are taken from the frontier villages for their good behaviour.

FIG. 2.—Takin (*Budorcas sp.*). From "Adventure, Sport, and Travel, on the Tibetan Steppes."

"These hostages are representative chiefs who take turns of imprisonment to go pledge for the good conduct of the tribes. These chiefs are paid a nominal sum by the Chinese Government for thus serving a period in durance, and after serving a term of three

[1] "Adventure, Sport, and Travel on the Tibetan Steppes." By W. N. Fergusson. Pp. xvi+343. (London: Constable and Co., Ltd., 1911.) Price 16s. net.

months they are allowed to be relieved by other representative men of their tribes." The accompanying photograph depicts some of these hostages, who may be taken as types of the tribe.

The people live in rude huts and seldom build substantial houses, like the settled Mantze. Whilst termed "Lolo" by the Chinese, they call themselves "Nosu," alternatively spelt "Nossu" and "Nesu." The former appellation appears to us to be the same that is applied by the Tibetans to these and other savage tribes on their borderland, namely "Lalo" (spelt *kla-klo*). Their features seem to us to resemble those of the head-hunting Indo-Mongolian tribes of Assam, called "Nāga" by the Indians. They are said by Mr. Fergusson to be "certainly not" Tibetan. Their mode of tying up the hair (see Fig. 1) is suggestive of that of the Lepchas, whose non-Tibetan and proto-Malayan affinities have been indicated by Lieut.-Colonel Waddell.

Lieut. Brooke won the distinction of being "the first Englishman to shoot" that rare Eastern antelope, the takin (*Budorcas sp.*: see Fig. 2), and to study it in its haunts, of which we have here a detailed description.

Mr. Fergusson furnishes a detailed map of the southern part of the country plotted out by himself, a valuable contribution to Chinese geography.

RUBBER CULTIVATION.[1]

TO students of African rubber, the volume (1) by Dr. Cuthbert Christy will prove of considerable value. Dr. Christy was for a considerable time connected with the Mabira Forest Rubber Company, Uganda, and had many opportunities of obtaining first-hand information regarding the environment most suitable for Funtumia, the yields of rubber obtainable, and the chemical and physical problems associated with the coagulation of the latex. The author first gives a general account of the African rubber industry, and shows the fluctuation in exports of raw rubber from the Gold Coast, Sierra Leone, Southern Nigeria, Liberia, the French Ivory Coast, Togoland, the Kameruns, the Belgian Congo, and East Africa. There is, however, nothing which would lead one to expect that Africa will henceforth increase its crop of raw rubber, despite the large number of vines and trees which have been planted during the last few years.

A considerable amount of information is given on the botany, life-history, and structure of *Funtumia elastica*, Stapf, known in the early days as *Kickxia elastica*, Preuss. It appears that in Uganda this tree loses most of its leaves during the dry, hot period of January to March. It is, however, never quite leafless. Young shoots are produced and old leaves fall more or less freely at all seasons of the year. The trees flower from November to December, and the fruits are mature six months later. The author is of the opinion that the wind-blown seeds carried beyond the limits of the forest never produce permanent plants, owing to the long grass covering the country outside the forest areas. In the scrub formation (Acanthus) the seeds appear to have a better chance. The permanent Funtumia trees are found largely in belts where the forest is hilly; though these belts are usually well-defined, their distribution appears to be influenced by water-level conditions. In Uganda the trees appear to grow in large groups varying from family parties to large belts and areas several square miles in extent; in some cases the growth is entirely made up of this species, but in other cases the species is scattered.

Photograph by E. Brown.

FIG. 1.—Chagwe Forests, Uganda. An area cleared of underwood and seed sown at stake. Nearly all the trees in view are *Funtumia elastica*. From "The African Rubber Industry and *Funtumia elastica*."

After discussing the distribution, climate, and soils for Funtumia, the author goes into detail regarding other species of Funtumia—*Funtumia latifolia*, and *Funtumia africana* the latex from which, however, possesses very little rubber, though it may be used.

[1] (1) "The African Rubber Industry and *Funtumia elastica* ('Kickxia')." By Dr. C. Christy. Pp. xvi+252. (London: John Bale, Sons, and Danielsson, Ltd., 1911.) Price 12*s.* 6*d.* net.
(2) "The Physiology and Diseases of *Hevea brasiliensis*, the Premier Plantation Rubber Tree." By T. Petch. Pp. iv+268. (London: Dulau and Co., Ltd., 1911.) Price 7*s.* 6*d.* net.
(3) "The Whole Art of Rubber Growing." By W. Wicherley. Pp. 154. London: West Strand Publishing Co., Ltd., 1911.) Price 5*s.* net.

even intentionally, by natives for adulteration. The chemical and physical characters of the latex and the methods of coagulation have received attention by Dr. Christy in Uganda, and his chapters on these subjects provide much interesting matter. The book is, however, one which must necessarily appeal to a limited section owing to the relative unimportance of the species dealt with as sources of rubber. It is true that Funtumia has supplied large quantities of Lagos-silk rubber in the past, and will continue to do so for many years to come. Nevertheless, it is a species which does not lend itself to cultivation; wherever it has been tried—in Ceylon, Malay, Samoa, New Guinea, &c.—its growth has been so slow and the yields so small that planters have abandoned all hopes of ever cultivating the tree profitably.

(2) This a book which deals with a very special side of the rubber industry, and is mainly of interest

FIG. 2.—High-tapping Funtumia (Mabira Forest). From "The Whole Art of Rubber Growing."

to planters in the East, and to students of mycology elsewhere.

After giving a general introductory statement on the structure of *Hevea brasiliensis*, its latex and rubber, and the tapping systems employed on plantations, the author comes to the special part for which he is qualified to deal, viz., plant sanitation from the mycological point of view. Leaf diseases—*Helminthosporium heveae and Gloeosporium heveae*—are dealt with, and the result of an examination of fallen leaves is described, it being shown that conspicuous defoliation was not due to these diseases. Among root diseases, the author pays particular attention to *Fomes semitostus*, which is now reported from most estates in Ceylon, Malaya, Sumatra, Java, and even Africa; to the Brown root disease—*Hymenochaete noxia* and to *Sphaerostilbe repens*, and he deals also with numerous miscellaneous fungi observed by himself and others on the roots of this particular tree.

Stem diseases are dealt with in a separate chapter. *Phytophthora Faberi* is described as a parasitic fungus affecting the stem and fruit of *Hevea brasiliensis*; it has also been associated with cocoa, with which rubber trees are often interplanted. Pink disease—*Corticium salmonicolor*, B. and Br.—formerly extensively known in Java as *Corticium javanicum*, Zimm., is also described. This disease appears to originate generally in the fork of the tree or where several branches arise close together from the main stem; it has caused considerable damage, especially in Java and Malaya. A new stem canker, *Coniothyrium sp.*, is reported to have made its appearance on a Ceylon estate in 1909; this apparently appears on young green shoots, the first sign of its appearance being the production of hard, yellowish patches due to the development of a corky layer under the epidermis. Stem diseases of seedlings and the sterilisation of nurseries also receive attention.

Some abnormalities in Hevea in the form of twisted seedlings, nodules, and twisted stems (fasciation) are well illustrated, and should prove of interest to teratological students.

Much of the information has already been published in Ceylon, but this should not seriously detract from its value. References to literature on each subject are freely given, and in this way the reader is enabled to secure further detail if he desires to do so.

It is to be regretted that this book deals only with diseases due to fungi and bacteria. The book would have been much more useful to planters and to others in Europe had it taken into consideration the numerous animal pests which at the present time are a source of great anxiety to all cultivators of rubber trees. It is the only book of its kind, and should find a place in the library of all who wish to maintain an interest in tropical agriculture.

(3) Mr. W. Wicherley's booklet covers a series of general problems connected with *Hevea brasiliensis*, *Manihot glaziovii*, *Ficus elastica*, *Castilloa elastica*, *Funtumia elastica*, and three of the new Manihots. The majority of the essays have already appeared in the London Press. The writer acknowledges his indebtedness to the officials of the Ceylon Botanic Gardens, and pays a tribute to past and present officers for the work they have done in connection with this cultivation.

The statistics given of planted acreages and probable future yields (p. 144) are, in our opinion, calculated to give a wrong impression; the acreages now under rubber are, and the future annual crops will be, much larger than those suggested by the author.

There are some interesting illustrations, especially those showing high tapping of Funtumia trees in Uganda, and of methods of tapping adopted on trees of *Manihot dichotoma*. The book deals almost exclusively with matters relating to plantation subjects, and will be found useful by the general reader who is anxious to acquire a general knowledge of this section of the industry.

THE COAST OF NORTH DEVON.[1]

THIS is a book which should be in the hands of all who are interested in the scenery of the British Isles, and especially of those who intend to visit any of the holiday resorts on the northern or western coasts of Devon. It is not an ordinary guide-book, and it is not a geological treatise, but a description and explanation of some of the most picturesque and interesting coast scenery to be found in England or Wales.

[1] "The Coast Scenery of North Devon." Being an Account of the Geological Features of the Coast-line Extending from Porlock in Somerset to Boscastle in North Cornwall. By E. A. Newell Arber. Pp. xxiv+261+2 sketch maps. (London: J. N. Dent and Sons, Ltd., 1911.) Price 10s. 6d. net.

It includes all information necessary as to the best means of seeing the different parts of the coast-line, and all the geological information that is requisite for understanding the structure of the country, the flexuring of the rocks, and the features which the cliffs present. Mr. Arber points out that one of the special features of this coast is the number of coastal waterfalls. "By this term," he says, "we imply waterfalls cut by streams in their passage over the sea-cut cliffs to the beach. Several of these coastal falls are of considerable height, and form striking landmarks on the coast. Their features, however, are so varied that no two of them are exactly alike in all respects. They show all stages in the evolution of a waterfall from its birth to its senile period of old age and decay."

Mr. Arber divides his subject, that is to say, the coast-line, into six districts, beginning with the most easterly, near Porlock, in Somerset, and ending with the most southerly, near Boscastle, in Cornwall. He mentions the best headquarters for each, and then describes the rocks seen in the cliffs, the ridges and headlands, the streams, and the waterfalls, all of which are illustrated by excellent photographs, fifty-nine in number, and two of these, reproduced in Figs. 1 and 2, will show the reader what kind of scenery is to be found in the area described.

The chief peculiarity of this area is that the two main watersheds are, roughly, parallel to the coast, and seldom more than three miles away from it. We have consequently the curious arrangement of a number of streams rising near the coast and flowing inland, and of a still larger number of short streams flowing from the watersheds to the cliff-line, over which most of them fall in one or more cascades. The explanation of this arrangement is that the sea has invaded and destroyed the country which originally lay outside the main watersheds, and is now advancing on the actual watershed ridges. This is illustrated by a clear map of the whole drainage system of the area.

Mr. Arber writes, on p. 20, as if there were only one watershed, and it is true that there are secondary watersheds which nearly unite them, but, as a matter of fact, there are two main watersheds separated by the Valley of the Taw, and it is doubtful if they were ever united. The Exmoor ridge may have been prolonged indefinitely westward, while the Hartland watershed must always have been truncated by the continuation of the Taw valley along the floor of Barnstaple Bay, before the recent depression or subsidence enabled the sea to advance so far over the western land.

This comparatively recent subsidence is a very important factor in the explanation of the present peculiar drainage system, and of the features presented by the coast-line, but Mr. Arber has not laid sufficient emphasis upon it. He refers to it in several places, but he also refers to what he terms the "recent elevation" of some parts of the coast, leaving the reader to infer that the one movement was as recent as the other. He should have made it clear that the upheaval which lifted the "Raised Beaches" to their present position, or rather to a still higher level, was antecedent to the subsidence which is indicated by the drowned valleys and the submerged forests. When the book reaches a second edition Mr. Arber will do well to add a short account of the Pleistocene history of the country to his introductory chapter.

Of the coast near Hartland Point Mr. Arber writes that it includes some of the wildest and grandest cliff scenery to be met with in the whole of Devon, and that as regards its coastal waterfalls he believes it to be quite unique so far as Britain is concerned. One

FIG. 1.—The valley of Milford Water and the head of the First Fall, from the cliffs above Speke's Mill Mouth, looking east (Hartland District). From "The Coast Scenery of North Devon."

of these waterfalls is that of Milford Water, and is shown in Fig. 1. This, moreover, is only the first fall of the stream from a level of about 160 feet above the sea; below it is a cañon, in which are three smaller falls before the stream reaches the beach. Fig. 2 is a side view of the same fall from below, showing the synclinal flexure of the rocks at this point, and the manner in which the stream turns at right angles along the syncline. After going for 132 yards to the south it again turns west across the strike of the rocks, a curious and interesting instance of the relation of stream channels to rock structure.

Part ii. of the book deals with some features of special geological interest, these being the marine erosion of folded rocks, sea-dissected valleys, and the evolution of coastal waterfalls. The author points out that the usual text-book explanation of bays and promontories along a sea-coast is not always the true one. They do not always coincide with the outcrops of softer and harder rocks. Some of the irregularities of the Devon coast seem to be due to the influence of previously existing physiographic features, the bays coinciding with the sites of valleys and the promontories with the dividing watershed ridges. Others are due to the influence of the flexures, and he finds that the anticlines are more stable under the action of sea erosion than are the synclines, while on land under the action of subaërial agencies the reverse is the case.

FIG. 2.—The First Fall of Milford Water and the synclinal fold, looking north. From "The Coast Scenery of North Devon."

Mr. Arber has certainly succeeded in showing how many points of interest there are along this piece of coast-line, both for the geological student and for the intelligent tourist. A. J. J.-B.

NOTES.

THE present summer is establishing a record for its high temperatures, and in many places for its persistent drought. At Greenwich the mean temperature for July was 68·3°, which is 4·6° above the average for the past sixty years. The mean of the day temperatures was 81°, and of the night temperatures 55·5°. There were nineteen days during the month with the shade temperature above 80°, and three days above 90°. This is the greatest number of days in July above 80° since 1868, and the third highest number since 1841. The highest shade temperature during the month at Greenwich was 95·6° on July 22, and the only two instances of a higher temperature at any period of the year are 97·1° on July 15, 1881, and 96·6° on July 22, 1868. There were seven days after July 20 with the thermometer in the sun's rays about 150°, and on July 22 the black bulb thermometer registered 161°. The duration of sunshine for the month was 331 hours, which is nearly 100 hours more than the average. No rain was measured until July 24, the period of drought being the longest in July since 1887. The aggregate rainfall for the month was 0·26 inch, which fell on three days. This is the driest July since 1864, and there is no other July so dry since 1841. At Bath, July was absolutely rainless. The reports received by the Meteorological Office give the following additional high temperatures:—On July 21 the thermometer registered 90° both at Oxford and Margate, on July 22 94° at Margate, on July 29 93° at Bath and 91° at Oxford. The type of weather was anticyclonic almost continuously throughout the month, and the region of high barometer readings extended over a large part of western Europe, where exceptionally high temperatures occurred almost throughout the month. At Rochefort the thermometer registered 93° on July 6, at Lorient 95° on July 7, 97° on July 8, and 99° on July 9. On July 14 the temperature at Rochefort was 100°, and at Stockholm 95°. Paris had a temperature of 96° on July 22 and 23, Frankfurt 100° on July 23. From July 24 to 29 several stations in France and Belgium had temperatures from 95° to 98°. Some exceptionally severe thunderstorms occurred during the month; on July 28 1·1 inches of rain fell in fifteen minutes at South Kensington, and on July 29 2·14 inches fell in 2½ hours at Kilkenny.

FOR the moment the remarkable archæological discoveries in Corfu have thrown other work in the eastern Ægean into the shade. But in various parts of this area, in the Greek mainland and islands, much progress has been made, the results of which are described in an interesting article in *The Times* of July 31. The Greek Archæological Society has restored the Propylæa on the Athenian Acropolis; repairs have been carried out at Mycenæ; and the museum at Olympia has been converted into a safe receptacle for its treasures. The French Mission at Delos has unearthed images of Egyptian and Syrian gods which illustrate the adoption of foreign cults into the religion of Greece; and some progress has been made at the island of Levkas (Santa Maura), which Dr. Dörpfeld believes to be the Homeric Ithaca. The British School has been at work on the Menelaion, the tomb of Menelaus and Helen at Sparta. Phylakopi, in Melos, the seat of an early trade in weapons of obsidian, has yielded some good vases imported from Crete. An appeal is now made for help towards the explorations in Macedonia, conducted by Messrs. A. J. B. Wace and M. Thompson, where important results in the examination of prehistoric, classical, Byzantine, and mediæval antiquities may be confidently expected.

PROF. CZERMAK, of the Brünn High School, who died on July 11 at the age of seventy-seven years, left, says the *Revue Scientifique*, a million crowns to the Vienna Academy of Sciences.

IT is announced in *The Times* that M. Ernest Mercadier, formerly director of studies at the École Polytechnique, died on July 27 in his seventy-sixth year. M. Mercadier entered the French telegraph service in 1859, and held the post of director of telegraphs during the siege of Paris, when he likewise organised the military telegraph service. After the war he became professor of physics at the École Supérieure de Télégraphie, and in 1881 he was appointed director of studies at the École Polytechnique, where he remained until the end of the year 1903. He was an honorary member of the Institution of Electrical Engineers and of the International Society of Electricians.

We regret to learn that Mrs. Helena B. Walcott, wife of Mr. Charles D. Walcott, formerly director of the United States Geological Survey, now secretary of the Smithsonian Institution, was instantly killed in a railway accident at Bridgeport, Connecticut, on July 11. Mrs. Walcott had been ardently and actively interested in the scientific work of her husband. In 1888 she accompanied him to Newfoundland, where they worked out together the key to the succession of the Cambrian formations of the North American continent. They then crossed to Wales and studied the classical Cambrian sections. For eighteen seasons she accompanied Mr. Walcott on his expeditions in connection with geological researches in various regions of eastern and western United States and Canada. Since his appointment as secretary of the Smithsonian Institution she had been greatly interested in the development of the United States National Museum and in the general study of museum systems. Possessed of unusual charm of person and manner, Mrs. Walcott's death is a heavy blow to a large circle of friends and acquaintances.

The fifth annual meeting of the Italian Society for the Advancement of Science will be held in Rome on October 12–18, under the presidency of Prof. G. Ciamician. The sections of the association, with their presidents, are as follows:—mathematics, astronomy, and geodesy, Prof. G. Castelnuovo and Prof. A. Di Legge; physics, Prof. P. Blaserna; applied mechanics and electrotechnics, Prof. C. Ceradini; pure and applied chemistry, Prof. E. Paternò; mineralogy and geology, Prof. R. Meli; geography, Prof. E. Millosevich; zoology, anatomy, and anthropology, Profs. G. B. Grassi, F. Todaro, and G. Sergi; pure and applied botany, Prof. R. Pirotta; physiology, Prof. L. Luciani; pathology, Profs. A. Bignami and E. Marchiafava; history and archæology, Profs. G. Beloch and L. Pigorini; philology, Prof. I. Guidi; social science, Prof. M. Pantaleoni; philosophy, Prof. P. Ragnisco. Several lectures on subjects of wide scientific interest will be delivered to general meetings of the association as a whole, and others to joint meetings of sections concerned with related subjects. Full particulars may be obtained from the secretary, to whom contributions for the sections should be addressed, Prof. V. Reina, Via del Collegio Romano 26, Roma.

In the first part of the second volume of the Museum Journal of the University of Philadelphia we find an interesting account of an exploration of the remarkable ruined city of Chichen Itza, in Yukatan. The place is familiar to students of Central American archæology from the enthusiastic accounts of Stephens with Calderwood's drawings, the photographs and measurements of Maudslay, and the sketches of Holmes. These, however, only imperfectly represent the decoration scheme, and for the frescoes and wall sculptures the only existing record is the fine series of water-colour drawings by Miss Adela Breton, who with rare devotion has succeeded in reproducing the beautiful work of the ancient artists. These drawings are as yet unpublished, and all students of art will join in the hope that arrangements may soon be made for their publication.

It is a good omen for the scientific value of the reports of the recent census of India, which are now in process of compilation, that Mr. E. A. Gait, the census commissioner, has prepared for the use of the provincial superintendents an abstract of several important reviews by eminent Continental anthropologists of the report by Sir H. Risley on the census of 1901. These criticisms are of much importance, and direct special attention to certain problems for the solution of which the reports of the last census may be expected to supply valuable material. Of special interest are the suggestions of Herr Baelz on the peculiar skin patches which seem to be a race characteristic of the Mongolians; Walcher's review of the results of artificial changes in the skull form; and Surgeon Captain E. P. Maynard's remarkable discovery among some coolies at the tea gardens of Assam of a curious form of melanoglossia which seems to be peculiar to certain of the Munda tribes of Chota Nagpore, and may be of great importance in identifying the modifications of this ethnical type.

In vol. iv., part iii., of the Transactions of the Hull Scientific and Field Naturalists' Club Mr. T. Pickersgill describes a remarkable collection of Roman coins made at South Ferriby by the well-known Thomas Smith, locally known as "Coin Tommy," which has recently been acquired by the Hull Municipal Museum. South Ferriby, lying on the direct route between Lincoln and York, was obviously a place of considerable importance in Roman times, and the interest of this collection lies in the fact that its 2600 specimens practically cover the whole period of the Roman occupation of north Lincolnshire. It begins with a coin of the Emperor Trajan (A.D. 98), and extends to the time of Honorius (A.D. 395–423), in whose reign the Romans finally withdrew from Britain. The collection includes the coins of thirty-nine emperors and members of their families, several of the wives of the emperors being represented. Mr. Pickersgill gives a full catalogue of these coins, with details of their mintage, and supplies two sheets of photographic reproductions of the most typical specimens, a valuable monograph which will be of interest to all numismatists.

In *The Eugenics Review* for July (x., No. 2) Sir Thomas Oliver directs attention to the disastrous effects of lead-poisoning on the race, particularly among potters. Lead-poisoning, insufficient definitely to cripple the workers, has a disastrous effect on the reproductive organs; females who work in lead before marriage miscarry twice, and females working in lead after marriage miscarry three times, more frequently than those engaged in ordinary housework. A high percentage of children born alive to lead workers die shortly after birth and during the first few months of life. Some of the worst effects of lead-poisoning are to be seen among the small pottery manufacturers of Hungary, of which Sir Thomas Oliver gives a graphic account.

Under the title of "The Hunted Otter," the Animals' Friend Society, Kingsway, W.C., has published a pamphlet urging the total prohibition of otter-hunting. While all, we hope, will support the proposal to establish a close time during the breeding season, it by no means follows that public opinion will demand the entire abolition of the sport of otter-hunting.

The Victorian Naturalist for June contains an obituary notice of the late Mr. A. O. Sayce, who was appointed demonstrator and assistant lecturer in bacteriology in Melbourne University six years ago. In addition to bacteriology, Mr. Sayce devoted special attention to crustaceans, on which he wrote numerous papers, the most important being one on the new malacostracous genus Koonunga. In recognition of the value of his work, Mr. Sayce was elected some years ago an associate of the Linnean Society of London.

In the July number of *The Museums Journal* Mr. C. O. Waterhouse directs attention to the urgent need for a very great extension in the space allotted to the study series of insects in the natural history branch of the British Museum—a subject which appears to have been in some degree overlooked during the recent discussion with regard to the disposal of the ground at the back of the building. At present the collection is housed in rooms originally described as workshops, where it is crowded to an almost unimaginable extent. The writer pleads for two new galleries for the entomological study series, and gives two alternative plans for such extension. In the second of these it is suggested that the present main front of the building should be continued to Queen's Gate, and the continued galleries used for public exhibition, with a further extension from the present west tower, at first northward and then westward, so as to form an open quadrangle facing Queen's Gate, the entomological collections to occupy the second floor of the latter part of the extension.

Two incidents of prime importance are recorded in the report of the U.S. National Museum at Washington for the year ending June 30, 1910, namely, the practical completion of the new buildings and the transference of a large portion of the collections, and, secondly, the reception of the natural history collections made by the Roosevelt expedition to East Africa in 1909. The latter are estimated to comprise more than 11,000 specimens of vertebrates and a large number of invertebrates, as well as several thousand plants and a few ethnological objects. It is claimed that the collection of East African mammals is probably more valuable than any similar series in any other museum. "Its importance lies not so much in the number of new forms as in the fact that it affords an adequate basis for a critical study of the mammal fauna of East Africa, and the establishment or rejection of the large number of forms which have been described, especially in recent years, from insufficient material."

In the July number of *The Zoologist* Prof. McIntosh, of the Gatty Marine Laboratory, St. Andrews, records the results of a number of experiments made in Ireland and Scotland for the purpose of ascertaining whether salmon and trout are liable to injury by the turbines so frequently used in Irish mills, many of which revolve at a very high rate of speed. So long ago as 1892 a number of similar experiments were instituted by Sir Thomas Brady, who was of opinion that very few fry survived an experience with a turbine, believing that the great majority were killed at once as they went through, their bodies dropping into the deep water as they were struck. The experiments of Prof. McIntosh give a much more favourable aspect of the matter from the point of view of the fish. It is stated, for instance, that "in all the experiments, which were twenty in number, one feature was marked, viz. the comparative ease with which healthy trout in the turbine-pits kept free from the vortex caused by the action of the turbine. They appeared to go through the turbine only when they pleased or by accident. Moreover, when circumstances were favourable, they swam out of the turbine-pit to the head-race, and thus . . . could have passed up-stream to the nearest by-wash, if such existed."

Directing attention to the varying descriptions of the manner in which fruit dispersal is effected by species of Geranium, Prof. W. Sorensen communicates the results of his own observations in the current Bulletin (No. 2) of L'Académie Royale des Sciences et des Lettres de Danemark. The details commonly overlooked are the existence of an aborted ovule, the detachment of the seed, the position of the lines of dehiscence, and the devices by which in certain species the seeds are retained temporarily in the open pericarp. The species *sibiricum* and *molle* are described as illustrative examples of the two methods of pericarp shedding, and the peculiar features of *dissectum* are noted.

A consideration of vegetative changes and the agencies inducing them, forming the subject of a presidential address delivered before the Association of American Geographers by Prof. H. C. Cowles, is published in *The Botanical Gazette* (March). Under physiographic agencies the author discusses regional and topographic successions; biotic factors are examined under the headings of humus, shade, and human agency. As an example of occasional plant plasticity, it is noted that the Douglas spruce may be a xerophytic pioneer, and then persist through successive stages of forest development, culminating in a mesophytic formation; throughout each stage it may be dominant, and yet it shows no striking change in leaf habit.

Rice cultivation in Siam provides the subject of an article contributed by Dr. C. C. Hosseus to the *Tropenpflanzer* (vol. xv., No. 6). Many varieties of rice are recognised by the Siamese, most of which fall under the common species *Oryza sativa*. In addition, three other species can be distinguished; *O. praecox* is a "wet" rice, yielding a grain very similar in its qualities to that of *O. sativa*, but is also cultivated on the mountain slopes; *O. glutinosa*, as its name implies, yields a glutinous grain, that is cooked by the tribes of the interior in bamboos, acquiring thereby a distinctive flavour; the fourth species is the "hill" rice, *O. montana*, less nutritious than ordinary rice, but preferred by the Laos tribes.

Bee-keepers should find much to interest them in No. 447 of the Farmers' Bulletin, published by the U.S. Department of Agriculture, under the title "Bees," and written by Dr. E. F. Phillips, the official expert on bee-culture. Full instructions are given for the installation, equipment, and management of apiaries, with notes on the production of honey and wax; in fact, the bee-keeper will find information on all points connected with his trade or hobby.

The mycologist of the Board of Agriculture, Trinidad, Mr. J. B. Rorer, describes a bacterial disease of plantains and bananas in the island (*Phytopathology*, i., No. 2, p. 45). The disease causes the leaves, progressively from below upwards, first to become yellow, then to droop, and finally to break off, and eventually the terminal bud is attacked, and the plant dies and rots down to the ground. The vascular bundles are filled with bacteria, pure cultures of which were obtained, and inoculations of them into healthy plants reproduced the disease.

The flowers of Chaucer form the subject of an article by the Rev. H. N. Ellacombe now in course of publication in *The Gardeners' Chronicle*. In the issue of July 22 it is pointed out that although the box is an indigenous tree, it never had an English name, "box" being an Anglicised form of the Latin *buxus*. Chaucer mentions cedar, but apparently never saw a specimen. The same issue includes an illustrated account of the rock-garden in course of construction for the Royal Horticultural

Society at Wisley. The rocks are Wealden sandstone, some of the rocks weighing as much as a couple of tons. A large moraine forms one of the subjects of interest, below this being a bog-garden, watered from the source which supplies the moraine.

THE poultry investigations at the Maine Experiment Station are well known, and the recently issued bulletins will be read with interest by those engaged in similar work elsewhere. Messrs. Pearl, Surface, and Curtis have compiled an account of the common poultry diseases in a bulletin which must be regarded as one of the most useful yet issued for the practical man. The symptoms are clearly described, and such remedies as are known are indicated. In a more technical publication Dr. Pearl continues his discussion of the inheritance of fecundity in the domestic fowl.

THE Boyle lecture on the fertility of the soil delivered by Mr. A. D. Hall before the Oxford University Scientific Club has now been issued as a separate reprint. It is shown that Boyle and some of his contemporaries discussed the question of soil fertility, and especially the part played by nitre. The investigation was widened by Daubeny, professor of botany and rural economy in Oxford, and the real founder of a science of agriculture in this country, and in recent years has been shown to be even more complex by the intervention of the micro-organic flora of the soil. The factors determining fertility are, however, being slowly disentangled and brought under control.

THE German Mineralogical Society, which now consists of 158 members, under the presidency of Prof. F. Becke, of Vienna, at its annual meeting in September last decided on the publication of a journal, to be called the *Fortschritte der Mineralogie, Krystallographie, und Petrographie*, and the first number has just made its appearance, under the editorship of Prof. G. Linck, of Jena. It is an imposing volume of nearly 300 pages, and contains fourteen articles by distinguished members of the society. One of the earlier ones is by Prof. Baumhauer, on "Geometrical Crystallography," in which he deals with the "Law of the Complication and the Development of Crystal-faces in Zones rich in Faces," and discusses the most important recent contributions to crystallographical literature from this point of view. Then there are two articles by Prof. Mügge, of Göttingen, and Prof. F. Becke, the president, on "Twin-Crystals," in which many recent descriptions of new twin-forms are discussed and correlated, including the important work of Dr. Stefan Kreutz on twins of calcite. Another interesting and important article is that by Dr. Albert Ritzel on the "Rapidity of Crystallisation and Solution," in which the facts concerning the different speeds of growth of a crystal in different directions, and the corresponding differences in the times taken by a solvent in dissolving the material from the different faces of the crystal are carefully compiled from all the recent work on the subject, and the general results discussed. These examples will suffice to show the value of this new publication, which reminds us very much of the annual reports published by the Chemical Society, but goes further in including a considerable number of text-figures, and in embodying original results obtained by the authors themselves. We heartily congratulate the German Mineralogical Society on its venture, and shall look forward to seeing a continuation of these excellent articles, presenting in an interesting form the essence of the progress made in the subjects included in the purview of the society.

WORKS are now in operation for improving a section of the navigable channel of the Mississippi, and at the same time developing the water resources of the river by the construction of an hydro-electrical plant, consisting of a power-house designed to contain machinery driven by turbines capable of developing 120,000 horse-power. This power-station lies about midway between Kansas City and Chicago, and 140 miles north-west of St. Louis. The site of the works is at the foot of the Des Moines rapids. These rapids now are only navigable at high stages of the river, and at other times vessels have to pass round them by means of a canal having three locks. When the works are completed there will only be a single lock, of dimensions sufficient to accommodate vessels of much larger size than those which now navigate this part of the river. The works include a concrete dam 1560 yards in length and 40 feet high, and the pool above formed by the dam will constitute a reservoir extending for forty or fifty miles.

AN instructive study of the mouth of the Scheld by F. Müller appears in the June number of the *Zeitschrift fur Erdkunde*, in which the form and character of the river mouth, its tidal conditions and its development during the past five centuries, are detailed. The various towns are described, and in some cases illustrated, to show their varying fortunes during the same period. Similar studies of some British coastal settlements would form a profitable object for geographical research in this country. In the same number Prof. K. Kretschmer describes a number of early manuscript maps in the Bibliothèque Nationale at Paris, and analyses them.

THE demarcation of boundaries in Africa continues steadily, one of the most recent being that between Tunis and Tripoli. A French party carried out a geodetic and topographical survey of a zone 10 kilometres wide from Ras Ajedir on the Mediterranean coast to Ghadames, of which the position was determined to be lat. 30° 7′ 48·7″ N. and long 7° 9′ 57·9″ W. of Paris, or some 27 kilometres east of Duveyrier's original determination; the mean altitude of the oasis was found to be 340 metres above sea-level. This information, given in the April number of *La Géographie*, is supplemented in the May number by a description of the route by L. Pervinquière, who was detailed to study the geology of the country traversed.

THE Survey of India has just published an account of explorations made by Kinthup, a native of Sikkim, in Bhutar, and on the lower Tsang-po, in 1886–7. He was despatched in July, 1880, with a Chinese Lama, from Darjeeling to Tibet by the late Captain Harman, and, after being detained in slavery in the Pemakoi country, finally succeeded in returning to India. He travelled along the Tsang-po, or Brahmaputra River, from the point where it turns southward towards India to the village of Mrii Padam, which he gives as about thirty-five miles from the British frontier. Though followed under very unfavourable conditions, the line of the river is probably indicated with fair accuracy, and goes part of the way towards filling the gap which has hitherto existed in our knowledge of the course of this great waterway.

NEW isothermal charts of Africa have been drawn for the atlas which is being prepared in the Survey Department of Egypt for use in Egyptian schools, and Mr. J. I. Craig gives those for January and July in the May number of *The Cairo Scientific Journal*. Temperatures have been reduced to sea-level, the gradient being taken as $-0{\cdot}6°$ C. per 100 metres in the equatorial zone, and as $-1°$ C. per 100 metres in the drier region of North Africa, on the basis of kite observations at the Helwan Observatory. With the recent values employed the isotherms run somewhat differently from their courses as shown in earlier charts. In July the highest temperature, 34° C., lies almost wholly to the east of the Nile, the greater part of the Sahara falling between that isotherm and that of 32° C.; and in Central Africa the isotherm of 26° C. extends southward to about latitude 17° S. in the basin of the Zambezi.

THE meteorological chart of the North Atlantic and Mediterranean for August (first issue, July 13), published by the Meteorological Committee, is of special interest in connection with the recent prolonged drought. The weather charts for July 6–12, and the useful summary which accompanies them, show that throughout that period a well-developed anticyclone dominated the situation over the eastern part of the ocean and western half of Europe; the temperature rose at places above 90°, and even to 84° in Iceland. For six out of the seven days this system of high barometric pressure lay practically motionless over these islands, and at the close of the period reports indicated the continuance of anticyclonic conditions of weather on the ocean.

IN an article in *Symons's Meteorological Magazine* for July, entitled "The Disappearance of Evening Cloud at Full Moon," Mr. W. Ellis, F.R.S., endeavours (owing to a recent reference to the subject) to refute the opinion held by Sir J. Herschel and others that the full moon possesses the faculty of clearing away clouds. This fallacy, like that of the artificial production of rain, is difficult to eradicate from the public mind. Mr. Ellis has shown from the Greenwich observations that a maximum cloudiness in the forenoon and a minimum in the evening represent the usual climatic variation. A change from a cloudy to a clear state in the evening sky is much more likely to attract attention when occurring near to full moon, and this is the opinion of leading meteorologists of the present day. Dr. W. N. Shaw (Quart. Journ. R. Met. Soc., April, 1902) suggests a physical explanation of the phenomenon, viz. that a floating cloud loses heat by radiating into space more heat than it receives from the earth beneath; the water globules consequently evaporate, and the cloud will vanish. "Any effect of direct radiation of the moon may be quite properly disregarded." A more recent opinion in the same sense (to which we have before referred) is contained in Mr. J. R. Sutton's paper on the lunar cloud period (Trans. South African Phil. Soc., December, 1907).

AN article by Mr. D. Owen in *The Electrician* for July 7 places in a very clear light the importance which now attaches to the "lively dance of bright spots," first noticed by the English botanist Brown, in any liquid containing minute particles in suspension when illuminated from the side. Sixty years ago the observation attracted little attention, but recently, through the improvements which have given us the ultra-microscope, the experiments of M. Perrin and the theoretical work of Dr. Einstein, the study of the Brownian movements has thrown considerable light on the properties and motions of the ultimate particles of which matter is composed.

SEPARATE copies of several of Prof. Righi's recent papers have reached us, and to one of them, which deals with the effect of a magnetic field parallel to the axis of a vacuum tube on the electric discharge through the tube, we should like to direct special attention. If such a tube with aluminium disc electrodes 15 cm. apart is covered outside with tin foil and placed in a magnetising solenoid, Prof. Righi finds that a potential difference of 3000 volts between the electrodes, which is insufficient to cause a measurable discharge in the absence of a magnetic field, will maintain a current through the tube with a field of 1250 gauss in the neighbourhood of the positive electrode, or a field of above 5000 gauss in the neighbourhood of the negative. He is disposed to attribute the phenomena to the production of electrons at the walls of the tube by the magnetic field, and is engaged in further work to test this hypothesis.

THE remarkable influence of borax in raising the rotatory power of mannitol has been known for nearly forty years, but the exact origin of this effect has been open to question, although the combination of the mannitol with the boric acid appeared the most probable explanation. It is therefore a matter of satisfaction that the compound should at last have been isolated and analysed. As described by Messrs. J. J. Fox and A. J. H. Guage in the June number of the Chemical Society's Journal, the compound is formed, according to the equation

$$C_6H_{11}O_6+H_3BO_3=H_2O+C_6H_{15}O_8B,$$

by dissolving mannitol and boric acid in hot alcohol, filtering, and allowing to stand. The mannitoboric acid slowly separates in compact, colourless prisms, melting at 89·5°, but dissociates again when attempts are made to recrystallise it.

THE tenth volume of the Transactions of the English Ceramic Society (part i.) contains as a frontispiece a portrait of the president, Mr. H. Johnson, whilst a portrait of the first president, Mr. William Burton, is issued as a frontispiece to vol. i. The new issue includes two important technical papers on electricity for potters' machinery, by Mr. Odelberg, and on liquid fuel, by Mr. Kermode; these may be regarded as additions to a series of papers of which those on gas-firing were noted in these columns recently. Attention may also be directed to a paper by Dr. J. W. Mellor on the constitution of the kaolinite molecule, and to a paper on colour and its measurement by Mr. J. W. Lovibond. The value of the work done by this society in emphasising the importance of scientific methods in one of the leading industries of the country can scarcely be overestimated.

THE extension of the system of multiple evaporation in the manufacture of sugar has been limited by the fact that whilst the evaporation may be effected safely under normal and reduced pressures of steam, the sugar begins to decompose when steam under pressure is used. A report on the effect of high temperatures on cane sugar in solution, by Noël Deerr, issued from the Experiment Station of the Hawaiian Sugar Planters' Association, describes an investigation of considerable technical and scientific importance. It is shown that sugar inversion begins to be important at 110°, but may be checked by the addition of alkali; this causes the juice to darken, but much of the colour disappears when the alkali is neutralised, and the coloration in no way corresponds with loss of sugar. The conclusion is drawn that the local juices may be relied upon to stand half an hour's heating at 120° without loss of sugar, whilst under careful control and observation a temperature of 125° (or even 130° for shorter periods) is permissible. This conclusion is important, not only by reason of economy in evaporation, but also because a temperature of 125° is sufficient to produce almost instant sterilisation, an effect that cannot be produced with any certainty at 100°. A point of considerable scientific interest, dealt with incidentally in the paper, is the reciprocal interconversion of dextrose and lævulose when the solutions are heated either alone or in presence of alkalis.

MESSRS. GEORGE ALLEN AND CO., LTD., are about to publish a work on "Bushman Folk Lore," by W. I. Bleek and L. C. Lloyd. The volume will be fully illustrated with numerous specimens of Bushman drawings, and will contain a preface by Dr. G. McCall Theal.

OUR ASTRONOMICAL COLUMN.

COMET 1911*b* (KIESS).—The numerous observations of Kiess's comet which appear in Nos. 4513–5 of the *Astronomische Nachrichten* agree in describing it as a nebulous mass some 2·5 to 5′ in diameter, with a condensation some 40″ to 50″ across, but no definite nucleus. The estimates of the magnitude, as one would expect of such an object, vary considerably, but about July 10 the magnitude was approximately 8·0.

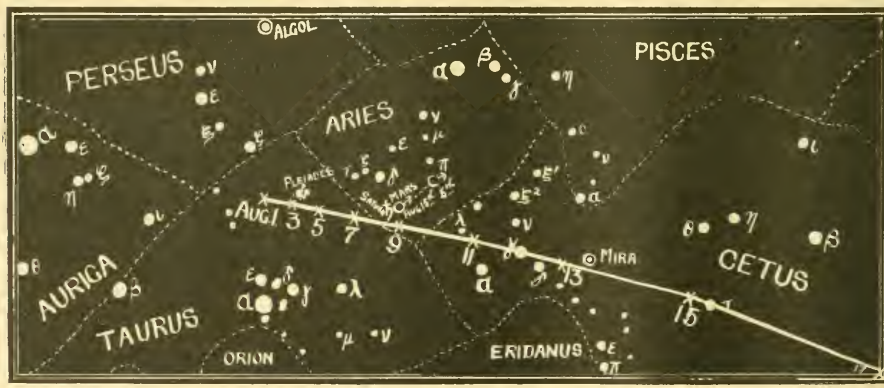
A forty-two minutes' exposure, made in a slit spectrograph attached to the reflector of the Königstuhl Observatory, on July 11, showed 390 μμ to be the brightest band. The radiation 388 μμ was fainter, and its companion of shorter wave-length fainter still. While the 390 μμ line extended to a distance of 1½′ from the condensed centre, the much fainter line 407–470 μμ, with a maximum at 472 μμ, extended only to about ½′. The bands 398–410 μμ and 423 μμ were extremely faint, and no continuous spectrum was shown on the plate.

Dr. Wolf adds that, as seen in the 12-inch refractor on July 8, the head showed a distinct dark space behind its centre, and a cone of matter was seen to be streaming out from the front of the coma. A brief observation by Herren Helffrich and Massinger showed a curved tail at least 1° long, but very faint.

Elements computed by Messrs. Einarsson and Meyer agree well with the corrected elements published by Dr. Kobold, and, with an ephemeris, appear in No. 4515. The following ephemeris is abstracted from that given by Dr. Kobold in No. 4514:—

1911	α (true) h. m.	δ (true)	log r	log Δ	mag.
Aug. 3 ...	3 49·7 ...	+24 5·6			
,, 5 ...	3 40·1 ...	+21 29·4 ...	9·9993 ..	9·6711 ...	5·0
,, 7 ...	3 28·2 ...	+18 6·0			
,, 9 ...	3 13·0 ...	+13 29·3 ...	0·0226 ...	9·5442 ...	4·5
,, 11 ...	2 52·8 ...	+ 7 2·7			
,, 13 ...	2 25·2 ...	− 2 1·6 ...	0·0452 ...	9·4013 ...	3·9
,, 14 .	2 7·2 ...	− 7 43·6 ...	— ...	9·3708	
,, 15 ...	1 46·9 ...	−14 15·8 ...	— ...	9·3439	
,, 16 ...	1 22·5 ..	−21 16·9 ...	— ...	9·3267	
,, 17 ...	0 54·0 ...	−28 26·1 ...	0·0670 ...	9·3212 ...	3·6

The positions in regard to the surrounding stars are shown approximately on the accompanying chart, the bottom line roughly corresponding to the mean horizon for London; after August 17 the distance from the earth begins to increase, and the comet also becomes invisible in these latitudes, its declination on August 18 being 35° S.



Apparent Path of Comet 1911*b*. August 1–17, 1911.

BROOKS'S COMET, 1911*c*.—Numerous observations recorded in No. 4515 of the *Astronomische Nachrichten* show that the magnitude of comet 1911*c*, during July 20–23, was about 10 or 11. Dr. Hartwig reports it, on July 22, as an irregular mass 2·5′ in diameter, with a faint 0·5′ condensation of the eleventh magnitude.

In the supplement Dr. Ebell gives provisional elements and a daily ephemeris extending to August 24. The elements give the time of perihelion as November 11, 1911, so that for some weeks we may expect the comet to brighten up, on account of both its decreasing distance and its increasing activity.

Ephemeris (12h. M.T. Berlin).

1911	α (true) h. m.	δ (true)	log r	log Δ	mag.
Aug. 4 ...	21 56·4 ...	+29 42·0 ...	0·2760 ...	0·0264 ...	9·4
,, 8 ...	21 48·8 .	+32 21·2 ...	0·2632 ...	0·0020 ...	9·2
,, 12 ...	21 39·7 ...	+35 6·7 ...	0·2500 ...	9·9783 ...	9·1
,, 16 ...	21 28·7 ...	+37 56·6 ...	0·2363 ...	9·9557 ...	8·9
,, 20 ...	21 15·6 ...	+40 48·2 ..	0·2221 ...	9·9345 ...	8·7
,, 24 ..	21 0·2 ...	+43 37·8	0·2074 .	9·9151	8·5

Not only is this comet becoming brighter, its position for observation in these latitudes is improving. Its apparent path is from Pegasus towards α Cygni, and the last position given here is very near ξ Cygni; thus for some time it will transit, with a small zenith distance, not far from midnight.

HORARY NUMBER OF METEORS VISIBLE.—Mr. Denning's publication, in No. 4515 of the *Astronomische Nachrichten*, of the horary number of meteors visible for every night in the year comes at an opportune moment, for the outstanding feature of his comprehensive table is the heavy preponderance of meteors per hour in late July and early August. The numbers are deduced from the Bristol observations made during 1866–1911, and give the horary number for one observer watching a clear, moonless sky uninterruptedly. From a glance at the table the average number per hour for the first six months of the year would not exceed six; but early in July an increase sets in, which culminates in sixty-nine per hour on August 10, and averages nearly twenty-four per hour for the whole month.

CHARTS FOR THE SOUTHERN HEAVENS.—Dr. Ristenpart announces in No. 4514 of the *Astronomische Nachrichten* the publication of charts of the southern heavens by the Santiago Observatory. Five series, including fifty charts, will cover the sky between the south pole and declination 19° S., and series 1 and 2 (90° to 67° south) are now ready.

THE CIRCUIT OF BRITAIN BY AËROPLANE.

THE most remarkable race the world has yet seen is over, and Naval-Lieutenant Conneau, flying a Blériot monoplane under the name of "Beaumont," has won the 10,000*l.* offered by *The Daily Mail* for the circuit of Britain—a total distance of 1010 miles in 22h. 28m. 18s. of actual flying time, or just under 45 miles an hour.[1]

The basic idea of the race was to test the trustworthiness of the competing aeroplanes. With this end in view, five parts of the machine and five parts of the engine were marked, viz. the wings, rudder, elevator and fuselage, two cylinders, and various portions of the crank-case.

Two of each of the five parts thus marked had to be in place throughout the race. The motor was marked with an electric needle, the fuselage with burnt-in letters, and the other parts with wired-on lead seals, their position being indicated with red paint on the fabric to assist the examiners at the various controls.

The course was divided into five sections, which were again divided, with the exception of the first and last, into controls, as follows:—*Section* 1.—Brooklands-Hendon (20 miles. *Section* 2.—Hendon-Harrogate (182 miles), Harrogate-Newcastle (68 miles), Newcastle-Edinburgh (93 miles). *Section* 3.—Edinburgh-Stirling (31 miles), Stirling-Glasgow (22 miles), Glasgow-Carlisle (86 miles), Carlisle-Manchester (103 miles), Manchester-Bristol (141 miles). *Section* 4.—Bristol-Exeter (65 miles), Exeter-Salisbury Plain (83 miles), Salisbury Plain-Brighton (76 miles). *Section* 5.—Brighton-Brooklands (40 miles).

Provision was thus made for the competitors to experience every kind of country, while the climate provided, as the event proved, every kind of weather. Twelve hours' resting time on the ground in a control had to be taken in Sections 2, 3, and 4, and no competitor was allowed to start in any of the Sections 3, 4, and 5 unless the full resting time had been taken in the previous section. This wise provision was made to ensure that the competitors had some rest and were not over-driven in the round. The times were taken from the start from one control to the arrival at the next, any stoppages in between counting as flying time, while any resting time taken in any section over and above the twelve hours specified was also counted as flying time.

On Saturday, July 22, the start was made at 4 p.m. from Brooklands. Of the original thirty entrants, twenty-eight were possible starters on the day; but only twenty actually went to the post, and only seventeen got away. Lieut. Porte (Déperdussin monoplane) and F. C. Jenkins (Blackburn monoplane) both fell just after starting, smashing their machines, fortunately without injury to themselves, while Gordon England (Bristol biplane) could not get sufficient altitude to leave the ground. The rest reached Hendon, Védrines making the fastest time, 19m. 48s., winning thereby the right to go first on Monday.

Monday was perhaps the most remarkable day of the race. At the earliest dawn the machines began to fly away to the north, and when night fell they were scattered all along the line from London to Edinburgh. Before noon Védrines and "Beaumont" both reached Edinburgh, where Valentine (Déperdussin monoplane) landed soon after four in the afternoon. Hamel (Blériot monoplane) arrived at Newcastle, Cody (Cody biplane) at Harrogate, and the rest lay between Harrogate and Hendon.

Tuesday night saw both the leaders at Bristol, Valentine at Glasgow, Hamel at Edinburgh, and Cody near Durham. On Wednesday, at a few minutes past two in the afternoon, the race was won, "Beaumont" beating Védrines on time by 1h. 9m. 47s. This result was chiefly due to the fact that the latter mistook the way at Bristol and alighted on the wrong ground, breaking a stay in doing so, and much precious time was lost before he was able to reach the actual aërodrome. Both arrived with all their marks intact.

There is nothing astonishing in the fact that they so far outdistanced the rest of the competitors. They are both acknowledged pilots of the very first rank, with great experience in cross-country flying, while their machines and motors were the pick of their types.

[1] Up to the time of going to press no official times have been issued.

"Beaumont's" Blériot monoplane was of the usual cross-country type, fitted with a 50 horse-power Gnome motor and a Normale propeller. Its total supporting area is 17·5 metres; span, 8·9 metres; length, 7·65 metres; and weight, 230 kilos.

Védrines's Morane-Borel monoplane is very similar to the Blériot, except in its landing chassis, the arrangement of the elevator, and the camber of its wings. In plain view also its wing tips are rounded from front to rear instead of from rear to front like the Blériot. It was fitted with a 50 horse-power Gnome motor and an Intégrale propeller. Its total supporting area is 17·5 metres; span, 9·3 metres; length, 6·7 metres; and weight, 200 kilos.

As aviators steer their way by map and compass, the winner naturally had, owing to his nautical training, a considerable advantage. The chief landmarks to the flyer are rivers and lakes, roads, railway lines, the contours of villages and towns, and the masses of deep colour afforded by woods. Good artificial guides are smoke columns in isolated positions, kites or balloons carrying flags, and white-washed sloping roofs of prominent buildings. A good map must be masterly in its omission of unnecessary detail, and must show distinctly the varying heights of the country and the landing places. One difficulty is the absence of trustworthy news, from the aviator's point of view, as to the weather 100 miles ahead. The opinion of the average man, who has no conception of what constitutes good flying weather, and is not equipped with any apparatus for sounding the air, is quite worthless. As flying becomes commoner we shall, no doubt, see a national system of meteorological stations linked up by telephone or wireless telegraphy. Charts of the atmosphere will be in common use so soon as regular services from point to point are established. Profs. A. L. Rotch and A. H. Palmer have foreseen this, and have just issued a pioneer work giving charts of the conditions prevalent at various times of the year in the vicinity of the Blue Hill Observatory, Mass., especially designed for the use of aeronauts and aviators.

Compasses for aëroplane work have only recently been made practicable. One of the most trustworthy is that invented by Mr. E. H. Clift, and it was largely used by competitors. The difficulty hitherto has been the iron and steel work, the framing, motor, wire stays, and so forth that are used on every aëroplane. A deflection, sometimes as great as 30°, is consequently set up, which has to be corrected by "swinging," that is to say, the head of the machine is moved to every point of the compass in turn, and the errors noted and brought to their lowest dimensions by means of magnets and soft iron balls and bars. Errors are then tabulated and reduced to a curve, which can be plotted to accord with the direction of flight. From this it can be seen that compasses are still far from perfect, and are thrown out by the movement of metal parts, their breakage, or removal.

In reviewing the race, one is inclined to regret that the biplanes showed up so badly. The cry has gone out that the biplane is dead. This, of course, is sheer nonsense. One of the finest machines built is the Curtiss biplane; the Wright biplane holds all the duration records in America; the Bréguet biplane holds the record for weight-carrying; the Cody biplane may not be very fast, but it is stable and trustworthy; the Bristol biplane went round the European Circuit in very creditable time; and the Roe biplane has shown what can be done in the way of speed. The monoplane for scouting, for racing, and perhaps for ease of transport, has proved itself superior, but the biplane has many points in its favour which cannot be disregarded. Another machine one would have wished to see do better was the Etrich monoplane, flown by Lieut. Bier with Lieut. Banfield as passenger, which, as the outcome of years of labour, is probably the most scientifically constructed monoplane, both from the aëronautical and engineering point of view, in existence. It broke down, like many others, from engine trouble.

People viewing the race from a distance, or by the more convenient method of newspapers, are inclined to entertain the idea that man can now get up and soar away to the ends of the earth on his lawful occasions with very little trouble, but they reckon without all the vital factors that make for success. First and foremost is the mechanic. Oily and dirty, often starving, usually exhausted to the point of collapse from want of sleep, he follows where the machine leads him. No other but he can tend his own machine; he knows its ways, its moods, and its weaknesses. The touch of his deft fingers removes all cause of complaint and freshens up every flagging part. Then he stands back, watching the white wings sail up into the sky; and they are scarcely out of sight before he takes the road again in his car to follow, anxious, fretful, but enthusiastic, to where his master leads. This is a side of flying as heroic as that of the pilot and as necessary, but gaining no applause and no glory.

A big race is won by everything being of the best—picked pilot, picked machine, picked motor, picked mechanics, and perfect organisation. If one fails, all fail. And here, perhaps, our English temperament fails. Nothing in flying is "good enough," as we are inclined to think; *it must be the best.*

THE BIRMINGHAM MEETING OF THE BRITISH MEDICAL ASSOCIATION.

THE proceedings in the Section of Electro-therapeutics and Radiography of the meeting of the British Medical Association, held in Birmingham on July 25–28, were of scientific as distinguished from purely medical interest. A form of treatment is being introduced in which the ions composing the drugs are sent into the diseased part—skin, nerve, joint—by means of the electric current, that is, by kataphoresis. For instance, a preparation of salicylic acid is ionised by the current, and thus introduced into a nerve—facial or sciatic—in a case of neuralgia with a directness and intensity not attainable by the method of solution in the blood. The consensus of opinion at the discussion was that this, the latest, form of medication was exceedingly useful, not only in neuralgia, but in many joint affections. The speakers agreed that we had yet a great deal to learn, as, for instance, how deeply the ions can penetrate and how many milliamperes it is best to employ.

The utility of this method in cases where the drug which has to be used would disturb digestion, is very obvious, and it is also probable that the drugs introduced by the method of ionisation act more energetically than if they had reached the part through the blood and lymph.

Sir Oliver Lodge addressed the section on the theory of electrical conveyance through solids, liquids, and gases. In solids, he said, the travelling electrons, which were negative in charge, moved through the solid matter; in liquids the electrons, which seemed to be charged negatively and positively in about equal numbers, travel along with the more mobile matter, whereas in gases the current seemed to consist of positive electrons moving independently of the molecules of the gas.

If we rarefy a gas—remove a great many of its molecules or allow it to expand until it fills a much larger space—the electrons are accelerated, and this acceleration is accompanied by a fine shimmer of light, and in certain cases by sound—a cracking noise. The kathode rays are due to the rush of electrons suddenly stopped by a metal plate or target. Sir Oliver concluded by demonstrating his well-known electric valve, a device whereby he permits electrons only of one sign to accumulate, and rejects the others by a series of ingenious "traps." In this way he can, for instance, dose plants with electricity of one kind only, a treatment which has given the most encouraging results in the ripening of wheat, tomatoes, and other vegetables on quite a large scale.

The joint meeting of the Section of Therapeutics and Dietetics with that of Anatomy and Physiology was for the purpose of discussing the problems associated with the work of Prof. Chittenden, of the department of physiological chemistry at the University of Yale, U.S.A. Prof. Chittenden holds, as the result of observations on a large number of persons selected at random, that the usually accepted quantity of protein food for the adult, 118 grams in the twenty-four hours, is excessive. One series of experiments extended over 130 days, so that the charge of insufficient data cannot be brought against the Yale researches. Prof. Chittenden gives about 70 grams, or less than half the German standard, as sufficient; and his contention is that, because the majority of mankind take much larger quantities of protein food, we have no right to assume that this has a scientific basis. He believes the time has come for dietetics, as for all else, to be studied by the methods applicable to other scientific problems.

It is admitted by the Yale school that the amount of nitrogen in food is no measure of our energy requirements, and that, provided we obtain from fats and carbohydrates the amount of potential energy necessary for the daily kinetic output, then the minimum of protein constitutes what we might also call the optimum. Chittenden's work is so well known in this country through his book "Economy in Nutrition" that it need only be said that, as regards analysis of the food and excreta, it is as careful and complete as could be desired. Although it may be proved that the subjects of his experiments were perfectly vigorous on their restricted diet, one failed to learn from Prof. Chittenden what were the bad results of taking more protein than the 70 grams. He said it "stimulated metabolism generally"; but, as one speaker pointed out, this is not in itself a bad thing, as the more active tissue-change is, within limits, the better is the physical and mental health of the individual.

Some speakers who followed in the discussion held that the usual quantity of protein ingested did no harm whatever, while others asserted that protein in excess of Voit's quantity of 118 grams gave rise to excessive intestinal putrefaction and toxæmia, with raised blood-pressure and gouty arterio-sclerosis.

The diets of poor Orientals are not to be quoted as exemplifying the benefits of a low protein intake, since they are indigestible and dietetically insufficient in many ways. The low stamina and frequent anæmia of these races is due to the deficiency in absorbable nitrogen, and an improvement is noticeable so soon as these people are able to afford the more generous *régime* of the European.

According to Dr. Provan Cathcart, the quality, and not the quantity, of the protein is the important matter physiologically, for the nearer the composition as regards the constituent amino-acids approaches that of the tissue-protein of the animal being fed, the less will there be of nitrogenous waste from that animal. Thus dogs wasted less nitrogen when fed on dog-flesh than on any other kind of protein.

In a paper by Dr. Fraser Harris on some physiological aspects of mine rescue apparatus, there were several points of scientific as distinguished from medical interest. For the last two years a committee of the South Midlands Coal Owners' Association has been investigating the various types of self-contained breathing apparatus for saving life in mines after explosions and underground fires. All the following types of apparatus were examined:—Aerolith, Draeger, Fleuss, Meco, Weg, Hall-Rees, and bellows and helmet. Each has its characteristic feature: in the Aerolith liquid air evaporates; the Draeger, Meco, and Weg supply pure oxygen, compressed under 120 atmospheres, at the rate of 2 litres a minute; in the Fleuss one breathes into a large bag in which sodium hydrate in sticks absorbs the carbonic acid gas. The Hall-Rees is used chiefly for submarine work, and in it oxygen is liberated from sodium-potassium peroxide, in which the carbonic acid gas is simultaneously absorbed.

A point for which the committee was not prepared was that the helmet is far from an ideal mechanism. To a person who has never worn a helmet or done hard work in a metal case, which entirely covers the head and face, the helmet seems the very thing required; but he soon finds that the face becomes excessively hot from the absence of ventilation, and the glass window becomes dimmed from the non-evaporated moisture, and, most serious of all, one's range of vision above and to the sides is very limited. This limitation of vision is particularly serious when one is crawling on hands and knees, which in mines it is often necessary to do. The enclosing of the whole head in a helmet diminishes one's power of hearing, a matter of some consequence, since the possible warning of falls from the roof cannot be heard. The committee favoured half-masks and nose-clips, with motor goggles rather than helmets. In order to make the helmets smoke-tight round the face, an indiarubber tyre has to be inflated, and in the cases where this does not fit the wearer a good deal of pain is experienced from the pressure.

Physiological observations on men wearing different forms of apparatus were carried out during this investigation, as it was clearly important to discover whether the wearing of the apparatus and the doing of hard work in them for upwards of two hours at a time was or was not injurious to the volunteers. The investigations were conducted in the experimental mine attached to the mining department of the University of Birmingham. This represents on a reduced scale all the typical workings found in a mine, and it is so constructed that it can be filled with smoke and its atmosphere made irrespirable, or can have steam driven into it so as to saturate the air, but leave it respirable.

The men, then, worked in three sorts of atmospheres:—

(1) With air at the ordinary temperature.

(2) Hot, moist, and irrespirable atmospheres, in which the wet bulb was about 80° F.

(3) Hot, moist, but respirable atmospheres with the wet bulb about 90° F.

The men varied in age from twenty-five to fifty, in height from 5 feet 7 inches to 6 feet 6 inches, and in weight from about 55 to 89 kilos. The men were weighed naked before and after a test, and the gross loss of weight so ascertained. The losses in weight varied from such figures as 226 grams to 1700 grams in two hours; they bore no definite relationship to the body-weight in any given case.

The loss of carbonic acid gas was ascertained by weighing the regenerators, or absorbents, before and after the experiment, the increase in weight giving the moist carbonic gas absorbed. Such figures as 52·7 grams of CO_2 in 30 minutes and 180·5 grams in 130 minutes were obtained. The CO_2 excreted depends on such a large number of conditions—mass of body, temperature, temperament, amount of work to be done, nature of food, light or dark surroundings, &c.—that it is best to express it per kilo. of body-weight per hour, and when this is done it is seen that the weight of moist CO_2 excreted is represented by a figure not greater than 2, and rarely so low as 0·5 gram. In other words, the amount of carbonic acid gas eliminated in unit time per unit of tissue is very much the same for all the men (12) subjected to the same external condition. There was a remarkable uniformity in the average weights of the gas excreted in all the four types of apparatus worn in rotation by all the experimenters, thus:—in the Fleuss, 1·25; Meco, 1·28; Weg, 0·86; Draeger, 1·14.

The observations on the pulse did not elicit anything very interesting, for, as was to be expected, the heart-beat was markedly accelerated. The minimum number of beats added per minute was 16, the highest 58, but it was satisfactory to know that in all cases the heart had returned to its normal within fifteen to twenty minutes after the test was stopped.

As regards the respiration, nothing more than a physiological hyperpnœa was observed in any case; true dyspnœa was never seen, even at the end of two hours' hard working. No bad effects of the inhalation of pure oxygen as observed by some physiologists in the case of the lower animals were noticed. The very absence of dyspnœa under conditions of oxygen deficiency may become a danger. It is usual for men to suffer from violent and embarrassed breathing when their supply of oxygen begins to run out, but a small proportion, about 10 per cent., appear to be seized with cardiac syncope instead of dyspnœa. The importance of this is that, suppose such a man is the last of a team, then, if his oxygen runs short, he simply falls down unconscious without giving any warning to his companions. He may be left behind in the smoke, as he is unable to call out to them that anything is wrong. The members of the committee, in view of an accident of this kind, point out the danger of allowing only two men to form a rescue-team and enter an irrespirable zone. The committtee was greatly struck with the enervating effects of moist heat on the workers. The report contains the following sentence:—"We were impressed by the rapid onset of fatigue, particularly mental, in very hot and moist atmospheres (group 3). When the wet bulb is higher than 85° F. or so, a man, especially if he has hard work to do, is overcome by irresistible lassitude. He becomes irritable, as well as indisposed to mental exertion. We think this partial mental enfeeblement a fact of some consequence, inasmuch as a person fatigued by hard work in a rescue apparatus in a hot and moist atmosphere might, in some situation requiring promptness of decision, coolness of judgment, the accurate recollecting of instructions, plans, &c., not prove himself equal to the emergency.

The heat developed in the regenerators was such that the men had the skin of the back burnt on more than one occasion. Temperatures of more than 200° F. were registered in the regenerators, and 135° F. was attained by the outside of the bag of the Fleuss. Undoubtedly one of the sources of this heat is that from the chemical combination ($2Na.OH + CO_2 = Na_2.CO_3 + H_2O$) which is slowly dissipated in the hot atmosphere. The last point of interest is that the temperature of the circulating oxygen in hot atmospheres became so high as to burn the throat. Now this temperature was rarely higher than 100° F., and yet it produced great discomfort, while we know that the air in a Turkish bath can be breathed without discomfort even when the temperature is as high as 200° F. The difference is that in the rescue apparatus it becomes saturated, whereas in the Turkish bath it is kept as dry as possible. The dry, although hot, air allows the water to evaporate from the mucous membrane, and so carry off heat in a latent state; but the saturated air circulating in the apparatus permits of no evaporation, and consequently of no corresponding loss of heat.

At an honorary degree celebration of the University of Birmingham on Thursday, July 27, a number of distinguished persons received honorary degrees in connection with the visit of the British Medical Association, and the following speeches were made by the principal (Sir Oliver Lodge) in presenting them to the Vice-Chancellor:

The president of the Royal College of Physicians of Edinburgh, physician to the Royal Edinburgh Infirmary, lecturer on medicine in the Extra Academical School of Medicine, and reader of the address in medicine at the present meeting of the British Medical Association, Dr. Bramwell is the author of many splendid works on medical subjects, in particular of a monumental atlas of clinical medicine, which have made his name known all over the world and will perpetuate his memory. An indefatigable worker, a brilliant clinical teacher, and one of the best known and esteemed physicians in the British Islands, I present for the honorary degree of Doctor of Laws

Byrom Bramwell.

The city of Birmingham has for many years believed strongly in local self-government and strenuous civic administration. Recently it has assumed enlarged responsibility, and in this expansion it gratefully acknowledges the assistance and high encouragement it has received from the President of the Local Government Board a man who, during his term of office, has consistently shown active and practical and powerful sympathy with the struggling period of more than one expanding or federating municipal enterprise; while the future housing of many a community will benefit by his energetic insistence on foresight in planning and thoroughness in drains.

We of this University, closely connected as we are with the city, wish to join in expressing to him our cordial good feeling and gratitude.

Fortunately the present occasion gives to this feeling an opportunity of expression quite apart from any kind of political or social controversy. For the medical faculty represented to the Senate that in his capacity as head of the department which is concerned with the sanitary administration of this country, the Member for Battersea has constantly cooperated with the medical profession in their efforts to improve public health and has given his powerful assistance to those municipalities which are trying to ameliorate the sanitary conditions of the areas under their control. A man of exceptional vigour and of health, both in mind and body, which he devotes without stint to the service of the community, I present to you for the honorary degree of Doctor of Laws

The Right Hon. John Burns.

The presence of Dr. Chittenden in our midst enables us to offer a welcome to a representative of our great kindred across the seas, with whom we are on terms of the most affectionate alliance—strengthened as it is, or as we trust it soon will be, by a permanent treaty of arbitration dealing with any and every difficulty such as may sometimes arise even between close friends.

Dr. Chittenden is professor of physiological chemistry at Yale, and director of the Sheffield Scientific School of Yale University, where his researches have led him to advocate a much less plentiful diet than is usually found to give satisfaction. He was for ten years president of the American Physiological Society. He is already Doctor of Philosophy and Doctor of Science, and is well known as the author of important works on the physiology of nutrition, which have been based on researches to which he has devoted the labour of many years. He has come to Birmingham by invitation to open a discussion in the Section of Therapeutics, which has attracted much interest.

Prof. Chittenden is welcome as a distinguished representative of American university teachers, and we are honoured by enrolling his name on the list of our honorary graduates. I present to you for the degree of Doctor of Laws

RUSSELL HENRY CHITTENDEN.

Among all the movements of our time fraught with benefit for the human race, surely the conquest of the broad belt of the earth from the diseases which ran riot there, and the fitting for white habitation of those sun-favoured regions, is among the most promising.

We do not forget that our Chancellor has exerted himself to promote the activity of officers of the Crown in this direction, and to-day we have the pleasure of welcoming one of the enthusiastic pioneers in this endeavour.

Sir Francis Lovell, Baronet, C.M.G., Fellow of the Royal College of Surgeons, has held high office in our colonies, especially in the West Indies, and has been entrusted with various missions on sanitary questions for the Colonial Office. He served his country first in the then deadly district of Sierra Leone, and subsequently was for many years chief medical officer and president of the General Board of Health and member of the Council of the Government, first of Mauritius, and then of Trinidad and Tobago. His active services abroad lasted from the early 'seventies into the present century, and now continue during his holidays, for he devotes his well-earned leisure to the promotion of the study of those diseases which render tropical climates fatal to Europeans and cause a high rate of mortality among the native populations.

As dean of the London School of Tropical Medicine, and as president of the Section of Tropical Diseases at this meeting of the British Medical Association, I have special pleasure in presenting

FRANCIS HENRY LOVELL.

James Alexander Macdonald is Doctor of Medicine of the Royal University of Ireland and physician to the Taunton and Somerset Hospital. He is the chairman of council of the British Medical Association, and was for three years chairman of the representative meeting of that body. He is also a member of the General Medical Council, in which he sits as a direct representative of the medical profession. His work in the association, and the important offices he has so ably filled, mark him out for the distinction which the University desires to confer upon him. For the honorary degree of Doctor of Laws I present to you

JAMES ALEXANDER MACDONALD.

The University rejoices at the opportunity of welcoming on this occasion many representatives of foreign nations, with all of which we cordially desire to be, not only at peace, but to be linked by ties of friendship and mutual effort—all harmoniously working together for the increase of civilisation and the welfare of the human race. Two of these representatives I shall have the honour of presenting on this occasion. Dr. Oppenheim, Doctor of Medicine and titular professor of the University of Berlin, is a neurologist of great distinction and the author of many important books on his subject. He has opened a discussion in the Section of Neurology at this meeting. His reputation extends all over the world and is of the highest kind. He is the author of a text-book which has been translated into many languages and is accepted as a standard work. His standing and repute as a scientific physician are such that no honour we can confer can enhance his dignity. I present for our honorary degree

HERMANN OPPENHEIM.

Of the self-governing Dominions of the Crown we welcome a representative in Dr. R. A. Reeve, Bachelor of Arts, Doctor of Medicine, who is professor of ophthalmology in the University of Toronto, and was for many years dean of the faculty of medicine there. He enjoys a wide reputation in Canada as a specialist in diseases of the eye, and the position he occupies is sufficiently attested by his having been elected president when the association met in Toronto in 1906. As a distinguished representative of the Dominion of Canada, the University is proud to add his name to its roll of graduates. I present to you

RICHARD ANDREWS REEVE.

In the person of the eminent surgeon Dr. Strassmann we recognise another representative of a great and friendly nation, and to him the introductory remarks prefixed at the presentation of our honorary graduate Dr. Oppenheim equally apply.

Dr. Strassmann is titular professor and assistant to the chair of obstetrics and gynæcology in the University of Berlin, the author of many monographs on various subjects in his department, and an accomplished operating surgeon. He is visiting Birmingham by invitation to take part in the proceedings of the Section of Obstetrics and Gynæcology, in which he has this morning opened a discussion. The University welcomes him as a shining example of sterling ability in his branch of practice, and empowers me to present for the honorary degree of Doctor of Laws

PAUL STRASSMANN.

The professor of pathology in the University of Cambridge is a friend of many of us, and a man regarded with affection wherever he is known, whether in Edinburgh, in Cambridge, or in Birmingham; for Sims Woodhead is no stranger to this University, which he has indeed served in the capacity of an external examiner. He is an M.D. of Edinburgh, the editor of *The Journal of Pathology*, the author of a manual of practical pathology, and for some years was superintendent of a research laboratory in Edinburgh University. Moreover, he is a member of the Royal Commission on Tuberculosis, and has carried out an enormous amount of experimental research in connection with that subject. Little of this work is known to the public, and the University is glad to recognise it by enrolling among its honorary graduates the name of

GERMAN SIMS WOODHEAD.

SCIENTIFIC ASPECTS OF THE UNIVERSAL RACES CONGRESS.

IT appears that the idea of a Universal Races Congress first originated with Prof. Felix Adler, of New York, but its realisation is due to the untiring energy and enthusiasm of Mr. Gustav Spiller. The avowed object of the congress was "to discuss, in the light of science and the modern conscience, the general relations subsisting between the peoples of the West and those of the East, between so-called white and so-called coloured peoples, with the view of encouraging between them a fuller understanding, the most friendly feelings, and a heartier cooperation." Invitations to attend the congress were scattered profusely, and delegates were appointed by a very large number of Governments and institutions, and there was an attendance of more than two thousand members. Rarely, if ever, have so many different nationalities and varieties of mankind been gathered under one roof. From this point of view the congress was an undoubted success; the bringing together of this heterogeneous assembly was no small task, and it cannot be doubted that the spirit of friendliness that permeated the congress, and the introduction to one another of varied peoples with similar or analogous aims, were all to the good, and will have permanent beneficial results.

The main work of the congress consisted of speeches and resolutions, as well as of the papers which were published before the meeting in a volume of nearly five hundred pages entitled "Inter-racial Problems" (P. S. King and Co.). These were taken as read, but many of the writers had a further opportunity of stating their views. The official meetings of the congress were held on July 26–29 in the large hall of the University of London, a room which, unfortunately, has bad acoustic properties. As a very large number of persons were invited or volunteered to speak, the time given to each was necessarily limited, and in consequence most of them spoke very rapidly, and often not distinctly; various languages were employed, and the oppressively sultry weather made it difficult to concentrate attention. The conditions were not favourable to a real discussion, and the proceedings were necessarily more of the nature of orations, sometimes perfervid, on a multiplicity of topics. On the previous Tuesday, however, an attempt was made to organise discussions on "The effects of miscegenation on intelligence and character," and "The influence of environment in forming and changing racial characteristics." These two problems and "the general problems of the conditions of progress" were also discussed on the Wednesday morning.

Prof. F. von Luschan in his printed paper states that "As long as man is not born with wings, like the angels, he will remain subject to the eternal laws of Nature, and therefore he will always have to struggle for life and existence. . . . Nations will come and go, but racial and national antagonism will remain; and this is well, for mankind would become like a herd of sheep if we were to lose our national ambition and cease to look with pride and delight, not only on our industries and science, but also on our splendid soldiers and our glorious ironclads." In his speech he humorously admitted that he was swimming against the stream of the congress, which was certainly the case. Dr. Haddon maintained that Dr. von Luschan had only partially stated the case; he assumed that it was largely on account of his weakness and social habits that man diverged from the other anthropoids; the least advanced peoples are, if anything, over-socialised, and all through human history progress depends upon the balance between individualism and collectivism, between self-help and mutual aid. Mr. John Gray, in opposition to the sentiments of many present, frankly stated that all men were not equal and never would be, nor was it desirable that they should be; but, on the other hand, equal opportunities should be given to all, so that the more capable should not be stifled. Drs. von Luschan and Haddon agreed that there were practically no pure races still existing, and that a discussion of races was not suitable for a congress such as this, as it was mainly of academic interest; the former went so far as to state that the old Indo-European, the African, and the east Asiatic all branched off from the same primitive stock, perhaps hundreds of thousands of years ago, "but all three forming a complete unity, intermarrying in all directions without the slighest decrease of fertility." This does not, however, mean, as some would have liked to believe, that there is no racial difference between men.

Prof. Lyde printed an informing paper on the climatic control of skin-colour. Most anthropologists admit this control, which, however, has not yet been sufficiently studied, nor are the very numerous exceptions yet accounted for. Colour has long been recognised as but a very secondary factor in race discrimination, and it was distinctly pointed out that the question of race was a purely zoological problem, and must be solved by zoological methods. Nearly every speaker confounded peoples with races, but perhaps this is inevitable among those who have not had a biological training; this confusion of terms is manifest in the first printed paper on the meaning of race, tribe, nation, by Dr. Brajendranath Seal, who speaks of a "national race" of complex elements. He also says "We may arrange the types of physical race . . . (1) . . . by a modified genealogical tree (with devices for intercrossing and retrogression), or by symbols and formulæ analogous to those of organic chemistry (as in arranging isomers, polymers, &c.) . . . (2) . . . in space (or more simply on a plane surface) the distance along different directions marking the degree of affinity as estimated by three (or two) groups of correlated characters. . . . A third way would be to conceive an ideal type as the goal towards which the normal development of the organism is tending, and to place the actual types round this as a centre, at distances corresponding, more or less, to their approximation to the ideal." Anyone who has tried to make an arrangement of human types on a plane surface will appreciate how impossible it is to do so in anything like a satisfactory manner; but who is to decide what is "the ideal type" (or does he mean "ideal types"?) "to which the normal development of the organism is tending"? He adds:—"Though the third method is not quite feasible, an occasional application of this test of normal or standard development is a useful corrective."

It is scarcely to be expected that this suggestion, if it were carried out, would lead to much precision, as we cannot be sure of what we are going to develop into. A classification of existing types must necessarily be static, a phylogeny (assuming that the requisite data are available) is dynamic, an ideal type is mainly a matter of sentiment, a goal is prophecy which belongs more to the domain of philosophy than to that of science. Later he says "No view of civilisation is sound or adequate which considers Race and Racial types statically, and not dynamically as growing, developing progressive entities"; however this may be, ethnologists will not entirely agree with Principal Seal when he says "There are other phenomena which are abnormal, pathological, implying degenerative transformation of structure or function. Cannibalism, promiscuity, Morgan's consanguineous marriage, group marriage, infanticide, black magic, &c., are of this class. In the first place they are far outside the line from the ape to the civilised man . . . and secondly, natural selection would ruthlessly weed out stocks in which such impulses would be normal. It follows, therefore, that, when such phenomena appear, as they undoubtedly do, among savages or primitive folk, they are not part and parcel of their normal physico-psycho-social type, but are phenomena of degeneration or retrogression in those peoples."

There are one or two other papers dealing with anthropological subjects, among which may be noted a valuable essay by Dr. C. S. Myers on the permanence of racial mental differences. Prof. Earl Finch writes on the effects of racial miscegenation, and he presents "some facts tending to prove that race blending, especially in the rare instances when it occurs under favourable circumstances, produces a type superior in fertility, vitality, and cultural worth to one or both of the parent stocks." This view was maintained, on the whole, in the preliminary discussion on the Tuesday, the manifest exceptions to the statement being explicable mainly by the unsatisfactory social conditions of half-breeds—in other words, the problems of miscegenation are sociological rather than physiological. In a paper on the instability of human types Prof. Franz Boas summarises his observations on European immigrants into New York, to which the attention of readers of NATURE has already been directed. He makes the very remarkable statement that "the child born in America, even if born only a few months after the arrival of the parents, has the head-form of the American born." The investigations of Prof. Boas were referred to by others as demonstrating the uncertain character of physical traits in racial problems and the rapid effect of the environment; a tendency, however, is observable for others to go beyond the conclusions arrived at by Prof. Boas. It was pointed out that so far Prof. Boas has not given us his methods, nor has he stated what precautions he has taken to control the personal equation of his numerous assistants; a further possibility of error lies in the working up of the statistics. Doubtless this information will be given in his final report.

The ethnologist will find various interesting facts and conclusions in some of the other papers, more especially those dealing with the negro in Africa and America. A lantern demonstration on the methods of racial discrimination and classification was given by Dr. Haddon on Thursday evening. There was also organised in connection with the congress an exhibition of nearly two thousand photographs, &c., representing a large number of peoples, and including a series of coloured drawings of types painted expressly for the occasion by Mr. Norman H. Hardy. A large number of books and pamphlets dealing with ethnological subjects were also on view. The exhibition of illustrations and literature was a great attraction, and was of great educational value. Considering the very few people connected with the congress who knew or cared about scientific matters or methods, the scientific results may be considered as fairly satisfactory.

THE INSTITUTION OF MECHANICAL ENGINEERS.

THE summer meeting of the Institution of Mechanical Engineers was held at Zurich and northern Switzerland, commencing on Monday, July 24. In addition to the meetings for the reading and discussion of papers, an extensive programme of visits to works and hydro-electric power stations had been arranged, and formed an important part of the meetings. The works visited included those of Brown Boveri, Esher Wyss and Co., Oerlikon Machine Works, Sulzer Brothers, and the Swiss Locomotive and Machine Works. The power stations at Rheinfelden, Laufenburg, Wangen, Schaffhausen, Beznau, and Löntsch were also included. The institution dinner was held on July 25. Brief notices of the papers read are given below, and a fuller abstract of a paper on high-pressure water-power works will appear in a later issue.

A paper on electric traction in Switzerland was presented by Mr. E. Huber-Stockar, of Zurich. It may be found astonishing that progress in electric traction has not been greater in Switzerland when one considers that it is necessary to buy all the coal supply from foreign countries, and that a large amount of water-power is still undeveloped. Further, Switzerland has had certain railways electrified at a comparatively early date, and might have been expected to go onward on this basis, especially as applied electricity is highly developed in the country generally. Economy of operation is having a decisive weight, and makes the problem, as it is presented, difficult. The railways already electrified, or about to be electrified in the near future, are such that the smoke nuisance would be an almost prohibitive feature with steam traction, as in the case of the Simplon tunnel, or where the capabilities of steam are near exhaustion, as in the case of the St. Gothard Railway. There are two gauges in use, 1·435-metre "normal" and 1-metre "narrow." There has been but slow progress in normal-gauge railways since 1883, and rapid progress in narrow-gauge railways since 1887.

The author describes very fully several typical Swiss railways and the methods of operation. Reference is made to the valuable scientific work which has been carried out by the Schweizerische Studiencommission für electrischen Bahnbetrieb. This society has investigated such problems as the elucidation of the question of general railway electrification under Swiss conditions. The merits of the several systems, the cost of plant and of operation, and the comparison of steam and electricity for definite lines or groups of lines. The electrification of the St. Gothard Railway, to be carried out in the near future, has been well prepared by the work of this society.

Railway electrification is making noteworthy rather than rapid progress in Switzerland. As regards system, single-phase current of low periodicity (15) and high contact-line voltage, varying from 5000 to 15,000, according to circumstances, is being sanctioned by experience and by authority. All electrification in Switzerland is directly connected with the utilisation of water-power. The heavy variations of load and the rapid seasonal variations in the fresh-water supply make water storage desirable, and even imperative.

A short survey of the practical development of the Diesel oil engine up to the present day was given by Mr. F. Schubeler, of London. It will be remembered that the characteristics of the Diesel principle are compression in the working cylinder up to the ignition temperature of the fuel (about 500 lb. per square inch and about 1000° F.) and the use of an independent multiple-stage air-pump for raising the pressure of the injection air to 600 or 850 lb. per square inch; the injection air is used for the introduction of atomised air into the cylinder. The extreme high pressures and temperatures of the Diesel process put a limit to the dimensions of the cylinders, which will scarcely exceed 30 inches in diameter. Assuming 150 revs. per min. and the ordinary Otto cycle, this corresponds to an approximate cylinder output of 300 to 400 horse-power. It is not desirable to have more than six cranks; hence, in dealing with large powers, it becomes necessary to seek means of increasing the specific cylinder output. For this there are three possibilities:—(1) by carrying out the single-acting Otto cycle machine as a double-acting one; (2) by adopting the single-acting two-stroke cycle process; (3) by adopting the double-acting two-stroke cycle process. The first method approximately doubles the cylinder output; the second produces the same result, but necessitates the provision of special scavenging pumps; the third theoretically quadruplicates the cylinder output, but in practice about 3·4 may be secured.

For small and medium size units the single-acting Otto cycle takes the preference. Such machines have worked for periods of six to eight weeks without interruption, even in cement factories and mills. The two-stroke cycle shows a somewhat higher consumption of fuel, amounting at least to the percentage of the energy absorbed by the air-pump; it has, however, a more favourable turning moment, and guarantees better starting and better conditions for regulation, which is specially important for direct coupling with alternators. The space required is smaller, and the engine is lighter and cheaper. There are many difficulties involved in the problem of the double-acting Diesel engine, and the author deprecates the proceeding at once to the double-acting two-stroke cycle without first gaining experience with the single-acting engine. Some firms have already claimed to be able to carry out a double-acting two-stroke marine engine. The results obtained with such engines are unknown to the author, and he feels somewhat doubtful whether success has already attended such efforts. Attempts have been made to build Diesel locomotives. The adoption of the Diesel engine for motor-cars and aëroplanes does not seem to be very promising.

Dr. Alfred Amsler, of Schaffhausen, described two new types of transmission dynamometers. The first of these is of the torsion type, and is intended for measuring the power transmitted to or from high-speed machines. The dynamometer couples the shaft of the driving engine direct to the driven machine, and consists essentially of a shaft the angle of twist of which gives a measure of the torque. To measure the angle of twist three discs are used, one fixed to one end of the shaft and the other two fixed to the other end. A transparent celluloid rim is attached to the first disc, and has divisions cut on it; each of the other two discs has a radial slit. The scale divisions are strongly illuminated, and may be clearly read through the slits when the shaft is running. An impression is given to the eye every revolution, and at high speeds these impressions become a continuous stationary image.

The other type of dynamometer is intended for use with slow-running machines of variable resistance. Two pulleys are placed close together on a common shaft, one being fixed to the shaft and the other pulley runs loose. The pulleys are connected by means of two cylinders fitted with pistons and charged with oil. The drive from the source of power is communicated to one pulley by belt, and the machine under test is driven by belt from the other pulley. In operation, the oil in the cylinders is put under pressure corresponding to the torque being transmitted. The shaft is hollow, and serves to make communication between the cylinders and a pressure gauge, the readings of which give a measure of the torque.

A paper on rack-railway locomotives of the Swiss mountain railways was read by Mr. T. Weber and Mr. S. Abt, of Winterthur. Switzerland has a total of 120 steam locomotives, as well as 45 electric locomotives and motor coaches arranged for working with rack gear. The total length of the rack railways is 87 miles. The whole of the systems of racks which are in use have been designed in Switzerland. The Abt system has been most adopted, and consists of flat-toothed plates, of which two or three, according to the tractive power, are bolted together on chairs in such a way that the tooth of one plate in regard to the other is displaced one-half or one-third of the pitch. The pitch is 4·7 inches, and the rack ensures a quiet motion and permits the trains to work at high speed.

A paper descriptive of the Zoelly steam turbine was presented by Mr. H. Zoelly, of Zurich. This turbine is of the impulse type, and as made at the present time has eight stages for turbines running at 3000, twelve stages for 1500, and sixteen stages for 1000 revolutions per minute. The first diaphragm plate of the high-speed turbines has nozzles which extend for a portion of the circumference only in the bottom half of the diaphragms, whilst in the other diaphragms the nozzles usually extend completely round the circumference. In the case of large units, steam is admitted through channels extending completely round the circumference for all stages. Governing is effected by throttling the live steam. The efficiency of this type of turbine will be evidenced by the following results for a 4000-kw. turbine:—steam consumption per horse-power-hour at full load, 9·36 lb.; at about three-quarter load, 9·58 lb.; at almost half load, 9·84 lb.; at about one quarter load, 10·12 lb. A set of two marine Zoelly turbines, each of 7500 horse-power, has been installed recently in the torpedo-boat destroyer G. 173 of the Imperial German Navy.

Prof. Franz Prášil, of Zurich, communicated the results of some of his tests on Francis turbines and on Pelton turbines. It is of interest to note that both types have developed in the direction of increase of horse-power per unit since 1900, and have now reached as high as 10,000 horse-power per wheel. The Francis turbine is applied with success to falls of 3·3 to 492 feet, the Pelton wheel to falls of 131 to 3116 feet. There has been steady improvement in the construction of the turbines, in the efficiency of the automatic governing, and in the safety mechanism.

In the case of four Francis turbines in open-wheel pits and working under heads of 4·4 to 10·4 metres, the efficiency was found to be more than 85 per cent. at about 80 per cent. of full load. Five Francis turbines in spiral wheel cases gave results showing that efficiencies of 85 per cent. and more are attainable in this style of turbine. The heads in the latter case ranged from 12 to 147 metres.

Four Pelton wheels were tested under falls ranging from 90 to 850 metres. At about 55 per cent. of full load all four turbines showed efficiencies lying between 84 and 85 per cent. The most favourable efficiencies varied between 84 and 89 per cent. The efficiency was lower than 80 per cent. only under loads which were 25 to 30 per cent. of the full load.

In regard to efficiency, there is not to be expected much further advance in the future. The problem of governing can still be considered as not yet completely solved, since there still appears in view a series of applications which will influence the further development of this problem.

THE BELFAST HEALTH CONGRESS.

THE annual congress of the Royal Sanitary Institute, which was held at Belfast on July 22–29, proved a great success; and if the papers dealing with the scientific research side were few, those dealing with the administrative side of preventive medicine amply made up for this deficiency. It is only possible in this short article to indicate those contributions which were of special interest and importance.

In a paper upon the non-nitrification of sewage in sea-water, Messrs. Purvis, McHattie, and Fisher recorded the results of many experiments, which demonstrated:—"That even after seventy days' incubation of 10 per cent. sewage in sea-water, with every facility for complete aeration, there was no production of nitrates or nitrites, and that the free-ammonia figure was increased in the sewage and sea-water at the end of forty-two days. The most obvious explanation of these facts is to assume that the sea-water destroys the useful nitrifying organisms. With regard to the continuous presence of free-ammonia, even after fifty-two days' incubation, it is of interest to note that it supports the suggestion of Kenwood and Kay-Menzies as affording a valuable clue to the contamination of sea-water by sewage."

Drs. T. Houston and T. Rankin contributed an important paper upon the diagnostic value of blood reactions in epidemic cerebro-spinal fever and allied conditions, and they maintain that their observations show that the cerebro-spinal cavity is the proper place to attack the causal organism—the Meningococcus—by means of an anti-serum.

Dr. Williams, the medical officer of health of the Port of London, contributed a paper on plague precautions in reference to the destruction of rats. After discussing the various means of destroying rats aboard of ships, and testifying to the unsatisfactory results obtained from pathogenic bacterial methods, he records the results of experiments on the lethal qualities of air containing 3 per cent. sulphur dioxide gas. These experiments indicate that rats and beetles are killed within from two to three hours of exposure to such air.

In a paper on the viability of *B. typhosus* in water and its isolation therefrom, Drs. J. Wilson and C. Dickson conclude that uncultivated *B. typhosi* (viz. those actually present in the urine and fæces of "carriers") may be recovered from water after a period of three weeks and two days, when conditions closely resembling those found in nature are imposed. "Dr. Houston was unable to recover uncultivated typhoid bacilli from water at a later period than one week from the time of addition, and states that 'less than a month's storage of a raw river water is apparently absolute protection against typhoid fever.' Our experiment shows that Dr. Houston's statement should be accepted with reserve."

Dr. King-Kerr, in an interesting and suggestive paper on the prevention of typhoid fever, dealt with the experience of Belfast. As recently as ten years ago the death-rate from typhoid fever in Belfast was a very high one (1·04 per 1000 in 1901), whereas for the past three years the rate has been only 0·05. Dr. King-Kerr explains that several factors were found to have exercised a powerful influence in this reduction, and that their coming into operation was followed by a marked, definite, and even immediate fall in the death-rate. These factors were the substitution of water-closets for privies, the stoppage of the sale of cockles, the establishment of an additional fever hospital, the sterilisation of the infected hospital sewage, and the more complete isolation of typhoid patients. The decline in the typhoid, zymotic, and general death-rates coincides with these operations.

In a paper on municipal hospitals, Dr. P. Boobbyer directed attention to experiments extending over fifteen years, which had been carried out at Nottingham, to test the value of the open-air treatment for all classes of acute specific diseases, including small-pox, scarlet fever, diphtheria, measles, whooping-cough, pneumonia, erysipelas, and even enteric fever. He was moved to make this experiment in the first instance by the reputed liability of isolation hospitals to favour the spread of many (and often complicated) cases in confined atmospheres. "During the past few years it has been our constant practice to nurse the more severe cases of the diseases mentioned above, as far as possible, in the open air, in bell tents with open sides, in the freely ventilated corridors between the various ward blocks of the hospital, or in the covered approaches to the latter. Cases of an acute and septic character certainly clear up more speedily in the open air than in closed wards. In no single instance, so far as I have been able to discover, has any untoward result accrued from the exposure."

The State endowment of motherhood, a paper by Dr. Eric Pritchard, aroused considerable interest. He advocated that the mother should be endowed in her capacity of mother in order to mitigate the evil effects of poverty and labour upon the woman advanced in pregnancy; and he impressed the importance of the adequate provision and training of midwives in the principles and practice of infant feeding and management. The whole object of maternity endowment should be centred in efforts to safeguard the interests of the infant before and immediately after birth, and these interests would be best studied by an efficient midwifery service, supplemented by the domiciliary visits of properly trained health visitors, both before and after birth; and both midwives and health visitors should be empowered to dispense free benefits of food, clothing, or other necessity which they might think proper for the welfare of the State's new citizen.

Mr. A. J. Martin's advocacy of a "National Health Week" met with much acceptance. We cannot expect to awaken all at once a sustained interest in matters of health, but it is practicable during one week in the year to secure for them a fair measure of public attention. "Health week" may fittingly start with Health Sunday. "If the clergy will but awaken and stir the conscience of the nation, and bring home to all their congregations a sense of their personal responsibility for their own health and that of their families and neighbours, the Press and other agencies for moulding public opinion may be trusted to do the rest. The Press of this country has again and again given proof of its readiness to work for the public health. Only a few months ago one of our great papers devoted columns day after day to a campaign against tuberculosis. Still more recently leading journals have taken a strenuous part in the agitation for wholesome bread.

"Our local authorities are largely occupied with health work. Let them for one week in the year take their constituents into their confidence. Let them hold one or more public meetings to discuss the special needs of the town or district, the work already accomplished, and that which still remains to be done.

"And then the schools. Throughout Health Week let the regular teaching in hygiene be supplemented, at least for the elder children and their parents, by one or more lectures from local medical men—lectures, not crammed with dry scientific facts, but brimful of that romance in which the pages of sanitation abound.

"I would also enlist the aid of the trade unions, the cooperative societies, the friendly societies, the funds of which are so cruelly depleted by preventable disease—every body of men, in short, who care for the well-being of their fellow men, and are willing to work for it."

The difficulties to be overcome should not be underestimated, but they need not be exaggerated. Hospital Saturday and Hospital Sunday in this country, and Tuberculosis Sunday in the United States, have shown the way. From small beginnings they have grown into great national institutions; and if the cure of disease has a claim on our sympathy and support, how much the more has its prevention?

THE FIFTH INTERNATIONAL DAIRY CONGRESS.

THE fifth International Dairy Congress met at Stockholm on June 28, and was closed on Saturday, July 1. There was a large attendance of members, and some interesting discussions arose on the various subjects contained in the programme.

The meetings were held in the two chambers of the Houses of Parliament, and to facilitate the procedure, the subjects under discussion were divided into two sections. In Section 1 the production of milk was the main subject of discussion, whilst in Section 2 attention was directed to the treatment and use of milk. It is not possible to follow in detail the discussions which took place on practically all the subjects which were dealt with by the two sections, so a short account of the questions placed before the congress, and a *résumé* of the conclusions or recommendations arrived at, will be given. The first question was on the effect of the different fodders on the quality of milk and dairy products; six reports had been presented, and abstracts published and issued to members. The discussion of this subject made it clear that there is still a great deal of uncertainty as to whether or not food can cause an increase of fat in milk. Kellner (Möckern—Leipzig) reported that feeding experiments which had been carried out under his direction proved that the use of palm-nut cake meal caused a rise in the amount of fat in the case of cows with a high milk yield.

Bøggild (Copenhagen) recalled the experience of Danish farmers some twelve or fifteen years ago, when it was found that palm-nut cake meal raised the percentage of fat in milk. The rise was not maintained and the use of palm-nut cake meal fell. The influence of the season should not be overlooked in these cases, for in some years the increase in the fat content of milk seemed to be due to this factor.

Further evidence of the possibility of increasing the fat in milk was given by several speakers, and Nils Hansson, in a very able paper, pointed out that it may be necessary to abandon the view that food has no quantitative influence upon the fat of milk. The part played by foods in influencing the flavour of milk was discussed, and particularly the bacteria from feeding stuffs. The entrance of organisms into the milk, either directly or indirectly, through fæcal matter, was considered important.

The interest displayed in this subject resulted in a *résumé* being prepared by Martini, Kellner, and Ostertag, and communicated to the next day's meeting. The final conclusions of the congress were that it is evident from practical observations and from scientific researches, particularly those of Kellner, that certain foods exercise an influence upon the quantity of fat in milk in the case of cows having a high milk yield, but that the following questions still need an answer:—(1) From what period does the influence of the food make itself felt? (2) To what degree is this influence maintained? (3) Does the addition of certain foods exercise an equal influence upon the quantity of fat? (4) Is the quantity of fat obtained by the use of these specific foods remunerative?

The second question dealt with the influence of the different fertilisers on forage plants with regard to the quality of milk and dairy products. Orla Jensen (Copenhagen) gave an account of a long series of experiments which he had conducted. The results proved, however, to be largely negative, and in spite of slight and irregular changes in the milk salts, and the coagulation of the milk, it was concluded that the chemical effect of the fertilisers was very little indeed. The effect of bacteria coming from fodder upon milk, particularly when associated with digestive disturbances, is very considerable and of far-reaching influence, in the making of cheese particularly. This being the case, the necessity for the strictest cleanliness in the cowshed and in the dairy, the adequate cooking of the milk, and the retention of healthy cows only, become once more the recommendations of those best fitted to advise. Unfortunately there was little discussion upon this question; in all probability the subject had not been investigated by others.

The third question dealt with a subject which is much discussed at the present time in this country, and the conclusions of the congress as noted below ought to prove conclusively that we are neglecting one of the best means of improving our milk supplies at practically no cost. The question was as to the importance of control associations (milk record societies) for the production of milk. Benno Martini (Gross Lichterfelde) criticised the manner in which these associations are generally run, and the conclusions which are often drawn from the results; but he agreed as to their usefulness in bringing the importance of the careful testing of each cow in the herd before the farmer himself, and this in many cases was first done when a travelling tester visited the farm. Every other speaker, and they were of all nations, had praise for the control associations, and if any evidence were needed that their operations resulted in the rise in quantity and quality of milk, it was furnished in abundance.

Funder (Christiania) reported on a condition of affairs in Norway which somewhat resembles that in England, namely, the reluctance of the farmers, especially the smaller ones, to join the associations, and the objection to the travelling tester staying at the farm.

The opinion of the congress is well expressed in the following resolution, which was passed:—

"Judging from the good results obtained in Sweden, Denmark, Germany, Finland, and Austria, the fifth International Dairy Congress declares that milk record societies exercising a control of the feeding of the cows furnish one of the best methods of raising good animals of a milking strain, and assist in the reduction of the cost of milk.

"The congress directs attention to the great importance of such control societies in initiating a rational, economical, and balanced mode of feeding, and in propagating the sound experience which has been gained in the keeping of animals."

The veterinary control of live stock as regards the production of milk was the fourth subject dealt with, and the discussion showed that very strong views were held as to the necessity of veterinary inspection of cows. The question of the food for cows from which special "infants'" milk is obtained, and the tests to which the milk should be subjected, were also discussed. It was agreed that when a change from dry to green food was made, it must be done gradually, and also that the milk from cows on good pasture was permissible for the feeding of young children, and could be recommended. The congress did not, however, feel that there was unanimity in the proposals which had been made, so it was finally decided that a special commission should be appointed to draw up regulations for the veterinary control of milk, and to submit them to the next International Dairy Congress.

The following were elected to the special commission:—Poels, Rotterdam; Regnér, Stockholm; C. O. Jensen, Copenhagen; Martel, Paris; Trotter, Glasgow; Bougert, Berlin; Ostertag, Berlin; Winkler, Vienna; Zschokke, Zurich; Malm, Christiania; Happich, Dorpat; Fettick, Budapest; Fiorentini, Milan; with power to add to their number.

A recommendation was made to the milk associations of the various countries to appoint committees, which should work with the object of getting the control system introduced into all public and private ventures.

The fifth subject dealt with the supervision of the milkers and attendants, and the visiting of them in their homes by a regularly appointed medical man was urged. Cleanliness in the habits of dress of the milkers was also strongly recommended.

In the second section of the congress the subjects dealt with have a more practical and less scientific bearing, with the exception of the seventh subject, noted below. The sixth subject, for example, treated of what demands should be made in the case of new milk intended for direct consumption, of condensed milk, and of dried milk. The congress passed a number of strong recommendations, which, if they could only be carried out, would be of the greatest possible benefit to the consumer, but to the producer they would necessitate a heavy expense and a consequent increase in the cost of the milk.

Subject number seven placed before the section was a question dealing with analytical methods to be employed in testing milk and dairy products. In addition to the ordinary fat determination, and the taste and smell, it was advocated that a test for dirt should be made also the reductase test (Barthel), the fermentation test (Walter), and the leucocythemia test (Walter) and the catalase test. The alcohol boiling test and a determination of the acidity were also advised.

No unanimous resolution was adopted, but the general feeling of the congress seemed to be that the above-mentioned tests could be used with most satisfactory results, whether the milk was intended for direct consumption or for the manufacture of butter, cheese, &c.

The ninth subject, which dealt with cheese control, attracted a large amount of attention from representatives of countries exporting cheese. It was resolved by the congress that it should be left to the next congress to fix what can be regarded as the normal amounts of dry matter and fat in cheese. The permanent committee was charged with the task of undertaking the necessary preliminary work. It was also recommended that margarine cheese should not be made up in form of the ordinary types of commercial cheese.

The question of the training and instruction of the *personnel* of dairies was closed with an invitation to the societies of each nation to draw up methods and conditions of instruction.

Finally the congress resolved that it is absolutely indispensable, for the avoidance of misunderstandings, that in all dairy publications the metric units of measure and weight should be used, and for temperatures the degrees centigrade.

At the conclusion of the congress most of the members paid a visit to Orebro, where the twenty-first General Swedish Agricultural Exhibition was held. These exhibitions are held once in five years in different parts of Sweden. The show, somewhat spoilt by rain on the first day, was excellent. The members of the Dairy Congress had then an opportunity of taking part in one of four different excursions. Those who were interested chiefly in agricultural and educational matters visited Ostergötland and Scania, and were rewarded by a most interesting and instructive trip.

THE BRITISH PHARMACEUTICAL CONFERENCE.

THE forty-eighth annual meeting of the British Pharmaceutical Conference was held at Portsmouth on July 25–27 under the presidency of Mr. W. F. Wells. The presidential address dealt mainly with pharmaceutical legislation, incidentally directing attention to the fact that the laws regulating the practice of pharmacy in Germany and France afford better protection and greater privileges for pharmacists than the British and Irish laws. Mr. Wells deprecated the practice of Irish boards of guardians of purchasing drugs of inferior quality at competitive prices, and expressed the opinion that a large proportion of the damaged drugs imported from abroad went to public institutions, the governors of which paid more attention to price than to quality.

For the first time in its history, the meeting was this year divided into two sections, the "science section" and the "practice section." In the former section eighteen papers were contributed, the larger number of which were of purely pharmaceutical interest.

Mr. H. Finnemore and Mr. G. E. Town contributed a short note on *Bartsia odontites*, a very common wayside plant of the natural order Scrophulariaceæ. It is well known that this plant is avoided by cattle, and bearing in mind the haphazard methods in which our knowledge of the use of medicinal plants has emerged, and also the fact that plants botanically related often contain similar chemical constituents, it occurred to the authors that this relative of digitalis might possibly be worthy of pharmacological and chemical study. A quantity of the plant was extracted with alcohol, but Dr. Laidlaw, who tested the action of the solution on frogs, found that it had no poisonous or digitalis-like effect. A crystalline matter which separated from the alcoholic solution was identified as mannite.

Mr. H. J. Henderson described an experiment in peppermint culture in the shade. The plants were grown on the bank of a stream at Hitchin, and some of them reached a height of 50 inches; the stems were stout, and the leaves correspondingly large. It was found, however, that the lack of sunlight, due to the shadow cast by the trees on the opposite bank, prevented the production of the hairs bearing the oil cells, and reacted powerfully on the yield of oil, this being only 0·1 per cent. from the fresh herb. The yield of oil from ordinary plants grown on the same farm was 0·409 per cent.

Mr. E. H. Farr and Mr. R. Wright contributed a paper in which they described experiments carried out with the view of testing the accuracy of the statement, which is frequently made, to the effect that in the conversion of opium into extract or tincture the quantity of morphine shown by the official assay of a sample of opium is always greater than the amount found in the finished product. The authors find this statement to be correct. In seven samples of opium worked upon, the loss of morphine varied between the limits of 0·8 per cent. and 9·0 per cent. of the whole, with an average for the whole series of 4·78 per cent. The loss appears to be due to occlusion of the alkaloid, rendering its complete extraction by water or alcohol a matter of practical impossibility, or to some other factor which has hitherto escaped recognition.

Mr. H. Deane, in a communication on extract of Indian hemp, demonstrated the variability of this extract as supplied by the manufacturers. He suggested a modification of the official process of manufacture by which an extract consisting practically of pure resin would be obtained.

Mr. R. R. Bennett suggested that an iodine standard should be officially adopted for *Thyroideum siccum*. The majority of pharmacologists are agreed that the activity of thyroid is dependent upon the combined iodine present, but the author finds that the combined iodine present in commercial preparations varies considerably. The percentage of iodine in dry thyroid prepared from a series of sheep's thyroids obtained direct from the slaughter-house varied from 0·21 per cent. to 0·096 per cent., the average value being 0·158 per cent. The author thinks that an iodine standard of 0·15 per cent. might be adopted without unduly harassing the manufacturer.

Mr. John C. Umney contributed a note on *Podophyllum emodi*. At the request of the Indigenous Drugs Committee (Calcutta) he conducted a series of experiments upon the drug, collected under different conditions and at different seasons. He finds that the resin obtained from the rhizome collected after flowering is much richer in podophyllotoxin than the sample he examined some years ago, and that it contains about twice as much podophyllotoxin as the resin of *P. peltatum*.

A paper on the composition of diabetic foods, by Mr. F. W. F. Arnaud, gave rise to a vigorous discussion. The author gave the results of the analysis of twelve different samples of gluten bread and flours, the products of seven manufacturers, which showed that the products of one manufacturer alone were satisfactory. Nine of the products contained from 40 per cent. to 70 per cent. of starch. The author cannot confirm the statement, frequently made in advertisements, that the starch has been altered, either by the qualitative iodine test or the microscope. A sample of an expensive diabetic food was found to consist of ordinary flour which had merely been heated. In the course of the discussion it was suggested that the conference should take some action with a view to the repression of the sale of ordinary bread and flour as specially prepared diabetic foodstuffs, and it was finally decided to refer the paper to the executive with the object of considering whether the attention of the British Medical Association should be directed to the facts disclosed.

In a paper on white precipitate, Mr. G. D. Elsdon described a method for the estimation of mercury. He confirms the statement made on previous occasions that the sulphide method gives results that are sometimes too high, but contends that the process is, in respect to its accuracy, no worse than the others in general use, and is to be preferred on account of its speed and simplicity. He also described a method of analysing white precipitate ointment for the purposes of the Sale of Food and Drugs Acts.

Mr. H. Finnemore communicated a brief note on solution of sodium ethylate. This liquid becomes brown on keeping, the change in colour being due to the action of the alkali on the acetaldehyde present in absolute alcohol. The use of methyl alcohol in place of ethyl alcohol is suggested; a sample of solution of sodium methylate showed no trace of discoloration after two years.

Other papers read in the science section included a note on the constitution of commercial bismuth subchloride, by Mr. J. B. P. Harrison; notes on arsenates of strychnine and strychnine hypophosphite, by Mr. D. B. Dott; and a paper on the moisture and ash contents of medicinal extracts, by Messrs. K. C. Allen and T. Brewis.

In the Practice Section a paper on the education of the pharmacist was read by Dr. F. Beddow. He expressed the opinion that the present system of educating the pharmacist is not an ideal one from the teacher's point of view, since a large majority of students do little or nothing until they are old enough to sit for their final examination; they try to compress all their work into a few months, the result being a process of cramming. So far as possible, educationists would like to minimise the importance of the examination and increase the importance of the education; and in Dr. Beddow's view the proposed pharmaceutical curriculum (NATURE, February 23, p. 564) is a step in this direction, for it substitutes to some extent proof of education for examination.

A paper was also read by Mr. E. F. Harrison on secret and proprietary remedies, and at the close of the discussion a resolution was passed calling upon the Government to institute an inquiry into the sale of these products. The position of pharmacists under the proposed national insurance scheme was also discussed.

Sir Edward Evans was elected president for the ensuing year, and an invitation to hold the next meeting of the conference at Edinburgh was accepted.

THE SCENTS OF BUTTERFLIES.[1]

AMONG all the country sights of spring, summer, and early autumn, I suppose there is none more familiar than that of the common white butterflies. They are to be seen, as we know, everywhere; haunting woods, hedgerows, lanes and gardens, crossing heaths and meadows, and visiting at times not only parks and squares, but even streets in the heart of London. Of these insects there are in this country, as is no doubt known to many of you, three especially abundant kinds. One of these is the large cabbage white; the other two species are smaller. These two latter kinds are much alike when seen on the wing; but on a closer view they are easily distinguished, the most obvious mark of difference being the presence in one of them of greyish-green streaks, following the course of the so-called "veins" or "nervures," on the under surface of the hind wing. From this character the form in question gets its common name of the "green-veined white." If anyone will capture a male green-veined white (easily distinguished from the female by the much slighter spotting of the male's upper surface), and will brush the upper surface of the fore or hind wing with a camel-hair pencil, he will become conscious of a strong agreeable odour like that of the so-called "lemon-plant." On further examination he will find that this perfume emanates from the wings of the butterfly, and is strongly perceptible on the brush with which the wings were rubbed. The rubbing process has, of course, dislodged large quantities of the minute scales with which the wings of this insect, like those of butterflies and moths in general, are clothed; and these dust-like scales, adhering to the brush, have in some way or other carried with them the characteristic odour of the butterfly. A similar scraping or rubbing of scales from the under surface of the wings does not emit the odour, nor is it found in association with any scales from either surface of the female.

We find, then, that in this butterfly the perfume attaches to the scales in one particular situation, namely, the upper surface of the wings of the male insect. This fact obviously suggests that we should examine these particular scales in order to find out whether they present any differences from the scales which appear to be odourless. On applying the microscope to the scraping which carries the scent, we find at once an answer to our question. The great majority of the scales are of the ordinary well-known kind, consisting of an elongated flattened lamina, provided at one end with a short quill-like footstalk by which they are attached to the membrane of the wing, and frequently showing at the other extremity a more or less marked indentation. But among these will be found certain scales of an entirely different appearance. These latter scales in the insect before us are somewhat heart-shaped, carrying a long footstalk which ends in an almost circular disc, and tapering at the other extremity to a point. But the greatest peculiarity of these special scales is to be found in the plume-like structure which crowns their apical portion. Under a low power of the microscope the appearance is that of a tuft of fine transparent hairs, strongly suggestive of the vibratile cilia which are so familiar in animal and vegetable histology; but these hair-like processes, unlike the cilia, have no faculty of active movement, and under a high power they bear rather the aspect of minute tubes, in many cases seeming to be open at their free extremity. On examining a similar scraping from the under surface of the male, or from either surface of the female wing, we find only scales of the ordinary kind; the special "plume-scales," as they have been called, being invariably absent. Inasmuch, then, as the characteristic fragrance is found only in scrapings which contain the plume-scales, we are justified in concluding that these remarkable structures act as carriers of the perfume.

So far we have considered only one species of butterfly, the common green-veined white; but the question will naturally be asked—what about other butterflies, the other common whites, for example? Is this flowery perfume a peculiarity of one species only, or is the property of emitting a fragrant odour shared by other related insects? In order to answer this question, let us suppose that we make a series of trials on the second species of smaller common white, the small cabbage or garden white, as it is usually called. Here, again, no trace of a flowery odour is discoverable in the female or in scales from the lower surface of the wings in the male; but, as before, the upper surface of the wings in the latter sex will be found to be scented, and, also as before, the scent will be found to adhere to the scales removed by scraping or brushing from the upper surface. Examining the scented scraping microscopically, we find that here, too, are a number of plume-scales mixed in with scales of the ordinary type. These

[1] Discourse delivered at the Royal Institution on Friday, March 3, by Dr. F. A. Dixey, F.R.S.

plume-scales bear a family resemblance to those of the previous species, but are easily distinguishable from them. In fact, it is quite as easy, perhaps easier, to discriminate between the two species of the common white by comparing two scales measuring not much more than one-tenth of a millimetre in length, as it is to tell them apart by examining entire specimens of both insects.

We conclude, then, that the scent-producing function is essentially similar in the two kinds of smaller common white. But it is to be observed that the endowments of the two in this respect, though similar, are not identical. The scent of the green-veined white (*Ganoris napi*) is, so far as my experience goes, always present and easily recognisable, this being the reason why I chose it for first mention. But with the common garden white (*Ganoris rapae*), the case is different. You will probably find some male specimens with no appreciable scent at all; others with the scent so faintly developed that you may be doubtful about its presence; in none, probably, will the scent be nearly so strong as in the case of the green-veined white that we began with. Moreover, the character of the perfume differs. It has been not inaptly compared to sweetbriar, and it is at all events quite distinct from that of its near relation *Ganoris napi*. Extending our observations to the large cabbage white (*Ganoris brassicae*), we find a plentiful supply of plume-scales of quite a different aspect, these being very much longer, tapering gradually from base to apex, and showing none of the elegant heart-shaped outline that we saw in the other two species. The regularly disposed fringe or plume of the smaller whites is here also replaced by a kind of untidy bundle. These scales, again, are present only in the male, and only on the upper surface of fore and hind wing. What about the scent? It cannot be said to be entirely non-existent, but it is certainly the case that anyone of average olfactory powers may examine many male specimens of the large white without being able to detect any characteristic odour whatever. In some individuals, however, it is unquestionably present, though it is, as a rule, only to be appreciated with difficulty. But when detected it is like a faint whiff of violet powder, or, as has been happily suggested by Dr. Longstaff, orris-root.

There is in Africa a well-marked genus of white butterflies which goes by the name of Mylothris. The members of this group are in many respects much like the common whites of our own country; they are, however, as a rule somewhat brighter in appearance, many of them having a touch of vermilion, orange, or some shade of yellow at the base of the wings close to the body. This is more frequent on the under surface, but in many cases it is seen on the upper side as well. The genus also differs from our common whites in usually possessing a distinct marginal row of dark spots. The figures shown on the screen, which were photographed in colour from nature, were prepared for another purpose; they give, however, a good idea of the general features of the group.

Now all the species of Mylothris which I have had the opportunity of examining during life possess a strong and fragrant odour, which is developed under just the same conditions as in the butterflies we have already discussed. That is to say, it belongs to the male alone, and in that sex is confined to the upper surface of the fore and hind wings.

The scent of *Mylothris agathina*, a species which is abundant in many parts of Africa south of the Sahara, appears to me to be exactly that of sweetbriar. It is a good deal like that of our garden white (not the green-veined species), but very much more intense. Indeed, so powerful is it, that I have more than once perceived it when the butterfly was held in the hand at some considerable distance.

There is a pretty species of Mylothris which I found rather common at East London (South Africa). It has been named *trimenia*, after the distinguished naturalist who presided for many years over the South African Museum at Cape Town. It has a graceful, floating flight, and the hindwings in the male are of a delicate lemon-yellow. The general attractiveness of this insect is increased by its pleasant fragrance. This is quite different from the odour of its congener *agathina*, though at least equally powerful. It is not easy to describe, but may perhaps best be compared to the scent of sweet-pea or clover, with a suggestion of orange-peel or lemon. The females of both these species of Mylothris are destitute of odour. The curious shape of the male scent-scales, which is tolerably uniform throughout the genus, is shown in an outline diagram.

In a couple of months' time our country lanes will be enlivened by the presence of a butterfly known no doubt to many of you as the "orange-tip." This very pretty insect is much like one of our common whites, but may be distinguished by the elaborate green mottling of portions of the under surface—a feature of colouring which causes the butterfly to be almost invisible when it settles with closed wings on the head of an umbelliferous plant. This green mottling is found in both sexes, but the male has in addition a large patch of bright orange at the apex of the forewing. Whether this butterfly is scented I am unable to say, as I never happen to have had the opportunity of examining live specimens since I began to search for butterfly odours, but the male certainly possesses plume-scales of the same general character as those of the common whites, though differing, as will be seen by reference to the diagram, in points of detail. I should be glad to receive information as to its power of scent-production from any of you who may make the acquaintance of the butterfly during the coming spring.

Though I have at present no information on this point as to our English orange-tip, I have been able to test several foreign species which are somewhat like it in aspect, and are not very far removed from it in point of affinity. These belong to the genus Teracolus. One of these Teracoli, called *omphale*, common in Africa, has a scent which I compare to that of Philadelphus, commonly called "Syringa," or perhaps more exactly to that of the white lily, together with a more aromatic constituent suggesting at one time chocolate, at another, musk. A second African orange-tip, *Teracolus achine*, has a scent, not always present, which reminds me of honeysuckle. The scent of a third African species, *Teracolus auxo*, in which the general coloration is yellow instead of white, recalls that of jasmine or Philadelphus.

Closely allied to these tropical and subtropical orange-tips is a group in which the orange apical patch is replaced by a brilliant crimson. The South African representative of this group has a scent which comes nearest to the garden heliotrope, commonly called "cherry-pie." In yet another group we find, instead of orange or crimson, an apical patch of glossy purple. The only species of purple-tip which I have had an opportunity of examining in the living condition is also possessed of a sweet, flowery scent somewhat different from that of the last.

Many more examples of these perfumed white butterflies could be given, but I should only weary you by multiplying cases. For our present purpose it is sufficient to say that among the butterflies that are fairly close relatives of our common whites, the odours, though not universal, are very frequently present; that they vary much in character and intensity, though possessing in common an agreeable quality and a likeness to the perfume of certain vegetable products, particularly to the scent of flowers. They are almost without exception confined to the male sex, and to the upper surface of the wings, and they are almost invariably found in connection with the peculiarly specialised scales that we have learned to distinguish as "plumules." The only exception to the latter statement that I know of among this particular assemblage of butterflies is the yellow African orange-tip, *Teracolus auxo*, in which I find no plume-scales, though it has a flowery odour which in some specimens is really strong.

Apart, then, from a few possible exceptions, we have certainly established a relation between the presence of plume-scales and the emission of a flower-like odour. What is the nature of this relation? To answer the question let us examine the plume-scale itself a little more closely. This diagram shows a typical form of plume-scale taken from one of the common African whites, *Belenois thysa*. This butterfly, which somewhat recalls one of our common whites, though generally larger, and still more closely resembles *Mylothris agathina* lately mentioned, has a strong, sweet odour like that of roses. The scale consists of a flattened plate, or lamina, rounded at the base and sharp at the apex. At the middle of the base is attached a slender footstalk, at the end of which furthest from the lamina we find another flattened structure, in this species shaped like a cheese-cutter, which may be called the "accessory disc," or simply the "disc." From the apex of the lamina arise the cilia-like processes, which may conveniently be termed the "fimbriæ." This may serve as an example of a form of plume-scale commonly found in the white butterflies or Pierinæ, but the scale in all its parts is liable to considerable modification; and, indeed, it may be said with truth that in no two species are the scent-scales exactly alike. The diagrams will show how very diverse are the forms assumed by the plumules of these white butterflies; but in all of them may be observed under various shapes the lamina, fimbriæ, footstalk, and accessory disc. The scale is formed of chitin, a substance which constitutes the outer covering, or external skeleton, as it is called, of many insects, and which when met with in bulk is of a hard and horny consistence, as may be seen, for instance, in the forewings or "elytra" of beetles. Chitin is practically a dead material, and there is no trace to be found in the scale of any protoplasmic or living matter. The granules which are present are probably pigment granules, the presence of which in the ordinary scales imparts to the wings their characteristic colour. So far we have discovered no apparatus to which we may attribute the production of perfume.

But now let us examine the means by which the scale is attached to the membrane of the wing. The point, or rather surface, of attachment is the accessory disc, which fits into a cup-shaped depression in the wing-membrane, which cavity, however, is generally not large enough to admit the whole of the disc. In many species can be seen an orifice in that part of the disc which is enclosed, when the scale is *in situ*, within the cup-shaped cavity or socket just mentioned. And when the fimbriæ are examined with a very high power, an appearance is seen in many species which suggests that their free extremities are not closed, but open; that they are, in fact, minute tubes which put the interior of the scale into communication with the outer air. Now can we discover any means by which, say, a vapour entering the disc by the orifice in its buried portion can be conveyed through the scale and find its way out through the patent extremities of the fimbriæ? It certainly appears that we can. Within the disc there is generally visible a chitinous structure which often bears the appearance of a convoluted tube; the footstalk which forms a bridge between disc and lamina is apparently not solid, but pervious. The lamina itself consists of two delicate chitinous layers, one of which may be called dorsal and the other ventral, enclosing a flattened cavity which contains a certain amount of interstitial material. This latter takes various forms in different species, but very often presents the appearance of a longitudinal striation, which in all probability betokens the existence of fine parallel channels or passages traversing the interior of the lamina side by side from base to apex. This longitudinal striation is frequently obscured by the accumulations of granular pigment; but in many cases there is a comparatively clear area near the apex where the striæ can be fairly well made out, and where they can be seen to correspond in number and position with the individual fimbriæ. There is, then, much reason to suppose that the cavity of the lamina is more or less completely divided into channels which communicate in one direction with the fimbriæ, and so, through the orifices of the latter, with the outer air; and in the other direction through the footstalk with the disc, and so through the aperture of the disc with the socket of the wing-membrane and its underlying structures. We have, therefore, some warrant for considering the scale to be a piece of apparatus not indeed for the manufacture, but for the distribution of scent; and to get some insight into the mode of production of the latter, it is evident that we must pursue our researches into the structure of the wing itself.

It was noticed by Weismann more than thirty years ago, and more recently by Günther, that in the hypodermis, as it is called, or cellular layer immediately underlying the homogeneous surface-membrane of the wing, there occur certain cells which appear to be specialised for the production of a secretion. These cells were described and figured by Günther under the name of "Drüsenzelle," or "gland-cells." In this diagram, which is copied from one of Günther's figures, we see two of these "gland-cells" in direct connection with the sockets in the wing-membrane into which fit the footstalks of two scales partly seen in section. These scales are not plume-scales, for they possess no disc; but if secreting cells are found, as here, in connection with scales of the ordinary kind, there seems to be no reason why we should not also find them in relation with plume-scales, supplying in that position the living and working protoplasmic element by means of which the scent-bearing secretion is elaborated. The clear spaces in these cells of Günther's figure are rather suggestive of the oil or fat vacuoles seen especially in growing cells of adipose tissue; and it may be conjectured that the scent-bearing secretion is of the nature of a volatile oil. In the case of the ordinary scales the secretion may still be oily. Probably most of us know how difficult it is to wet a butterfly's wing with water. This is no doubt partly due to the mechanical conditions involved in the coating of minute scales, but it is possible that, as in the case of the plumage of aquatic birds, some additional power of resistance to wet is afforded by the presence of an oily secretion, which may be conveyed to the surface by the scales of ordinary character. It is also possible, as has been suggested by Weismann, that the secretion formed in connection with the ordinary scales may bear an odour, though of a different nature from that of the plume-scales, and, at least in many cases, imperceptible by our senses. All this is a matter of more or less probable conjecture, and it is very clear that there is a good deal more work to be done before we can be sure that we know all about the various functions of the scales and their associated structures.

Before we go on to the next part of our subject I should like to call your attention to some figures that will be thrown upon the screen of various forms of plume-scales. In these figures the chitinous sculpturing of the scale will be seen. It differs in character from species to species, but in all there is more or less visible a longitudinal striation of the lamina, which we have seen reason for interpreting as an indication of channels along which pass the odoriferous secretions or exhalations from the gland-cells buried in the substance of the wing to the fimbriæ and so into the open.

The question will no doubt have occurred: are these plume-scales the only structures by which the scents of butterflies are distributed? They are by no means the only ones. There are many other methods of distribution of these flower-like odours, some of which we can find without going beyond the group of so-called white butterflies, or Pierines. Visitors to the south coast of England in the late summer and autumn months can hardly have failed to notice a very active butterfly of a fine bright orange colour with a dark border, which is especially given to haunting fields of lucerne and clover. This is the butterfly commonly called the "clouded yellow," one of the most conspicuous of the whites, or, as we ought rather to say, the Pierine butterflies. In this insect we should search for plume-scales in vain; but on examining in a male specimen the front edge of the hindwing where it is overlapped by the forewing, we find on the upper surface a patch of scales distinguished from their surroundings by their lighter colour. The microscope shows that these scales are of a different shape from those of the rest of the wing, and are packed much more closely together; moreover, instead of lying nearly flat upon the wing, like the tiles on a roof, they are set up on end, sometimes almost at a right angle. When the wing membrane is denuded of scales and examined with a high power, the situation of the patch is easily recognisable by the crowding together of the sockets for the insertion of the footstalks, and also by the fact that tracheæ, or air-tubes, are seen to be leaving one of the main "veins" of the wing and supplying this particular area, breaking up into smaller branches as they go.

In ordinary circumstances the scent of the clouded yellow is not easily detected; but if in a living specimen the scales be scraped off one of the patches that have just been described, they will in many cases be found to have an odour which is somewhat like that of the garden heliotrope, or "cherry-pie." The South African clouded yellow, which is much like ours, though quite distinct, has a similar patch and a similar odour. The scent-producing apparatus in these clouded yellow butterflies presents many features of interest; in the first place, the scent-scales are crowded together into one small area, instead of being generally distributed over the wing-surface as in the common whites. Then the scales are quite unlike plume-scales, having neither fimbriæ nor accessory disc, while the footstalk is short and quill-like, instead of being long and flexible as in the plume-scales. They are, indeed, quite of the type of the ordinary scales, except that they differ a little in size and shape from the scales of their immediate surroundings. The distribution of tracheæ, or air-tubes, to the site of the scent patch is noteworthy, and so also is the fact that in ordinary circumstances the patch is covered by the overlap of the forewing, which acts like a sliding lid. It may reasonably be conjectured that this arrangement ensures economy of the perfume. The production of the scent is confined to a limited area, and its escape is prevented under ordinary conditions by the overlapping edge of the forewing. When emission of the scent is required, a slight separation of the fore and hind wings gives it exit. The special distribution of tracheæ may be a provision for pumping air into the patch from below, and so supplying a *vis a tergo* to assist the escape of the perfume.

Many other butterflies possess similar patches of scent-distributing scales. They are generally, though not always, so placed as to be covered up in the ordinary position of the insect. In some instances there are two patches on each side, one on the upper surface of the hindwing, the other on the under surface of the forewing, these being so arranged that they exactly cover one another when the butterfly holds its wings in the normal position. It is to be observed that in these patches the rule is for the scent-scales to be of the same general character as the ordinary scales of the wing, though they may differ much from the latter in shape, size, and arrangement. The patches seldom contain plume-scales, and, when fitted with a sliding lid, I believe it would be correct to say that they never do.

The question may be asked: is it not necessary that the scent should be economised in the case of the plume-scales quite as much as in the case of the definite patches? No doubt it is; and a little further consideration of the typical plume-scale may show us how this is effected. The plume-scales, it is true, being as a rule generally distributed over the wing, cannot be shut down under a lid; but they are frequently scattered among ordinary scales which are a good deal longer and larger, and which may act as coverings to the individual scales, though there is no general covering for the whole. Then again, as we have seen, the plume-scale has an accessory disc and a long footstalk. The disc with its internal chitinous structure may act as a reservoir for the scent; it will be remembered that in many cases it appears to contain a convoluted tube. The footstalk seems to be flexible, and it often shows one or more sharp bends in its course. These bends may impede the passage of the scent from the reservoir in the disc to the lamina and fimbriæ, and the butterfly may be able, by some movement of its wings, to bring about a straightening of the footstalk and a consequent liberation of the odour. At any rate, it is probably significant that the apparatus of accessory disc and long flexible footstalk belongs to the plume-scale alone.

There is a handsome butterfly, common in Africa, which is not far removed in affinity from our well-known "brimstone." This butterfly, which is known as *Catopsilia florella*, has in the male a strong fragrant scent. Now *Catopsilia florella* possesses on the hindwing a patch of special scales which is somewhat similar in aspect and position to the scent-patch in the clouded yellow. But, curiously enough, the characteristic scent appears to proceed, not from the patch on the hindwing, but from another structure altogether. This is a beautiful silky fringe of long hair-like scales which are set along the edge of the forewing on its underside, and are covered as a rule by the overlap of the hindwing. When the wings are parted and the fringe spread out, a scent is exhaled which appears to both Dr. Longstaff and myself to be like that of jasmine or tuberose. The portion of the wing which forms the seat of this silky fringe, as well as that underlying the scent-patch of the hindwings, is furnished, like the patch in the clouded yellow, with a plentiful supply of air-tubes, proceeding to it from the adjacent "vein." In the case of the patch in *Catopsilia florella*, the ramifications of these air-tubes seem to form a fine polygonal network, each mesh of which surrounds the socket of a scent-scale. A similar appearance may be seen in the scent-patch of one of the Teracoli (*T. fausta*), and probably in that of others.

Sessile scent-patches, which may or may not be accompanied by silky fringes, occur in many other species of the brimstone-like section of Pierines, and in several of these, including both Asiatic and American species, a flowery odour has been detected both by the late Mr. de Nicéville and by Dr. Longstaff. An observation which would be of great interest, but which, so far as I am aware, has not yet been made, would be to compare the odour diffused by the fringes with that conveyed by the sessile patches in those species where both these forms of apparatus occur together.

An accumulation of hair-like scales, no doubt serving as scent-distributors, may also be seen in another genus of Pierines (*Dismorphia*) which is remote in affinity from those butterflies which have just been considered. But these odoriferous tufts or fringes are by no means confined to the Pierines. In the very different group of Satyrines, to which our common brown hedgerow butterflies belong, the males of some species possess fringes or tufts which are clearly similar in function to those of their distant cousins, the Whites. In one of these, an African species, I found that the odour produced was like that of vanilla chocolate. Another species of the same genus, a native of India, was named by Wood-Mason and de Nicéville *suaveolens*, from its pleasant fragrance. The vanilla odour was found by the same two observers in several other Indian butterflies belonging to different groups.

Some Satyrines have plume-scales which are not unlike those of the Pierines, but differ in seldom, or perhaps never, possessing an accessory disc. At the utmost they may show a slight dilatation of the articulating end of the footstalk. Plume-scales much like those of the common browns are also found in the Fritillaries, which belong to the great group of Nymphaline butterflies.

There is yet another kind of scent-scale, specialised in form. This is the well-known "battledore" scale, present in the male of many of the small blue butterflies belonging to the subfamily of Lycænids. These battledore scales are provided with apertures on their general surface which no doubt serve, like the apertures of the fimbriæ in the plume-scales, for the escape of the odour into the outer air. The ribs apparent in the "battledore" are in all probability homologous with the longitudinal channels seen in the Pierine plume-scale. These in Mylothris, as we have seen on the screen, take the form of ribs as definitely marked as those of the Lycænids.

So far, all the scents with which we have been concerned are of a kind that is agreeable to our own senses. But there is another sort of odour which is also commonly present, especially in the butterflies of tropical and subtropical regions, and which, instead of being pleasant to the human sense, is disagreeable or even repulsive. The Acræas, which are mostly reddish or brownish butterflies with small dark spots; the Euploeas, large butterflies which often show a brilliant purple gloss like that of our own purple emperor; the Papilios, of which a good example is the black and yellow swallowtail butterfly of the Cambridgeshire fens, have many of them an odour which may be called disgusting. Musty straw, stable litter, rabbit-hutches, acetylene, bilge-water, these are some of the substances to which the odours of these unsavoury butterflies have been compared. In some cases, as in the instance of the agreeable perfumes, the seat of these evil-smelling odours has been found in patches or tufts of specialised scales or hairs; in others the scent appears to be emitted from the general wing-surface. But in no instance, so far as I am aware, has any structure like a plume-scale been found guilty of emitting anything but a pleasing fragrance. A very remarkable difference between the scents pleasant and the scents unpleasant is this: that the former kind usually, though not invariably, is confined to the male sex; while the latter kind is common to both sexes, being often, indeed, stronger in the female.

It has, no doubt, occurred to you to ask: has the presence of these scents any particular significance with regard to the needs of their possessors; and if so, what? And why should the agreeable scents be so commonly confined to the one sex, while the repulsive odours are shared by both?

The second question helps us to answer the first. With regard to the scents of the disagreeable kind, which are probably often accompanied by a nauseous flavour, there is good reason to suppose that they are in effect a means of protection from insect-eating enemies. We have much actual evidence bearing upon the point. Evil-smelling butterflies, like the Acraeas or the well-known *Limnas chrysippus* (a large brown butterfly common throughout many parts of Africa and Asia), are often conspicuous, slow-flying, and given to courting observation rather than to avoiding it. These are all marks of butterflies which are more or less immune from attack by birds; and it may be added that the frequency with which many of them are copied by other butterflies gives further reason for the conclusion that they enjoy protection in virtue of their distasteful qualities—a protection which other butterflies are enabled to share by resembling them in outward appearance.

Now, granted that the avoidance of attack by birds is the object of the repulsive scents, we should, of course, expect to find them present not in one sex only, but in both alike. And this is precisely what we do find; moreover, since it is well recognised that the preservation of the life of the female is more important than that of the male for the welfare of the species, we should expect that if there is a difference between the sexes in the intensity of the odour, that difference would be in favour of the female. This, again, is borne out by observation in a number of cases. Where both sexes are repulsive, the female, as a rule, is the more repulsive of the two, and therefore (as a consolation) the safer from attack.

So much for the odours unpleasant. Now let us turn to the other kind, the fragrant flower-like perfumes with which we dealt at the outset. These, we saw, are frequently associated with specialised scales which are the exclusive property of the male sex. We cannot say quite so much for the odours themselves, for though in the great majority of cases they belong to the males alone, yet the females are not left entirely destitute. Fritz Müller many years ago found evidence of sweet scent in a female white butterfly, and since then Dr. Longstaff has detected in the females of several species a fragrance not unlike that of the male, but usually much weaker. Still, we may certainly say, speaking generally, that the pleasant odours show a vast preponderance in favour of the male. This suggests that they must have some significance in regard to the relations between the sexes; and, indeed, there can be little or no doubt that, as was first pointed out by Fritz Müller, these scents are employed by the males in courtship as a means of attraction; they may also perhaps serve as a means of recognition. That their employment is occasional, and not constant, appears from the fact that they are so often furnished with a provision for keeping them confined until wanted. There is, so far as I am aware, no direct evidence that they are more plentifully liberated during courtship; but to anyone who has observed the persistent fluttering of white butterflies about and around each other under those circumstances, it can hardly fail to occur that the fanning wing-movements of the male must have the effect of encouraging the evaporation and diffusion of the odour; also perhaps of aiding its escape from the disc through the footstalk and so into the lamina of the plume-scale. The flowery scents would thus come under the head of those features which have been called by Prof. Poulton "epigamic": characters, that is, which, like the splendid plumage of some cock-birds, are believed to further the cause of matrimony. If this interpretation be correct, it is most interesting to find that the æsthetic preferences of butterflies in the matter of scents are so much like our own. In other insects, as well as in many of the higher animals, we find attraction exercised by odours that to our senses are disgusting. Butterflies themselves are not exempt from a depraved taste where food is concerned; the best bait for the purple emperor is well known to be a piece of putrid meat. But in matters of love-making, the butterfly seems to resort for his means of fascination to methods which recall the human lover with his gifts of flowers and boxes of vanilla chocolate.

The evil odours tend to be somewhat persistent. In some cases they may be detected for a long time after the butterfly is dead and stiff. The agreeable scents, on the other hand, are usually evanescent, becoming imperceptible very soon after the insect has ceased to live. On one occasion I was able to detect the lemon-plant odour of a green-veined white when the butterfly had been dead for eleven days, but this is probably an extreme case. Both kinds of odour may be present in the same species; when this is so, it is commonly found that the first impression given by the butterfly is a disagreeable one, the pleasant constituent only becoming apparent when its distributing apparatus is specially exposed. These cases of a double odour follow the same rule of repulsive scents being common to the two sexes, and agreeable perfumes being confined to the male.

This finishes what I have to say on the subject of the scents of butterflies. I am conscious that I stand in need of your indulgence; as, from the force of unavoidable circumstances, I have had but a short time in which to prepare this lecture. But, "qui s'excuse, s'accuse," and I trust that in spite of its sketchy and imperfect character the discourse to which you have just listened may have succeeded in quickening the interest that most of us feel in these very attractive objects of nature, and in giving fresh emphasis to the fact that the study of insects in general, and of butterflies in particular, is capable of shedding light upon questions of high importance in the science of biology.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Mr. Hugh Gunn, formerly Director of Education of the Orange Free State, has accepted an invitation from the Government of Western Australia to act as adviser and organiser for the university which that State is founding at Perth.

Mr. W. H. McMillan has been appointed to the newly founded chair of mining at University College, Nottingham. Prof. Heaton has been appointed principal of the college in succession to the Rev. J. E. Symes, who has resigned.

Among the bequests of M. Marino Corgialegno, a naturalised British subject, who died on April 26, are:—40,000*l.* to institute a school at Athens on the lines of Eton or Harrow, "sharing in the desire expressed to me by his Majesty King George that education in Greece should be rendered more perfect by the establishment of a public or secondary school upon the model of the English public schools, where boys will receive a regular course of teaching as well as of good breeding"; 40,000*l.* for a school for craftsmen at Argostoli, in the island of Cephalonia; 15,000*l.* for technical scholarships; 10,000*l.* each for a school for girls in Cephalonia, for schools or gymnasia in Argostoli, for a public library at Argostoli, for the Agricultural Society at Athens, for a polyclinical hospital in Athens, and for the Society for the Propagation of Useful Books.

The Educational Science Section of the British Association will meet at Portsmouth, under the presidency of the Right Rev. J. E. C. Welldon, Dean of Manchester. The president in his inaugural address, which will be delivered in the section on Thursday, August 31, will treat of educational problems of the day. His address will be followed by a discussion on the overlapping between secondary schools and universities and other places of higher education, which will be opened by Prof. A. Smithells, F.R.S., and Prof. R. A. Gregory. On Friday, September 1, there will be a discussion on the place of examinations in education, with papers by Mr. P. J. Hartog, Miss Burstall, Dr. T. P. Nunn, and Mrs. Dr. White. The discussion will be opened by Mr. A. A. Somerville and Mr. W. D. Bentliff. A discussion on grammatical terminology will be opened by Prof. E. A. Sonnenschein and Mr. P. Shaw Jeffery. On Monday, September 4, the subcommittee on mental and physical factors involved in education will present its report, which will deal with the question of feeble-mindedness in children. There will be a discussion on the diagnosis of feeble-mindedness, with papers by Dr. Abelson, Dr. C. W. Saleeby, and Dr. Tredgold, followed by a discussion on the education of feeble-minded children, with papers by Mrs. Burgwin, Miss Dendy, and Dr. Auden. Prof. J. A. Green will also read a paper on backward children. On Tuesday, September 5, there will be a discussion on practical education in the Dockyard and Naval Schools, with papers by Mr. George Dawe, headmaster of the Dockyard School, and Mr. W. H. T. Pain, of H.M.S.

Fisgard. The discussion will be opened by Dr. C. W. Kimmins. A paper on the study of German will also be read by Mr. G. F. Bridge, and a paper on school books and eyesight by Mr. G. F. Daniell.

A "MEMORANDUM on Physical Training in Secondary Schools" has just been issued by the Board of Education, and is obtainable from Messrs. Eyre and Spottiswoode, price 2*d*. That physical education at the secondary-school age is of primary importance scarcely needs to be insisted on, but it is well to have the large generalities of such education set forth, as here, in a coherent exposition. The secondary school covers the adolescent age of boys and girls—the age when growth is very rapid and the transit to manhood and womanhood demands all the care and knowledge that the best informed teacher can provide. The present memorandum does take some account of this, but does not emphasise it quite so much as the trainers of male and female youth might properly expect. Under the "objects of physical training"—it is a pity that the term "physical education" is not uniformly used—Sir George Newman gives a good summary of the nervous basis of training and the value of training in promoting "habits of discipline, obedience, ready response, and self-control." Doubtless, physical education, being a special department of mental education, *can* be used to generate such "habits"; but why insist on the merely passive aspect of education? The end of education is not to produce habits of obedience or ready response except as means to the greater end of personal self-sufficiency and independence of character. Self-development is as important as self-control, and presupposes it. But Sir George Newman is not unaware of this, for he says, "undue emphasis should not be laid upon the disciplinary effects of physical training." He justifies the Swedish system on the whole. He gives general directions as to length of lessons, the place of physical education in the time-table, and the qualifications of the teachers. "Especially as regards children and young people, physical training is not a mere matter of technical expertness." "Girls should, of course, be taught by women." Any system should be practised under the general supervision and with the constant cooperation of the medical officer of the school. The memorandum is really a memorandum, and should be to every secondary-school teacher a constant reminder of the principles and risks of physical education.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, July 24.—M. Troost in the chair.—H. **Deslandres**: Remarks on the movements of the solar prominences. The author regards the upper layer of the solar atmosphere as being ionised and under the action of a magnetic field. This field causes movements in the solar ions, especially those rising and falling. The theory explains easily all the observed peculiarities of the velocity of rotation in the prominences and the upper layer. In the present paper some further consequences of this theory are developed, and a scheme of research suggested for its control.—A. **Laveran** and M. **Roudsky**: Concerning the action of oxazine (triaminophenazoxonium chloride) on trypanosomes. The selective action of the centrosomes of the trypanosomes for oxazine, noted by Werbitzki, takes place both *in vitro* and *in vivo*. The disappearance of the centrosomes in *T. brucei*, and the fact that this morphological modification can be transmitted by heredity, is confirmed. Other species are similarly affected, but to varying degrees. The virulence of the trypanosomes submitted to the action of oxazine is reduced.—R. **Zeiller**: A Triassic flora discovered at Madagascar by M. Perrier de la Bâthie.—Emile **Belot**: The period of rotation of Venus. The observed period of rotation of Venus has been recently given by M. Bigourdan as twenty-nine hours. The author points out that in a communication to the academy in 1906 he gave a general formula from which this period was deduced to be 28h. 12m.—M. **Giacobini**: Observations of the Brooks comet (1911*c*) made at the Observatory of Paris. Data given for July 22 and 23. The comet appears as a rounded nebulosity 35″ to 45″ diameter, with a well-defined central nucleus. Magnitude 11·5 to 12.—L. **Picart** and F. **Courty**: Observations of the Brooks comet (1911*c*) made at the Observatory of Bordeaux with the 38 cm. equatorial. Data given for July 22 and 23. Comet showed a clear nucleus about tenth magnitude.—Witwold **Jarkowski**: An approximate law for the ascent of an aëroplane.—Marcel **Brillouin**: Polymorphism and molecular orientation.—G. **Sagnac**: Some paradoxes concerning the optical actions of the first order of the translation of the earth.—A. **Cotton**: Circular dichroism and rotatory dispersion.—G. **Bruhat**: The study of rotatory dichroism of a definite organic compound (diphenyl-*l*-bornyldithiourethane).—E. **Besson**: The asymmetry of the positive and negative ions relatively to the condensation of water vapour. An attempt to record photographically the results described by C. T. R. Wilson.—H. **Buisson** and Ch. **Fabry**: The amount of energy necessary to produce the unit of luminous intensity. Working with a Heraeus quartz mercury vapour lamp, the number of watts radiated per mean spherical candle was found to be 0·31 for the violet (4538), 0·018 for the green (5460), and 0·031 for the yellow (5780).—M. **Herschfinkel**: The action of the radium emanation on thorium salts.—Ettore **Cardoso**: The densities of the coexistent phases (orthobaric densities) and the diameter of sulphur dioxide in the neighbourhood of the critical point. Part of a series of researches on the law of the rectilinear diameter at temperatures near the critical point. The influence of agitating the liquid under experiment is clearly shown in the results.—L. **Tchougaeff** and P. **Koch**: An anomaly of the molecular refraction in the series of the substituted gloximes.—L. **Gay**: The notion of an expansibility pressure.—Victor **Henri**: Study of the ultra-violet radiation of quartz mercury vapour lamps. The ultra-violet rays from a mercury lamp increase very rapidly with the watts used, this increase being especially rapid in the neighbourhood of 209 watts. The action on citrate of silver papers is parallel with the bactericidal action upon the coli bacillus, and the yield of such a lamp when used for sterilising purposes may be very conveniently controlled by such papers.—G. **Massol** and A. **Faucon**: The latent heat of fusion and specific heat of the fatty acids. The discrepancy previously noted between the latent heats of fusion and solidification of formic, acetic, and propionic acids is now shown to occur with lauric acid. The possible causes of this difference are discussed.—G. **Darzens** and F. **Bourion**: The action of thionyl chloride upon metallic oxides. In numerous cases in which the action of thionyl chloride upon metallic oxides was studied the chloride behaved as a mixture of chlorine and sulphur dichloride. Since the latter is easier to prepare and purify, its use for chlorinating oxides is preferable.—Marcel **Guichard**: The extraction of the gases from copper by a chemical reaction, and the estimation of oxygen. Methods are described for converting copper either into the iodide or oxide, and recovery of the gases contained in the metallic copper. The limits of error of the two methods are indicated.—Georges **Dupont**: The catalytic preparation of some substituted ketohydrofurfuranes. Some examples of the hydration of some acetylenic pinacones by the catalytic action of a dilute solution of mercuric sulphate.—Frédéric **Reverdin**: The nitration of the ortho-, meta-, and para-nitrobenzoyl-*p*-anisidines.—Marcel **Delepine**: The sulpho-ether salts or thionic esters R.CS.OR′.—H. **Colin** and A. **Sénéchal**: The action of acids on the catalytic oxidation of the phenols by ferric salts.—R. **Locquin**: α-Methyl-laurenone, a new ketone derived from camphor. Baeyer and Villiger have shown that one of the products of Caro's reagent on camphor is a lactone, $C_{10}H_{16}O_3$. A compound $C_9H_{14}O$ has been isolated in the course of researches made to determine the constitution of this lactone, and this compound is shown to be a tetramethyl-*cyclo*pentenone. It is a methyl derivative of the laurenone previously described by Tiemann.—Th. **Nicoloff**: The ovule and the embryonic sac of the Plataneæ.—A. **Guilliermond**: The formation of the chloroleucites at the expense of the mitochondria. P. A. **Dangeard**: Complementary chromatic adaptation in plants. A. **Magnan**: The digestive surface of the ventricule and the muscular arrangement of the gizzard in birds.—Jacques **Pellegrin**: The distribution of the soft-water fishes in Africa.—Paul **Marchal**: Spanandria and the obliteration of sexual reproduction in Chermes.—M. **Bordas**: Considerations on the reagents employed for the determination of blood stains in legal medicine. Remarks in confirmation of the views put forward in a recent paper by A. Sartory on the unsatisfactory nature of various colour reactions in use for the detection of blood stains.—Y. **Manouelian**: Researches on the pathogeny of arterio-sclerous lesions.—L. **Launoy** and C. **Levaditi**: Mercurial treatment of experimental syphilis of the rabbit and of Brazilian spirillosis.—Albert **Berthelot**: Researches on the intestinal flora. Isolation of the micro-organisms which specially attack the ultimate products of the digestion of proteids.—Em. **de Martonne**: The principles of morphological analysis of erosion levels applied to the Alpine valleys.

CALCUTTA.

Asiatic Society of Bengal, July 5.—B. C. **Mazumdar**: The Stambhesvari. Mr. Mazumdar identifies the goddess Stambhesvari, whose name is to be found in the copper-plate inscriptions of Kulastambhadeva and Ranastambhadeva, with a goddess still worshipped by some aboriginal tribes.—D. **Hooper**: Phosphorus in Indian foodstuffs. This paper is the result of an inquiry, made in collaboration with Major E. D. W. Greig, into the diet of patients suffering from epidemic dropsy in Calcutta in 1909–10. The amount of phosphorus in the form of phosphoric anhydride is given in several samples of rice, wheat, and other cereal grains, as well as in animal foods, farinaceous foods, vegetables, nuts, and fruits consumed in India.—W. **Kirkpatrick**: Folk songs and folk lore of the Gehara (Kanjars).

CAPE TOWN.

Royal Society of South Africa, June 21.—Dr. Marius Wilson in the chair.—E. P. **Phillips**: A note on the principal systematic work and publications dealing with the South African Proteaceæ. The first recorded publication of a member of this order was by Clusius in 1605. In 1720 Boerhaave attempted a systematic study of the order, but it was not until 1809 that a really scientific monograph was published by Salisbury; in the following year appeared the classic work of Robert Brown. The standard work on the order is a monograph by Dr. Meisner, which appeared in De Candolle's "Prodromus" in 1856, where 279 species are described. The writer undertook to revise the order, and has recorded between 300 and 400 species of the genera Diastella, Salisb., and Orothamnus. Pappe, sunk by Meisner, have been re-established, and one new genus, Spatallopsis, Phillips, founded.—J. **Moir**: The spectrum of the ruby, part ii., and the artificial ruby. By examination of the ruby with better instruments, the complete spectrum of eight hair lines has been discovered; they are best seen in the artificial ruby, which is identical with the natural ruby in all respects, and when free from flaws is actually superior to the natural gem.—J. **Moir**: Notes on the spectrum of the precious emerald, and other gem stones. The emerald spectrum contains three very distinct hair lines in the red. Sapphires have no hair lines in their spectrum. Artificial emeralds are green sapphires, and have an indefinite spectrum, as is also the case with the following:—rubellite, spinel, amethyst, fluor, aquamarine, rose-quartz, lepidolite, and topaz. The almandine spectrum has been re-examined.—J. R. **Sutton**: A note on the land and sea breezes of South Africa.

FORTHCOMING CONGRESSES.

AUGUST.—Centenary of the Foundation of the University of Breslau.

AUGUST 12–18.—First International Congress of Pedology. Brussels. President: M. Alexis Sluys. Secretary: M. Vital Plas, 35 Avenue Paul de Jaer, Brussels.

AUGUST 13-[illegible].—Prehistoric Society of France. Nimes.

AUGUST 31–SEPTEMBER 6.—British Association. Portsmouth. President: Sir William Ramsay, K.C.B., F.R.S. Address for inquiries: General Secretaries, Burlington House, W.

SEPTEMBER 4–6.—Centenary of the University of Christiania. President of Festival Committee: Prof. Brögger.

SEPTEMBER 9–20.—International Congress of the Applications of Electricity. Turin. President of the Committee of Honour: H.R.H. the Duke of the Abruzzi. Honorary Secretary of the Committee: Signor Guido Semenza, Via S. Paolo 10, Milano. International Secretary: Col. R. E. Crompton, C.B., R.E., Crompton Laboratory, Kensington Court, W.

SEPTEMBER 12–15.—Celebration of the Five-hundredth Anniversary of the University of St. Andrews.

SEPTEMBER 18–23.—International Conference of Genetics. Paris. President: Dr. Viger. Secretary: M. Philippe de Vilmorin.

OCTOBER 2–7.—Third International Congress of Hygiene. Dresden. General Secretary: Dr. Hopf, Reichsstrasse 4, Dresden.

OCTOBER 12–18.—Italian Society for the Advancement of Science. Rome. President: Prof. G. Ciamician. General Secretary: Prof. V. Reina, Via del Collegio Romano 26, Roma.

OCTOBER 15–22.—Tenth International Geographical Congress. Rome. President: Marquis Raffaele Cappelli. General Secretary: Commander Giovanni Roncagli, Italian Geographical Society, Rome.

DECEMBER 27.—American Association for the Advancement of Science. President: Dr. C. E. Bessey, University of Nebraska. Permanent Secretary: Dr. L. O. Howard, Smithsonian Institution, Washington, D.C.

CONTENTS.

THURSDAY, AUGUST 10, 1911.

GYMNOSPERMS.

Morphology of Gymnosperms. By Prof. J. M. Coulter and Prof. C. J. Chamberlain. Pp. xi+458. (Chicago: The University of Chicago Press; London: Cambridge University Press, 1910.) Price 16*s.* net.

In 1901 Profs. Coulter and Chamberlain published a short treatise on the Gymnosperms, forming the first volume of their "Morphology of Spermatophyta." Their present work takes the place of this volume, and is practically a new book, designed on a far more liberal scale than its predecessor. The number of pages has grown from 188 to 458, and the illustrations have increased in an even greater proportion. The extension of the book is in no small degree due to the original researches of the authors and their pupils; the special contributions from the Chicago laboratory have amounted to twenty-six since 1901.

"The present account, therefore, is based upon our own work, supplemented by the work of other investigators, rather than a compilation from literature, supplemented by occasional personal observations" (preface).

A striking feature of the book is the prominence now given to palæobotanical evidence.

The book is an invaluable record, admirably illustrated, of our present knowledge of the older type of seed-plants; on reading it one is enabled to realise in what respects essential progress has been made, and where, in spite of the accumulation of detail, there has been little real advance. The latter, less favourable position exists, in the reviewer's opinion, in respect of the Conifers, in which the most fundamental points of morphology and affinity still remain obscure.

The book begins with an account of the Palæozoic class, Cycadofilicales, a name which the authors prefer to the more modern designation, Pteridospermeæ, now generally adopted in England and France. The authors are certainly well-advised to include a description of the Pteridosperms in their book, though some botanists have thought it best to keep these fern-like seed-plants of the Palæozoic apart from the Gymnosperms, on the ground of their manifestly primitive characters. In this book there is a tendency to minimise the peculiar features of the Pteridosperms, which mark them off as an archaic group. The entire absence of anything approaching to a strobilus separates them, among other characters, from all Gymnosperms except the female plant of Cycas. In any case, however, the close relations between the seed-ferns and the true Gymnosperms are undisputed and of fundamental importance.

The Cycadofilices were recognised as a distinct group before their reproductive organs were discovered. The authors scarcely do justice to this rather impressive instance of the successful use of anatomical characters in determining systematic position; they say:—

"The striking anatomical feature of the Cycadofilices is the association of secondary wood with a fern-like vascular system. There was no occasion, on this account, to remove Cycadofilices from Pteridophytes" (p. 2).

No one who knew Williamson's work was likely to found a new group on such a basis; other considerations, as, for example, the close agreement between the leaf-trace strands of Lyginodendreæ and those of Cycads carried much more weight; the authors appear in this instance not to have consulted adequately the original memoirs. They do full justice, however, to the importance of the work done in recent years on morphological anatomy, especially that of the vascular system:—

"Vascular anatomy has emerged as a subject organised upon a morphological basis, and its value in supplementing the older morphology cannot be overestimated" (p. 4).

Though open to some criticism in detail, the account given of the Pteridosperms is on the whole an excellent summary, and will be welcomed by readers who are not familiar with special works on palæobotany.

The interesting question of the constant absence of an embryo in all Palæozoic seeds hitherto investigated is discussed. This has been regarded as the normal condition, the development of the embryo not having begun until after the seeds were shed, and then having passed over at once into germination. The authors, on the other hand, incline to the view that all Palæozoic seeds investigated were abortive, having been shed prematurely. The fact that nearly all the seeds observed are at the same stage of development, and the usual presence of normal pollen in the pollen-chamber scarcely seem consistent with this view.

The remark that the seeds of Pteridosperms

"are very far from being primitive in structure, and are no more suggestive of the origin of seeds in general than are the seeds of existing seed-plants" (p. 34),

appears just, and indicates how much remains to be learnt in this field.

In discussing the relations of the Pteridosperms to the ferns it is pointed out that "Filicales are probably so ancient that all of our evidence is relatively modern" (p. 55).

"The gap between the homosporous Primofilices (or their unknown ancestors) and the seed-bearing Cycadofilicales is an enormous one, including the evolution of both heterospory and the seed" (p. 57).

The authors divide Gymnosperms into Cycadophytes and Coniferophytes (the latter name too glaringly hybrid to be acceptable). They include the Cycadofilicales in the former, which is not Nathorst's arrangement, as erroneously stated on p. 59. The two great phyla are regarded as "both differentiating from the Cycadofilicales or each arising independently from the progenitors of the Cycadofilicales" (p. 59). This is a little confusing, for on the former alternative the Cycadofilicales would have differentiated from themselves. It would have been better to leave the Cycadofilicales (Pteridosperms) as an independent ancestral group, lying at the root of all the other branches.

Chapter ii. is devoted to the Bennettitales, the characteristic Mesozoic Cycadophytes, remarkable for their anticipation of the angiospermous flower.

The authors have been misled by the synonymy in one instance, for they describe *Williamsonia angustifolia* and Wielandiella as distinct plants, whereas they are merely two names for the same thing (pp. 66 and 86). A more serious error is the statement that Nathorst confirms the view that the flowers of the Yorkshire Williamsonias are *bisporangiate* strobili (p. 76). Nathorst's conclusion is that these flowers were monosporangiate (unisexual).

The derivation of the Mesozoic Bennettitales from the Palæozoic Cycadofilicales will be generally accepted, but the statement that "the bisporangiate character of the strobilus is probably to be explained by the bisporangiate character of the fronds of those Cycadofilicales which gave rise to Bennettitales" (p. 87) is more open to question. We have at present no evidence of the existence of bisporangiate fronds in the Palæozoic group; neither is it necessary to assume their existence in order to explain the association of stamens and carpels in the same flower.

Chapter iii., on the Cycadales, is no doubt the best account we have of this important and fascinating family. A large number of original observations, by members of the Chicago School of Research, are embodied, and there are some very fine new figures.

Dioon edule, a Mexican Cycad, said to attain an age of 1000 years, has now been added to the list of species in which fertilisation by motile spermatozoids has been observed.

The statement that the Cycadales are "probably not so old as either the Ginkgoales or the Coniferales" may need revision. Our records are scanty, but carpels scarcely distinguishable from those of recent species of Cycas are known as far back as the Lias.

In the chapter on the Palæozoic Cordaitales there is not much room for novelty, for here our knowledge has advanced but slowly of late. The current views of their affinities are adopted. The related phylum of the Ginkgoales (chapter v.), of which there is only one survivor, the maidenhair tree, is regarded as retaining certain primitive features in common with the Cycadophytes, while it has advanced more in the direction of the Coniferales, and has developed certain peculiarities of its own (p. 217).

Chapters vi. and vii. are on the Coniferales, which, from their extent and variety, naturally demand a fuller treatment than any other group. The account given is excellent, and contains much of interest, but one realises that the Conifer problem still remains to be solved.

The class is divided into Pinaceæ and Taxaceæ, but it is very doubtful whether even this first grouping is natural, for the Podocarps among the Taxaceæ seem to have little to do with the Yews, while they have much in common with the Araucarians among Pinaceæ.

Perhaps too much is made of the supposed special antiquity of the Abietineæ (firs). The arguments in support of the primitive nature of this tribe are not altogether convincing.

In stating that the Taxaceæ have not been recognised further back than the Cretaceous (p. 349), the authors ignore Nathorst's suggestion that the Rhætic genera Stachyotaxus and Palissya may be early representations of the Podocarps.

The heterogeneous group of the Gnetales forms the subject of chapter viii. We think that more stress might have been laid on the possible affinity, originally suggested by Wieland, between Welwitschia and the Mesozoic Bennettitales. The hermaphrodite flowers and monadelphous stamens occurring in Welwitschia are striking points of agreement with the extinct group.

The account of the three extremely diverse genera which make up the Gnetales is of much interest, and contains various details hitherto not readily accessible to the student. The relationship of such isolated types, with no known fossil history, necessarily remains obscure.

The final chapter, on "Evolutionary Tendencies among Gymnosperms," previously published in part as a separate paper, sums up the main results. The diagram on p. 409 gives a good idea of the probable evolutionary connections of the various groups, though in one or two points it is not quite consistent with the statements in the text. Though the reviewer does not agree with quite all the authors' conclusions, he is in entire sympathy with their principle that

"the relative position of any form in a scheme of classification can be determined only by averaging all its characters; and its relative age in a scheme of phylogeny can be determined only by the sure testimony of history" (p. 425).

D. H. S.

THE EVOLUTION OF OUR ISLANDS.

The Building of the British Isles, being a History of the Construction and Geographical Evolution of the British Region. By A. J. Jukes-Browne, F.R.S. Third edition, rewritten and enlarged. Pp. xv + 470. (London: E. Stanford, 1911.) Price 12*s*. net.

THIS new edition of Mr. Jukes-Browne's well-known book makes it virtually a manual of the geology of the British Isles. The photographic illustrations bring the relations of the rocks clearly home to us, and many of them are works of art, such as Prof. Reynolds's view of chalk and lavas at Garron Point (Fig. 61), and Mr. R. F. Gwinnell's Miocene folding at Lulworth (Fig. 63). The numerous maps, suggesting the relations of land and water at various epochs, suffer, as all such maps must do, from our ignorance of details. The sweeping boundaries of continents and the generalised forms of firths and sounds are perforce unlike anything that we now know upon the earth. Printed explanations on the maps would greatly aid the reader, such as "area of Bunter pebble-beds," "Lake-basin," and so forth. There is a mysterious dotted line on Fig. 19, for which one must search the text, while much guidance is required for the lines and colours on Fig. 57. The result may, however, be regarded as happy, if the casual reader is sent through a lengthy chapter, to find there a summary of the latest researches, and evidence of a critical mind that looks eastward across Europe. Mr. Jukes-Browne does not hope to satisfy everyone. He gives us a marine Lower Devonian series across south-west Ireland (Fig. 19), the Glengarriff Grits being supposed to represent the deposits of a land-locked bay. He carries the Upper Senonian sea (Fig. 53 and p. 333) boldly into Scotland, Wales, and central Ireland, though flints are scarce in the surface-deposits of some of the areas thus invaded, and though they are not likely to have been carried away by subsequent marine action (compare p. 426). The rapidity of the oscillatory movements in Cretaceous times is properly insisted on, if we are to regard the chalk as a deep-water rather than merely as a pure-water deposit.

The consideration given by the author to the conditions under which successive series were formed is well seen in his comparison of the Bunter pebble-beds with the alluvium of the Helmand River (p. 234), or in his very interesting discussion of the Pliocene and Pleistocene deposits (pp. 404–61). The references to recent literature show how keenly he has watched the progress of research. We thus have Mr. Hickling's views on the Permian affinities of the outliers of sandstone near Dumfries, which are often supposed to be of Triassic age (p. 208); Prof. Watts's suggestion (p. 379) of the Eocene age of igneous rocks in the English Midlands; and Mr. Bernard Smith (p. 237) on the "skerries" of the Keuper marls. Anyone who has become attracted by the varied surface of our islands, or even by the scenery of a single county, will find his views enlarged when he follows Mr. Jukes-Browne into the past. He will at once feel the complexity of the subject, and the vast range of the events that have determined the present forms of hill and dale. After reading a few pages, a healthy reaction sets in against the superficial physical descriptions in which we all are liable to indulge. No one can read "The Building of the British Isles" without becoming again a student. The author's expressions of personal opinion will stimulate inquiry rather than remove all doubt. This is the manner of the true scientific teacher, and we feel that Mr. Jukes-Browne has made new claims on our regard.

To enjoy a book so full of detail, one must see and remember the country it describes. In ten years, in holidays of a few days at a time, the geologist may learn a great deal of the aspect of our islands. To anyone who has happily crossed the open country, from the rocky coves of Cornwall to the heather-covered slopes above the Moray Firth, or from the sunlit dunes of Donegal to the grey mud-flats near the Nore, these pages will make a singular appeal. Perhaps we may read into the book a good deal obtained from other sources, since it presupposes a general knowledge of the great tectonic movements that have affected the European area. In spite of what we have said, it is intended primarily for the geologist.

Every British or Irish geologist, moreover, will find points that he will like to criticise. Why, for instance, should stratified gravels be difficult to understand (p. 440) on the hypothesis that they result from the washing of boulder-clay? Does not the melting ice supply the very agent for their stratification? A "very deep basin" would not be required (p. 128) for the accumulation of the Cornstone series in Wales, but only a continuously subsiding floor. The omission of the Snowdon area from the description of the Ordovician rocks of North Wales seems surprising (pp. 68 and 69), and no stranger would suspect the immense part played by volcanic action in originating the scenery between the Conwy and Llanberis. Other geologists, however, must now enjoy the book, and discover their particular grievances to the author, who has done so much to help them. G. A. J. C.

TECHNICAL THERMODYNAMICS.

Applied Thermodynamics for Engineers. By Prof. W. D. Ennis. Pp. viii+438. (London: Constable and Co., Ltd., 1910.) Price 24*s*. net.

THIS is by far the most comprehensive book published in the English language on the subject of technical thermodynamics. It contains an account, brief but lucid, of the transformations of heat and mechanical energy which occur in almost every conceivable industrial process. As evidence of this widespread treatment, it is only necessary to mention that among the processes discussed are the development of power in the internal combustion engine, in the steam engine, in the hot-air engine, air and gas compressors, distillation plant, mechanical refrigeration, fusion and liquefaction of gases. To the discussion of these various topics Prof. Ennis brings experience gained in the mechanical engineering side of the Polytechnic Institute of Brooklyn, and it is clear that in his study of these problems he has made a digest of recent work on the subject of gases and vapours. His style of writing is graphic, forceful—but eccentric in so far as he seems actually to seek opportunities for splitting the infinitive; in fact, he does so no fewer than four times in the first five pages of the book, and after that we gave up counting.

A useful feature is the appendage to each chapter of a brief synopsis of its contents, together with a bibliography of the authorities quoted. Problems are added for the use of students, but the author does not commit himself to their solution, a cautious step in a first edition.

Prof. Ennis's immediate aim is expressed in the following words:—

"Thermodynamics is physics, not mathematics or logic. This book takes a middle ground between those text-books which replace all theory by empiricism and that of the other class of treatises which are too apt to ignore the engineering significance of their vocabulary of differential equations. We here aim to present ideal operations, to show how they are modified in practice, to amplify underlying principles, and to stop when the further application of those principles becomes a matter of machine design."

The author may fairly be said to have carried out these intentions successfully, in spite of the necessarily considerable labour which must have gone to the compilation of so compressed a treatise.

It is not possible to discuss at length the methods followed by the author even in a section of the subjects he deals with, but some call for passing notice. Thus, he introduces early the idea of increasing specific heats of gases, and uses a formula of the form $k=a+bT$, which he applies to the calculation of entropy. He shows that when expansion follows the path (called a "polytropic" path) $pv^n=$ constant, the rate of heat absorption or emission is directly proportional to the temperature change, and the author therefore deduces that the "specific heat" *must* be constant along any such path. This seems confusing when it is realised that this particular proof rests on the hypothesis of a constant specific heat, but investigation shows the confusion to be due to a somewhat loose use of the term "specific heat." This may prove a stumbling-block to some readers. After a careful and necessarily compressed account of the basic thermodynamic laws, the author gives an account of the properties of entropy, and of the limitations to be observed when non-reversible cycles are being studied. He rightly points out that many of the most important engineering processes are not even "cyclic," to say nothing of their not being "reversible." He remarks—

"A careful distinction should be made at this point between the expression $\int\frac{dH}{T}$ and the term 'entropy.' The former is merely an expression for the latter under specific conditions . . . perhaps the most general statement possible for the second law of thermodynamics is that all actual processes tend to increase the entropy; as we have seen, this keeps possible efficiencies below those of the perfect reversible engine." He concludes, however, that "most operations in power machinery may, without serious error, be analysed as if reversible; unrestricted expansions must always be excepted. The entropy diagram to this extent ceases to have an automatic meaning."

We seem here to be getting nearer to the desired harmony between the various views, as to the nature of entropy and its utilisation, which have been expressed in the past. Brief as the author has found it necessary to make his description of the action in a gas producer, he has been able, we are glad to see, to consider the important case where exhaust products are employed instead of steam as a "heat reservoir," and he gives on p. 153 an interesting diagram comparing the two alternatives, which should prove very useful in practice.

It may be a surprise to some readers to find that, contrary to the usual custom, the internal combustion engine is dealt with before the steam engine; but since the study of gases is easier than that of vapours, it is in reality a rational sequence to adopt. The section on the steam engine is very complete, and includes an account of wire-drawing, condensation, steam-jacketing, superheating, compounding, the use of turbines, boilers, drafts, fans, chimneys, stokers, economisers, pumps, and injectors. It would have seemed rash to forecast that so many subjects could be treated in one book, but the author has succeeded in including all this, and more, in his four hundred and forty pages.

In conclusion, we have no hesitation in welcoming the book as a valuable addition to the literature of the subject. It will be of special use to scientific engineers, to practical physicists, and to that growing student class which aspires to become the one or the other.

THE SOURCES OF EDUCATIONAL THEORY.

The Child's Inheritance: its Scientific and Imaginative Meaning. By Dr. G. Macdonald. Pp. xii+339. (London: Smith, Elder and Co., 1910.) Price 12s. 6d. net.

THIS book, which some readers will find prolix and whimsical, but all must acknowledge to be eloquent and sincere, seeks the ideal form of the educational process as a development of the child's racial inheritance.

"In the understanding of the child's inheritance both the poet and the biologist are worth deep and close study, not because they are necessarily antagonistic, but because, if they understood each other better, the gain to education would be incalculable."

For this reason the author directs us to Wordsworth's "Prelude" and Weismann's theory of the continuity of germ-plasm as the best sources of educational doctrine. The synthesis is original, and Dr. Macdonald is probably right in thinking that Weismann "would find his place somewhat unexpected while standing as the poet's squire." He would possibly be still more astonished at his proximity to William Blake, who is also repeatedly quoted.

Dr. Macdonald has published elsewhere a lecture on "The Sanity of William Blake." The citations in the present work certainly indicate that a teacher with the right temperament may learn much professional wisdom from the mystical poet. With the aid of these oddly consorted authorities the author discusses the nature and interaction of the child's endowment and environment. The former is "the old world within"—the epitome, as Haeckel taught, of phylogenesis. The latter is "the new world without," which, by imitation, by suggestion, and in other ways, moulds the plastic substance of the child's mind. Examining in further detail the interplay between these fundamental factors, the author finds two processes or aspects of mental growth to be of the first importance—expression and imagination. The chief means of expression is "the service of the hand." The discussion of this topic is rather one-sided, but is nevertheless an interesting and valuable contribution to a subject of much present importance.

The chapter on imagination—described as "that something in the child which recognises the shining light in all things living"—gives occasion for some not ill-founded criticisms of existing views of man's nature and of educational practices based on them. The chapter headed "Faith and Recreation" contains an admirable doctrine of the functions and value of play. In an intermediate chapter "On Specialisation," the author is led by his favourite thesis that mental life is more than "an assembly of various functions" to combat vigorously any form of specificity in education. It is perhaps unfortunate that a criticism of education, which, though ill-balanced and occasionally extravagant, must on the whole command respect, should lead to this position. For many of us feel that vocational education, properly understood, is the most hopeful means of giving the child effective possession of his inheritance.

T. P. N.

SPECULATIVE COSMOGONY.

Essai de Cosmogonie tourbillonnaire. By E. Belot. Pp. xi+280. (Paris: Gauthier and Villars, 1911.) Price 10 francs.

THE preface to this volume of speculative cosmogony will not raise much hope in the mind of the orthodox or sceptical man of science. "Faisant table rase de toutes les méthodes actuelles de la mécanique céleste spécialement créées pour des astres isolés . . . il doit chercher par la pure logique appuyée sur l'expérience comment ces corps ont pu réaliser *tous* leurs mouvements actuels. . . ." The advice is too sweeping to be readily accepted. The phenomena which the one new theory is to explain are so varied and numerous that suspicion is at once aroused against the arguments employed.

A hypothesis that, in a short chapter of twenty-seven pages, is to account for "les alignements d'étoiles, les étoiles doubles, multiples; les amas d'étoiles; les nébuleuses amorphes, planétaires, annulaires, elliptiques, les étoiles nébuleuses, les nébuleuses spirales, les courants d'étoiles" must be well grounded to stand any reasonable chance of general acceptance. And when this hypothesis is also to explain the solar periodicity and equatorial acceleration and the masses, mean distances, and inclinations of the planets, even the most credulous mind must pause before giving adhesion to the new views. It is true that in the law of gravitation an explanation of a vast number of diverse phenomena was sought. But gravitation could be and has been triumphantly put to the supreme test of prophecy. The alternative law put forward by M. Belot as replacing gravitation in an earlier stage in the evolution of the present cosmos can be put to no such test. At the best it can be shown more or less satisfactorily to lead to the present condition of affairs and to suggest views about some phenomena other than those commonly held.

The suggestion that a spiral nebula is revolving in the direction of the increasing radius of its arms may be verified by the spectroscope, but such a discovery would not in any real sense prove the truth of the theories of M. Belot. Neither facts nor arguments of sufficient weight have been brought forward to call for very serious consideration of his views.

Put very briefly, M. Belot's account of the evolution of our solar system amounts to this. Some 90,000,000 years ago a vortex-tube, moving through space at a speed of about 75,000 kilometres per second, encountered a slowly moving mass of nebulous gas. In the subsequent disturbance huge vibrations were set up in the vortex which led to the throwing off of successive portions forming the planets of the system. In a matter of two years the nova formed by the collision had expanded into the solar system, and in the manner of this expansion, coupled with a one-sided development of the planetary portions, lies the meaning of the present constants of our system.

M. Belot seeks by ingenious methods to justify certain curious empirical laws which he has found to fit the rotation-periods, inclinations, and mean distances of most of the planets. In these empirical laws and the many facts about different parts of the solar system which M. Belot has gathered together will probably lie the chief interest of the book to serious students of cosmogony.

For those who are unable to read the book as a whole but desire to gather the views of the author, a very complete account is given in the last chapter of the book. M. Belot, in his insistence on the importance of the energy of initial translatory motion upon the evolution of our system, may have brought into deserved prominence a factor which other cosmogonists have overlooked. It is true that it hardly seems to fit in with the fact that increasing stellar velocity generally accompanies increase in age, while the extremely high velocities required by M. Belot seem out of the question. Still, the idea may prove a useful addition to cosmological speculations. The second great point of the book—the need and use of a universal *dualisme* to explain the phenomena of the heavens—does not seem likely to be fertile of useful results. It leads the author to the following fantastic comparison between the celestial and the organic world:—

"Le tourbillon qui pénètre dans la nébuleuse se met à vibrer dans le choc; à chacune de ces vibrations correspond une émission de matière, qui se mélangeant à celle de la nébuleuse, va constituer l'embryon planétaire. Puis dans la nébuleuse se dessine un vaste ovoïde à l'intérieur duquel se trouvent enfermés tous les noyaux de planètes directes; pendant leur croissance ces noyaux sont reliés à la nébuleuse par de longs filaments tourbillonnaires, véritables cordons ombilicaux amenant les aliments cosmiques aux deux pôles de chaque œuf planétaire"!

BRITISH LICHEN FLORA.

A Monograph of the British Lichens: a Descriptive Catalogue of the Species in the Department of Botany, British Museum. Part ii. By Anne L. Smith. Pp. v+409+59 plates. (London: Printed by order of the Trustees of the British Museum, and sold by Longmans and Co., B. Quaritch, Dulau and Co., Ltd., and at the British Museum (Natural History), 1911.) Price 20s.

THE appearance of the second volume of the "British Museum Catalogue of British Lichens" has been looked forward to eagerly by lichenologists for some time. This fact will be realised when it is recalled that the first volume, written by Crombie, was reviewed in these columns so long ago as 1894. Crombie was one of the last of the more prominent lichenologists to protest against the dual nature of the lichen thallus. The author of the new volume, however, belongs to the modern school, and we therefore find the algal constituents of the lichens given their correct names. The gonidia are thus more accurately defined, and the determination of the genera is greatly facilitated.

The descriptions of the species are given in terms which will be more easily understood than the very technical words used in the previous volume, and it is clear that they have been compiled with very great care, for as a rule they are very much to the point.

The introduction of keys here and there is also of great use. The first volume was illustrated by a number of drawings in the text, all of which, with the exception of the last six, were made by Nylander. The new volume has at the end fifty-nine plates which form a very valuable part of this catalogue. The figures of the lichen habits and the sections of the apothecia are really excellent, but the sections of the thallus are in most cases too diagrammatic to be of any use. In the glossary we miss any reference to the very important and not uncommon soredia.

The ecological study of the lichens is of the greatest interest, but until now it has been hampered by the absence of a complete and modern flora. It is to be hoped that botanists will now attempt more thoroughly to study the physiology of the distribution of lichens. Everywhere, on trees, on solitary rocks, on the tops of hills and mountains, towards the Arctic and Antarctic limits of plant life, the lichens form practically the only vegetation present. But this vegetation shows, though on a small scale, of course, all the gradations, from the small tree-like Cladonias of the "lichen-forest" to the minute crustaceous lichens which occur on the bare rock faces, there forming very often a typical interrupted "desert-vegetation." Numerous xerophil and hygrophil, and even hydrophil formations, can be distinguished, which are characterised by the regular association of certain definite species. But all ecological work must be based on an accurate knowledge of the species under examination, and we must therefore be glad that this lichen flora is now complete. The author is to be congratulated on having successfully carried out a very arduous bit of work.

O. V. D.

MODERN CUBA.

Cuba. By Irene A. Wright. Pp. xiv+512. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1910.) Price 10*s.* 6*d.* net.

It is a somewhat thankless task to write a book upon an island like Cuba, which, although large and tropical, is devoid of really grand scenery, and the original natives of which have vanished without a trace, whilst the colonial population has made no history in comparison with other Latin-American countries. The conquests of Mexico and of Peru were dramatic; they and the rest have retained a large native population full of interesting problems; they all had their wars of independence; they combined or split, and kept themselves in evidence by countless revolutions or wars of mutual conquest; and not a few of them have attained an important position among the nations of the world. Cuba, from the time of its discovery until a few years ago, was a Spanish colony, the usual unhappy condition of which concerned none but the mother-country. It is the "Pearl of the Antilles" simply because it is so large and marvellously fertile. Its history means recent politics, and such are difficult to write upon.

The author has resided for ten years in Cuba as a journalist, either on the staff of some local newspaper, or as agent of the Cuban Department of Agriculture, or lastly as editor of a magazine devoted to the commercial industries of the island, in which capacities she travelled largely through its provinces to write up, or down, as the case may be, some mine, plantation, or other concern.

After the overthrow of the Spanish *régime* in 1898 followed the four years' military administration by the U.S.A. Thanks to the vigorous cleaning-up of the devastated country and enforced quietude, everything assumed a brighter outlook until the American Government withdrew, leaving Palma as the first president of the new republic. Then followed the inevitable internal strife, those who were out wanting the jobs enjoyed by those who were in. It was no longer Cubans against Spain, but Cubans against each other. The prevailing condition is perplexing. Of the two million inhabitants, more than 11 per cent. are foreigners. This foreign-born element consists mainly of Spaniards (80 per cent.), the rest of Chinese, former African slaves, Americans, and various other nations in much diminished proportion. The Cubans themselves are for the most part the island-born descendants of white stock, but inextricably mixed with black and brown.

The foreigners hold at least three-fourths of all the valuable lands, and the commerce also is in their hands, but as uitlanders they have no voice in the government, although they pay most of the property taxes and, at least directly, the Customs duties, whilst the Cubans represent the governing class, or rather they fill the Government offices. As usual in these Latin republics, the numbers of the politically active natives are small, the overwhelming mass being petty traders and labourers, who take no interest in a strife which they do not understand. They prefer being left in peace, but they take up arms and become patriots merely because as men in arms they may forage.

The staple industries are sugar and tobacco, and as these pay best other agricultural pursuits are rather neglected, so that in parts this fertile island can scarcely feed itself. There is a chapter on tobacco, interesting for its history, but this is culled from some other work; and the reader will learn nothing about the working of such a plantation, or, let us say, the life-history of a Havana cigar, from seed to finish, a story which would be more attractive, even to non-smokers, than the information that "modern implements, intelligent and scientific irrigation are bound to increase quantity, without impairing quality in the least."

The bulk of the book, illustrated with some seventy well-executed photographs of scenery, building, town and country life, is devoted to the description of several journeys, interspersed with remarks upon commerce, industries, and local history. A long residence in the island, and the active interest taken in its politics during stirring times, entitle the writer to take sides in her expressed opinions. The chapters on home life, days in Habana, rice with beans, foreigners in Cuba are vividly true of Hispano-American life, and sketched by one who has not merely peeped but lived behind the curtain.

NEW TEXT-BOOKS OF CHEMISTRY.

(1) *A Course in Qualitative Chemical Analysis.* By Prof. C. Baskerville and Dr. L. J. Curtman. Pp. ix+200. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1910.) Price 6*s.* net.

(2) *Elementary Chemical Theory.* By J. M. Wadmore. Pp. xi+275. (London: Methuen and Co., Ltd., n.d.) Price 3*s.* 6*d.*

(3) *Physikalisch-Chemische Praktikumsaufgaben.* By Prof. G. Kümmell. Pp. vii+71. (Leipzig and Berlin: B. G. Teubner, 1910.) Price 1.60 marks.

(4) *Inorganic Chemistry.* By Prof. F. S. Kipping, F.R.S., and Prof. W. H. Perkin, F.R.S. Pp. xiv+750. (London and Edinburgh: W. R. Chambers, Ltd., 1911.) Price 7*s.* 6*d.*

(5) *Outlines of Experimental Chemistry.* By Dr. E. B. Ludlam and H. Preston. Pp. iv+95. (London: Edward Arnold, 1910.) Price 2*s.*

(1) AT first sight the volume on qualitative analysis by Messrs. Baskerville and Curtman appears to follow the old, familiar arrangement, in which individual tests are followed by simple schemes of separation. But on closer inspection one comes across at the end of each scheme a series of notes in small print, which seem to us to be the really valuable part of the book. These notes, whilst they destroy to some extent the apparent simplicity of the analytical tables, acquaint the student with facts which he usually has to learn from experience, viz. that reactions are modified by their environment and that few separations are quite complete. Anomalous results are thus anticipated, and the pitfalls, into which a belief in the infallibility of tables often leads, are avoided. Importance is attached to careful manipulation, and to the use of solutions of known strength for examination, so that the student may become accustomed to forming a rough estimate of the composition of a mixture. It should be added that the book does not profess to teach manipulation, and there are no detailed descriptions of apparatus or laboratory operations.

(2) This is a book on chemical theory for use in schools, that is, one dealing with laws and hypotheses in an elementary way. Such a study naturally implies a fairly extensive quantitative as well as qualitative knowledge of chemical facts. Assuming that the schoolboy knows his facts, such a book as Mr. Wadmore's should be of real assistance to him in systematising his information. Moreover, the emphasis laid on quantitative results and the method of plotting them as curves is a process which should be early assimilated. On the other hand, such a book as this will have to be used with the utmost discrimination, for it is not every schoolboy, even in the higher forms, who will be in a position to grasp the real significance of Pasteur's work on asymmetry, the meaning of optical activity, the use of the phase rule or the nature of osmotic pressure.

The subjects on the whole are well selected, and the material is put together in a simple and attractive form. We have one criticism to offer. Some of the historical references are so curtailed as to be quite valueless, and might, for any purpose they serve, be omitted. "He [Marignac] was misled by the erroneous hypothesis of an English doctor, Prout"; but what the erroneous hypothesis was is not stated. "It occurred to no one, however, to make a special investigation of this point [constancy of composition] till . . . Berthollet denied it"; but what Berthollet's views were, or why he denied it, is left untold. "Attention was originally directed to this [diffusion] by the chance observation that hydrogen could escape through a fine crack in a gas jar." This was certainly not the chance observation, and it would have been remarkable if anything else had happened. It may be true that Dalton's quantitative results were inaccurate; but it is a novelty to read that he "cooked" them (p. 12).

(3) This small volume of seventy pages is intended, as its name indicates, to serve as a practical guide to physical chemistry. It contains exercises in chemical statics and dynamics, thermo-, photo-, and electro-chemistry, the latter forming nearly half the volume. No fault can be found with the arrangement or character of the exercises; but it may be doubted if the meagre descriptions of the operations would enable any student to carry out a single determination without either previous experience or the constant supervision and help of the demonstrator. In short, the descriptions afford little more than might be found in any ordinary text-book in which these subjects are discussed. A comparison with such a book as Dr. Findlay's at once reveals its shortcomings in the all-important matter of descriptive detail.

(4) This is practically two books, an elementary and a more advanced text-book, which are published separately, and also in one volume. The first, or elementary part, covers the subject-matter required by the matriculation examination of London University; the second part is intended for students who are working for a pass degree. The object, so the authors state in the preface, of thus combining two stages of a student's chemical course, is to avoid the necessity in which a student entering a college finds himself of procuring a different and much larger text-book. For the advanced book usually takes him back to the beginning of the subject in which "some of the new matter which he requires is scattered here and there in the earlier chapters dealing with the non-metals, most of it is contained in the chapters on the metals, but in both cases there is generally the further difficulty that it is not differentiated from the more advanced matter required in his third year."

It is no doubt true that the schoolboy has to go to some expense in stocking his library with more advanced text-books when he enters on a university course. This seems almost inevitable, and the process necessitates a certain discontinuity of treatment, and, to some extent, a repetition of previous information. It has obvious disadvantages no doubt, but also perhaps less obvious advantages. It is with the object of avoiding the former that the authors have developed their method, and it may be admitted at once that it is extremely well done. To give examples: the subject of solution is discussed in a simple elementary manner in an early chapter of part i., in which the meaning of the term, determination of solubility, and the plotting of curves is explained. The subject is taken up again at the beginning of part ii., when equilibrium between solids and liquids is discussed, and such topics as supersaturation and eutectics are considered. Again, the effect of the electric current in effecting chemical change described in part i. serves as an introduction to the theory of ionic dissociation presented in part ii. In this way there is little or no overlapping, and the subjects are systematically developed. Also, a zealous beginner who wishes to learn something more of a subject may, if he chooses, turn to part ii., and satisfy his curiosity, although unfortunately no reference is given in the text to the continuation in the advanced section. The possible disadvantage of such treatment is that it limits the scope of part ii. through want of space, and consequently restricts the range of some of the subjects which might otherwise have been expanded with advantage. This criticism may, of course, be met by the different view of the authors as to the standard of knowledge demanded for the pass degree.

Putting this point on one side, the book, we feel sure, will commend itself to teachers and students by its logical arrangement, clear descriptions, excellent illustrations (with the exception of Fig. 51), and convenient size. It may also be pointed out that, unlike some of its predecessors, it is not overloaded with facts. There are some omissions in the index. Thus "the law or rule of Le Chatelier" is twice referred to in the text, but is left out of the index, and so is "vapour pressure." Charcoal stoves (p. 121) are said to yield carbon monoxide, which is true enough, but so do coke stoves, which are much more common, at least in this country, and a frequent source of danger.

(5) Every teacher sooner or later will probably consider that his peculiar experience will afford him special advantages for producing a book on practical chemistry. Indeed, it seems a natural and proper feeling in anyone devoted to the subject. Whether the results obtained by different methods are essentially different is another question. One is inclined to think that it is the teacher rather than the book that counts in the long run. Here at least is a book produced by two teachers whose hearts are in their work, and who possess the additional advantage of being "untrammelled by examination requirements of any kind." Through their laboratory 300 boys pass weekly and are instructed by the methods described in their book. This, along with the traditions of the school, on its scientific side, are strong recommendations in themselves, and are further emphasised by a study of the character and arrangement of the exercises. The latter are clearly described and illustrated, and follow in a natural and logical sequence. The apparatus is simple and easily made and set up, and the number of quantitative operations sufficient to ensure exact manipulation. One feels that school chemistry is here dignified as a rational study rather than imposed as a compulsory acquirement of "the dirty part of physics." It is a book that may be warmly recommended for use in any well-equipped school laboratory.

J. B. C.

OUR BOOK SHELF.

Factor-table for the First Ten Millions containing the Smallest Factor of every Number not Divisible by 2, 3, 5, or 7 between the Limits 0 and 10,017,000. By Derrick N. Lehmer. Pp. xvi+476. (Washington: Carnegie Institution, 1909.)

THE condensation of a ten-million factor-table into a single volume of fewer than 500 pages is a remarkable feat, and it is interesting to learn how it has been done. The author's manuscript was first typewritten in duplicate, and these sheets, after correction, were photographed on glass. The photographs were inspected and corrected and then transferred to zinc plates, so that no movable types were employed in the printing. It is difficult to imagine a more effective way of preventing errors after passing for the press. The result is very compact and quite legible; auxiliary tables are provided for finding the proper entries in the main table: these may, however, be dispensed with, if desired. Multiples of 2, 3, 5, 7 are omitted, so the arrangement is really that of residues prime to 210.

There is an interesting introduction, giving accounts of previous tables and the method of sifting out successive primes; it also contains a valuable list of errors in former tables. More interesting still is the account of the MS. tables by Kulik, preserved by the Vienna Royal Academy. They are in six volumes, and profess to give the smallest factors of all numbers not divisible by 2, 3, or 5 up to a hundred millions. Kulik uses a special notation, and, judging by his tenth million, his work is not very trustworthy (not nearly so good as Dase's, for example); but the existence of such an enormous calculation by one man is very remarkable. He appears to have worked at it for twenty years.

The author makes due acknowledgments for help received; one of these is of international interest. The funds for preparing the manuscript and publishing the tables were furnished by the Carnegie Institution of Washington. Such a contribution to abstract science deserves cordial recognition and gratitude; and we hope that colleges that can afford to do so will promptly buy copies of this work. For although a factor-table is not often wanted, it is in certain circumstances indispensable, and it is very convenient to have one at a reasonable distance that can be personally consulted.

G. B. M.

Didaktische Handbücher für den realistischen Unterricht an höheren Schulen. Edited by Prof. A. Höfler and Prof. F. Poske. Band vii., Didaktik des botanischen Unterrichts. By Prof. B. Landsberg. Pp. xiii+303. (Leipzig and Berlin: B. G. Teubner, 1910.) Price 8 marks.

A CONSIDERATION of the title gives rise to the reflection, how far this series of didactic handbooks owes its inception to the German educational system controlled to a great extent by official regulations; yet the present volume affords proof that changes in teaching methods can be, and are, effected by individual efforts. The main idea, advocated by Prof. Lindenberg, of instruction based on practical observation and experiment, has already received general approval, but the proposed sequence of procedure, explicitly scheduled under three stages, does not appear to be entirely realisable or acceptable. During the first stage, that extends over two years, the governing principle, expressed briefly, is to induce the study of single organisms in their environment with regard to form and working of the different members. The collation of individuals into groups, both ecological and classificatory, is relegated to the second stage, when it is proposed that a course of anatomy and physiology, as also an introductory survey of cryptogamic life, should be taken.

The chief aims during the advanced stage are to amplify the earlier courses of anatomy and physiology, to expound the theory of development and other working hypotheses, to correlate botany with other sciences, and to indicate the nature of biological investigation. It is manifest that from the elementary stage, when the author considers it necessary to offer a word of warning lest impatience on the part of the teacher should discourage the youthful inquirer, to the summit of the advanced course is an exceedingly long journey, too long to be traversable during school life. However, if the scheme is not workable in its entirety, various sections are practicable, and one can confidently bring the volume to the notice of teachers.

It will be found that the book is not overweighted with philosophic discussion, and that the greater part of it is devoted to illustrative examples and hints for various substages of the course. The precise paragraphing of the subject-matter under chapter contents affords a ready means of reference and a useful bibliography is appended.

Treherne's Nature Series.—(1) *British Butterflies and Moths.* Arranged by W. F. Kirby. Pp. vii+26+xii plates.
(2) *Animals: Wild and Tame.* Arranged by W. F. Kirby. Pp. ii+22+xii plates.
(4) *Minerals.* Arranged by W. F. Kirby. Pp. ii+24+xii plates.
(London: A. Treherne and Co., Ltd., n.d.) Price 8*d.* net each.

The Nature-lover's Handbook. By Richard Kearton and others. Pp. viii+265. (London, New York, Toronto, and Melbourne: Cassell and Co., Ltd., 1911.) Price 2*s.* 6*d.* net.

The fox is "a destructive animal in hen-roosts, but still common in Britain, being preserved for the fashionable sport of fox-hunting"; and, again, the female of the black arches moth "is furnished with a very sharp projecting ovipositor, an organ not usually very conspicuous in moths." Such are the main items in the notices of two species in a couple of the volumes in Treherne's Nature Series; and it will be perfectly manifest that the reader who wants the first (which, by the way, is not true for Britain as a whole) can have no possible use for the second. Again, in the volume on minerals, we find, to take one example only, under the heading of cerusite, a statement to the effect that carbonate of lead is common in most parts of the world, but nothing to show that cerusite and lead carbonate are one and the same. If little is to be said in favour of the text of these volumes, in the case of the one on animals it is difficult to give much praise to the illustrations. The case is, however, quite different with the volume on butterflies and moths, in which the coloured plates are really excellent; and, in a somewhat modified degree, commendation may be bestowed on those in the mineral volume. The low price of these "booklets" renders them accessible to all, and if they serve to awaken an interest in natural history, their issue is no doubt justified.

"The Nature-lover's Handbook" is on an altogether different platform from that of the other volumes, and cannot fail to be useful to the young student, giving, as it does, interesting notes on the animals and plants specially noticeable in each month, followed by lists of birds, butterflies and moths, and wild flowers, with the respective "station," or season of appearance of each species, in our islands. The only alteration we can suggest is that the species in the lists should be arranged alphabetically, as they are now difficult to find; and that if it is necessary to use names like "barn swallow," the dominant term should come first. R. L.

Introduction to Chemistry. By William Ostwald. Authorised translation by W. T. Hall and R. S. Williams. Pp. ix+368. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd., 1911.) Price 6*s.* 6*d.* net.

In this volume the contents of Prof. Ostwald's "Schule der Chemie" are reproduced in narrative form, in place of the conversational method previously adopted. From the point of view of the average reader the change is a great advantage, and the book is now written in such a form as to be readily available for use in the teaching of classes of elementary students. As might be expected, much attention is directed to physical and physico-chemical properties; it is quite refreshing in an elementary book to find crystals classified according to their axes of symmetry, in contrast with the emphasis which is usually laid exclusively upon the planes of symmetry.

The most surprising fault of a book, which is in nearly every respect an admirable introduction to the study of chemistry, is found in its treatment of equivalents, atomic weights and molecular weights. After a discussion of the laws of simple, multiple, and reciprocal proportions, Dalton's atomic theory is introduced, but is followed by a table of "Combining Weights of the Most Important Elements," which represent, not the equivalents—which alone can be deduced from this theory—but the modern system of atomic weights, as firmly based by Cannizzaro upon Avogadro's hypothesis. This hypothesis is not mentioned by name, either in the text or in the index, and the latter contains no reference to gas-densities or vapour-densities; these important matters are smuggled into a chapter on carbon, and the theory which is really the basis of all determinations of atomic weights is merely used to provide a few exercises on the combining volumes of gases. A pupil who had the curiosity to inquire why the atomic or "combining" weight of oxygen relatively to hydrogen is taken as sixteen, and not as eight, would find it very difficult, if not impossible, to find a satisfactory answer in the book now under review.

This is, however, the only serious fault that has been noticed in a volume that in other respects displays the admirable quality of lucid exposition, which is characteristic of the author. The translation has been so well done that the book gives the impression of having been written first in English and then translated into German. T. M. L.

Milk Testing, a Simple, Practical Handbook for Dairy Farmers, Estate Agents, Creamery Managers, Milk Distributors, and Consumers. By C. W. Walker-Tisdale. Revised edition. Pp. 86. (London: *Dairy World* Office, 98 Fetter Lane, 1911.) Price 1*s.* net.

This useful little book has so commended itself to those for whom it was intended that it is now for the second time revised and enlarged. The new matter includes such recent developments of the dairy industry as the testing of sour milk and the description of portable appliances for use by travelling inspectors. It is a happy circumstance that Mr. Walker-Tisdale, who is himself the manager and a director of a large milk company, should thus place his experience at the disposal of other dairy managers, and it is equally fortunate that the British dairy manager and farmer, so far from abusing the monopoly he possesses (for there is practically no importation of milk from abroad) should show himself so ready to apply chemical tests in order satisfactorily to establish the purity of his milk.

LETTERS TO THE EDITOR.

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

The "Stomatograph."

THE recent controversy regarding the causes which had depreciated the yield of Egypt's cotton crop, terminating in the Egyptian Government's Cotton Commission of 1910, showed very clearly how little accurate knowledge of the physiology of the cotton plant was available, more especially in regard to field conditions. This ignorance was most striking in respect to the water relationships, which—Egypt being dependent on the Nile for its water—are very largely within human control.

One point of interest in this respect is the action of the stomata, especially since I showed that growth is completely arrested by direct sun, from the first emergence of the seedling until late in the summer, the heavy water loss involved by the high sun temperature (160° C. in May to August) and the low day humidity being the limiting factor.

Investigation of plant physiology in the field, however, usually requires special and automatic apparatus, and no suitable appliances were available for investigation of the stomata. After several trials I succeeded in constructing a self-recording form of Mr. Francis Darwin's "porometer," which will work without appreciable errors under any variation of wind, sun, temperature, or barometric pressure, in rain or in dust-storms.

Briefly described, the apparatus consists of an electrical air-pump expelling 3 c.c. of air at each stroke under a constant pressure of 1 millimetre of mercury. The outflow tube is closed by a definite area of leaf, so that the air in escaping has to pass through the leaf tissues. The resistance to this escape depends almost entirely on the aperture of the stomata, of which there are some seventy on the upper leaf surface and two hundred on the lower in adult leaves of Egyptian cotton. The rate of escape is a direct measure of the porosity of the leaf, as in the "porometer." A relay circuit is operated when one stroke of the pump has been completed, and this telegraphs the signal to an electromagnet carrying a pen on its armature; this pen writes on a spiral drum which revolves once every hour.

The complete appliance is very convenient in use, being composed of a box like a microscope case, which is placed on the ground under the plant to be examined; from this box issues the air-tube leading to the leaf and the telegraph wire to the recorder. The number of adjustments which have to be made in the field is thus reduced to a minimum, which is no unimportant consideration under the field conditions obtaining during an Egyptian summer.

The trace of five consecutive days recorded from the same leaf without adjustment shows the stomata slowly closing as the hottest part of the day approaches, then closing when the sun goes behind the trees at 1.40 p.m., and remaining closed all night, opening slowly after sunrise, more rapidly when the direct sun strikes the leaf about 7 a.m., attaining a maximum at 9 a.m., and thenceforward closing steadily, in spite of the brilliant illumination, since the soil around the roots is being dried up by the heavy transpiration.

A side-issue from such records as this, which promises to give further unexpected results, deals with the effect of such stomatal closure on assimilation of CO_2. I have already mentioned that the stem of an Egyptian cotton plant does not grow in sunshine, and it appears that the growth of the root is also checked; it now seems not unlikely that photosynthesis may also be arrested or reduced after a certain hour of the day through stomatal closure, this closure being dependent on the development of the root system and on the water content of the soil.

The beneficial effects of Egyptian sunshine seem to be rather indirect. W. LAWRENCE BALLS.

Ghezireh House, Cairo, July 10.

Photograph of Multiple Lightning Flash.

I BEG to enclose a copy of a remarkable flash of lightning which I took some years ago in Uruguay, South America, and which, so far as I know, has never been published—with my knowledge or permission, at any rate.

This copy is an enlargement from a small negative about $1\frac{1}{2}$ inches square, and shows the curious curl-like form in some of the streaks. One noteworthy point about this photograph is that I "snapshotted" it. I had wasted many plates in the usual way, and obtained nothing of any value, but noticed that before every big flash there was a slight flicker in the clouds where the flash came from; I waited for this, let the shutter go just as I saw the flicker, and obtained the enclosed result.

Uruguay is noted for its severe thunderstorms, and animals, fences, trees, and houses are constantly struck. Some years before this photo was taken a powder-house was blown up by lightning not far from where this flash occurred, and in the sand a few miles off

I found a fulgurite—a glass tube about $2\frac{1}{2}$ inches in diameter made by the lightning striking and fusing the sand. These fulgurites are mentioned by Darwin in "The Cruise of the *Beagle*"; he found some near Monte Video. also in Uruguay. A. E. WALBY.

67 Lansdowne Street, Hove, Brighton, July 27.

The Rearing of Sea Urchins.

I HAVE read with much interest in NATURE of July 27 a short letter from Prof. Stanley Gardiner in which he communicates the fact that a hybrid of the species *Echinus esculentus* and *E. miliaris* was successfully reared from the egg through all the larval period until after the completion of metamorphosis in the zoological laboratory at Cambridge. It may interest your readers to learn that by means of salt-water aquaria established last year in the zoological laboratory of the Imperial College of Science in

London we have reared very considerable numbers of *E. miliaris* from the egg through the metamorphosis. The eggs were fertilised in the beginning of April, and when I left London in the middle of June there were many young Echini creeping about. The details of the methods adopted will be described in a paper shortly to appear in *The Quarterly Journal of Microscopical Science*. Last year we reared the eggs of the Serpulid *Pomatoceros* until the larvæ had attained the adult condition and had formed tubes, which were attached to the sides of the vessel in which they were.

E. W. MacBride.

Marine Biological Association of the West of Scotland, July 28.

FLIGHT, NATURAL AND ARTIFICIAL.[1]

In the words of the introduction, "The object of this report is to place at the disposal of the members of the society some of the information now available regarding the physical characteristics, powers of flight, &c., of birds. It must be clearly understood that, owing to the great difficulty experienced in collecting the details of weights, wing area, &c., the report is of a temporary nature only, and does not profess to give the fullest possible information regarding the subject dealt with. The details given, however, have been taken from the best available sources, and it is hoped that the report as a whole will be found a useful introduction to the study of bird flight." It will be seen that original observation and experiment did not fall within the scope of the committee, but, subject to this and the other limitations mentioned above, the results of their labours cannot fail to be of value.

The first section deals with the classification of birds from (*a*) the ornithological and (*b*) the aëronautical point of view. Under (*a*) table i. gives a classification after Finn into twelve main groups, further subdivided into families. The aëronautical classification presents difficulties. In table iii., column 17, are given the values of $S^{\frac{1}{2}}/W^{\frac{1}{3}}$, S being the surface and W the weight, together with other particulars for a large number of birds.

Section ii. is devoted to a description of the principal sorts of flight and of various manœuvres, such as turning in the air. Under the first head are mentioned gliding flight, flapping flight, and soaring flight, of which, however, the first does not differ essentially from the third. Instructive photographs after Marey and Milla are reproduced. Soaring has been the subject of much discussion at various times, no small part of it being hopelessly confused by misunderstanding of mechanical principles. Even in the present section paragraph 12 is not above reproach. The comparison of soaring with the normal performance of a sailing ship is certainly misleading.

When a bird maintains or increases his elevation without working his wings, the explanation is to be sought in a special movement of the air. It cannot be too much emphasised that for this purpose a uniform horizontal wind is of no avail. The larger soaring birds, such as condors and pelicans, probably find their support on ascending currents. Such currents must exist, though we on the ground perceive little of them. Even though the wind be strictly horizontal in the space where the bird is flying, advantage may be taken of variation with height or with time. As a matter of fact, the wind, near the ground at any rate, is always more or less gusty.

Travellers at sea have frequent opportunity of making interesting observations. In these latitudes one may see gulls following the ship and taking advantage of upward currents deflected from the sails or hull. From other parts of the world the albatross is often reported to follow the ship, maintaining his position for minutes or hours together without flapping of wings. Since in this case the distance from the ship may be considerable, one must appeal to upward currents deflected from the waves or to the other specialities of wind already mentioned. But is it certain that a flapping of the wings could not escape attentive observation? One would have supposed so; but the evidence is not free from ambiguity. Following upon a lecture upon the mechanical principles of flight, given in 1900,[1] a correspondent sent me an instantaneous photograph of an albatross flying "very near indeed" to the ship. In the picture the wings appear elevated as if near the top of a stroke, but to the observers at the time "the wings were fully extended in a line with the body." In answer to further inquiries my correspondent wrote: "*Without question* none of the many passengers who were watching the albatross (which was *exceptionally* near the side of the ship) saw the slightest movement of the wings when I took my snap-shot. To all appearance they were fully extended and immovable—certainly 10 to 12 feet from tip to tip." Here, indeed, is a question worthy of further attention from travellers in the southern seas.

Section iii. of the present report deals with weight, wing area, &c. The heaviest bird in the table is the Californian vulture, weighing 13·6 kilog. (30 lb.). The bird carrying the greatest weight per sq. m. is the whooper swan (21·3 kilog. per sq. m.). In section iv. we find observations and calculations regarding the velocity of birds, the power expended, &c. It appears that the maximum speed in ordinary flight does not much exceed 50 miles per hour, and that no bird moving near the earth's surface attains the enormous speed with which flying creatures are sometimes credited. These speeds are, of course, relative to the air. At considerable heights migrating birds may easily experience winds of like amount, so that 100 miles per hour, or more, relative to the ground may well be admissible.

The opinion is expressed that the power required for flapping flight has been much exaggerated. This may be true as regards regular horizontal flight, but it remains a fact that the power exerted by some birds, *e.g.* pigeons, in rising nearly vertically is very great. The question was discussed by Penaud in 1876. "In the ascent the total work developed by the bird is divided into two parts, the one fixed, that is, the work of elevation; the other variable and increasing with the time, that is, the work dispensed in finding a support in the air."

"It is thus to the interest of the bird to rise as quickly as possible, which it generally does, even when under no sense of fear. Their velocity of direct ascent is always several yards per second." And, further: "Thus, and apart from all theory, it is certain that birds are capable of developing momentarily a force corresponding at least: for the peacock, to 1 horse-power for every 66 lb., and for the pigeon and ring-dove, 57 lb."; and, as before mentioned, the work of elevation is not the whole.

In these days there is a natural tendency to overlook the work of the early pioneers. In principle not much has been added to the conclusions of Wenham and Penaud, and the latter constructed actual flying-machines. What was wanted to make flight practical was the advent of the light motor, as developed for the motor-car. When this became available, the skill and courage of such men as the brothers Wright soon led to successful human flight. Further progress is assured, but how far it will go would require a bold man to prophesy.

Rayleigh.

[1] Aëronautical Society of Great Britain. First Report of the Bird Construction Committee. Compiled by Col. J. D. Fullerton. Pp. 61. (London: Aëronautical Society of Great Britain, 1911.) Price 10*s*. 6*d*. net.

[1] Manchester Memoirs, xliv., p. 1; Scientific Papers, iv., p. 462

SOME SCIENTIFIC CENTRES.

No. XVI.—Prof. Weismann's Zoological Institute at Freiburg-im-Breisgau.

MOST students of zoology arrive at some period or other of their Wanderjahre at Freiburg, that quaint and beautiful old town on the edge of the Black Forest. To some the chief interest will lie in the Münster, in the university buildings, old and new, and in the numerous statues and fountains that are scattered through the town; yet the majority of the students will not consider the visit satisfactorily ended if they omit to call at that institute in Katherinenstrasse, which Prof. August Weismann has made famous.

The institute itself stands in a small garden close beside the Chemical and Physiological Institutes, and is built in the shape of an L, with the laboratory windows facing north. It stands gable on to the street, and its exterior presents no striking features, so that by anyone going there for the first time it could easily be passed unnoticed, as it was by the writer on his first visit. The interior, however, presents quite a different appearance: everything necessary for research is there, and the work-benches are splendidly equipped with gas and water and the necessary electric plugs and switches.

In addition to the senior and junior laboratories, rooms are set aside for the students at different stages in their course. There are special rooms for diagrams, apparatus, &c., and in the basement a large tank room. The lecture theatre, from which a small tramway runs to the museum, is large, has plenty of wall space for diagrams, and is fitted with a large Zeiss epidiascope. Finally, there is a fine suite of rooms for the members of the staff, a large and representative museum, and an extensive library, and, further, through the kindness of Prof. Weismann, his private library is placed at the disposal of those engaged in research.

A typical day's work may be of more interest than a mere detailed description of the buildings. In summer by 8 a.m., and in winter by 9 a.m., the senior students are at work. The morning's work usually starts with a short discussion. it may be on some points that have arisen in someone's "Arbeit," but very often the discussions are on any subject under the sun but zoology. As a rule this discussion soon finishes, and each student seats himself at his bench to collect the knotty points in his research for the professor's consideration, or to get some passage in a book or journal ready to lay before the professor as soon as he appears in order to get his own interpretation confirmed or utterly quashed.

Sometimes the morning's discussion is disturbed when near its height by the whisper, "Der Chef," which is always followed by a general and hurried scamper to get ready for the morning's visit. This whisper of "Der Chef" has been used on more than one occasion as a means of getting out of a tight place in an argument.

Prof. Weismann begins his day by visiting each student, going over the interesting points in his work, comparing them with other results, or by a series of questions getting the student on to the right track. During the remainder of the day the laboratories are in charge of the senior assistant, and students may either spend all their time there, or attend one or more of the courses of lectures delivered at the institute, either by Prof. Weismann on some general subject, or by one or other of the assistants on some special subject.

Photograph] [*G. v. Guaita.*

Prof. August Weismann in his Study.

On one afternoon weekly there is the seminar, which is attended by the professors, the other members of the staff, and the senior students. Some time previously recent books or articles from the scientific journals are distributed to the students and members of the staff, and at the seminar each student must criticise the book or paper given to him. As soon as the criticism is finished, the other students and the members of the staff give their opinions, and then Prof. Weismann sums up the discussion. The work in the seminar is not restricted to recent literature, nor to works published in German. Frequently a student is requested to give a review of the present state of knowledge in some biological problem, or to give a summary of the results achieved in some particular group.

The day's work is arranged and carried out in such a way as to give the student opportunity of observing, forming opinions of his own, and gaining confidence in his own judgment. There also the student is taught to get at the root of things, and, without knowing it, gradually copies the example and is imbued with the earnestness of the director.

The general routine differs very little from that followed in most German universities, and yet year after year every Arbeitsplatz in the institute is occupied, and that by a very cosmopolitan group of zoologists and of zoologists in the making.

Why is it that students from all quarters flock there? It is certainly not due to the equipment, for many of the newer zoological institutes in Germany are more lavishly equipped; nor is it due to the fact that the institute is situated in a very pleasant town. On the contrary, it is due to the reputation, but still more to the personality of the director.

Prof. Weismann's research has covered a wide field, and the resulting articles are all marked by a thoroughness and a mastery of detail which shows that he, at any rate, has just that power, often lacking in German men of science, of not allowing the details, while giving them their full value, to obscure the main issue.

Of his original investigations, that on the origin of the germ-cells in the Hydrozoa is specially interesting, as it led him from the facts there observed to formulate his greatest doctrine—the continuity of the germ-plasm, and to found thereon a theory of heredity. This doctrine had a much wider significance than was at first thought. If it be accepted, the only conclusion possible is that all variations—by this is meant inherited variations—must be congenital, and that as the direct result of this there can be no transmission of acquired characters, that is to say, of such characters as are acquired during the lifetime of the individual. Needless to say, the publication of this doctrine caused an enormous sensation everywhere, but particularly so among men of science and breeders. In spite of all the jibes and sneers hurled at it, its effect on the natural sciences has been deep and permanent, and, however much modified, however much tampered with, it forms the one firm basis of all modern views of heredity.

His thorough knowledge of both animal and vegetable cytology helped him to place his theory of heredity on a surer basis, one might well venture to say on a firmer foundation of fact than was possible for most of his predecessors and many of his contemporaries.

In the development of Darwinism Prof. Weismann has taken a leading part, not only in gaining for it in Germany an almost universal acceptance, but also in explaining its real meaning to the world at large and in freeing it from such traces of Lamarckism as still existed.

Moreover, a style which is beautiful and at the same time lucid, a persuasiveness which is equalled by few, and a capacity for following a hypothesis to its logical end, has made Prof. Weismann one of the foremost, if not the foremost, exponent of all that is best in Darwinism and in the teaching of Wallace.

His views have exercised on evolution a far-reaching influence, for they have been the direct cause, and this must be peculiarly gratifying to Prof. Weismann, of much of the recent research undertaken in this subject.

But a record brilliant as his has been is not sufficient to fill the institute to overflowing, or to rouse such enthusiasm and affection for the director as is seen there. This is purely due to the personality of Prof. Weismann, to his geniality, and to the kindness with which he guides the faltering steps, especially of strangers within his gates. In fact, his Gemüthlichkeit soon overcomes the diffidence of his students, and at the same time rouses in them a regard and affection which it is given to few teachers to gain.

No student can work through a course in zoology at Freiburg without being influenced by the enthusiasm, the earnestness, and the profound thoroughness he finds there, and gaining and retaining a feeling of the deepest admiration for that veteran in science, the director of the institute, Prof. Weismann.

No better tribute can be paid to Prof. Weismann than the affection in which he is held by his former students, to whom the phrase, "Der Chef," calls up so many pleasant memories, and no better proof of this exists than the longing with which they look back to the time spent within his halls.

W. D. H.

PREHISTORIC SOUTH AFRICA.[1]

MR. J. P. JOHNSON continues to make good use of the opportunities his mining practice gives him for the careful study of South African geology and archæology. The latest addition to his series of short books is, like its predecessors, valuable from its record of carefully observed facts and instructive illustrations. The subjects included range from the period of the Zimbabwe ruins back to the oldest of the stone implements, and perhaps even older. Occasional remarks show that Mr. Johnson had been a diligent collector of stone implements in the south of England, so that he went to South Africa as a trained observer. He has found in the rich implement-bearing gravels there abundant scope for his energies. He classifies the South African implements into three groups—Eolithic and two divisions of Palæolithic. No Neolithic implements have as yet been found. He identifies as Eolithic a series of implements collected from a gravel at Leijfontein, in the Campbell Rand. He compares them with the eoliths of Kent, which he accepts as probably of artificial origin, though he admits that this conclusion is still open to doubt.

He gives two pages of sketches of these eoliths, and though they resemble some of the characteristic Kent types, the illustrations are inadequate for any independent opinion as to their relations with the English "eoliths."

The Palæolithic implements are divided into two groups—the Acheulic, which are generally of the type which he has called amygdaliths, and the Solutric, which are generally scrapers. He regards the implements which he refers to the Solutric type as of later date than the Acheulic. Some authorities, however, hold that both belong to the same period. Mr. Johnson regards them as of different dates from the evidence of their distribution. The Acheulic implements must, he thinks, be the earlier, as they are found in older deposits, and none of the Solutric sites have yielded any of the typical Acheulic forms. He has collected Acheulic implements from seven or more feet below the surface, and found some in gravel that has been cemented to a hard conglomerate. Many of the Acheulic implements must be of considerable antiquity. They are abundantly distributed over the plateau around the Victoria Falls, and Colonel Fielden, who collected many there, is of the opinion that they were deposited before the erosion of the

[1] "The Prehistoric Period in South Africa." By J. P. Johnson. Pp. iv+89. (London: Longmans, Green, and Co., 1910.) Price 10s.

great Zambezi gorge. Mr. Johnson, however, agrees with Mr. Codrington that these implement-bearing gravels are later than the gorge, and were washed to their present position from slightly higher ground.

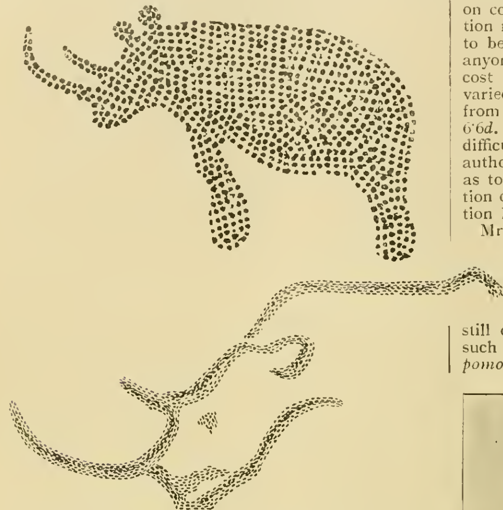


Figure of rhinoceros coarsely pecked in full, and of head of rhinoceros pecked in outline, Wolmaransstad. From "The Prehistoric Period in South Africa."

They are of a considerable, though not of the enormous antiquity, demanded by the other hypothesis.

The author adds many new examples of the rock drawings to those issued in his previous works, including some formed by pecking rock surfaces. Some of these drawings he regards as made by men of the Solutric period; and, as the men of Solutré, though skilled artists, did not use the rock-pecking process, Mr. Johnson concludes that the European and South African makers of Solutric implements were derived by separate migrations from a common eastern ancestor.

Mr. Johnson accepts the view that the Zimbabwe was made by a Bantu people. He records (p. 80) an interesting tradition in the northern Transvaal of a race of miners who were not Kaffirs, and whom he suggests were Arabs; but as these miners had guns they belonged to comparatively modern times.

J. W. G.

THE ADVISORY WORK OF AN AGRICULTURAL COLLEGE.[1]

WHEN county councils make grants to agricultural colleges they expect to get in return for their money a certain amount of instruction for students at the college and for farmers at market-day lectures, and a good deal of advisory work for rate-paying agriculturists. The volume before us represents the output of the Wye College staff in advisory work during the year 1910.

In view of the great importance of milk production in Surrey, and to a smaller extent in the suburban districts of Kent, it is natural to find a large part of the farm report taken up by the preliminary results of an inquiry into the cost of milk production. On no aspect of farming have we less information than on costs of production, and on none is more information needed at the present time, when economies have to be introduced at every turn. It will not astonish anyone acquainted with farmers to learn that the cost of food required to produce a gallon of milk varied from 3·8*d.* to 10·5*d.* The usual variation was from 5*d.* to 8*d.*, the average on fifty-nine farms being 6·6*d.* An inquiry of this nature is beset with many difficulties and pitfalls, and it would be well for the authors to obtain advice from an expert statistician as to the methods to be employed and the interpretation of the results; a more useful subject for investigation has rarely been attacked by dairy workers.

Mr. Theobald's report on economic zoology covers 130 pages, and is, as usual, well illustrated. Among new fruit-tree pests are noted the pale brindled beauty (*Phigalia pilosaria*, Hb.) and the light emerald moth (*Metrocampa margaritaria*, Linn.). Many of the old pests still continue to baffle all the efforts of the grower, such as the apple blossom weevil (*Anthonomus pomorum*, Linn.) and the raspberry beetle (*Byturus*

FIG. 1.—Female March Moths. The lower moth laying on her egg-band beneath one of the Lackey moth (×4). From the Journal of the South-Eastern Agricultural College.

tomentosus, Fab.), but there is put forward for consideration an interesting statement from "an old book" to the effect that woolly aphis may be cured by planting a nasturtium against the infested tree. But the two

[1] The Journal of the South-Eastern Agricultural College, Wye, Kent. No. 19. Pp. 426. (London and Ashford: Headley Bros., 1910.) Price 7*s.* 6*d.* (Residents in Kent and Surrey, 3*s.* 6*d.*)

problems Mr. Theobald considers of most pressing importance are the bionomics of nematodes and the study of Strongylidæ. Nematodes are responsible for considerable losses to the hop-grower, the market-gardener, the strawberry-grower, and the farmer; they have long been known to damage cereal crops, and are now recognised as potato pests. The Strongylidæ are serious parasites of sheep and other animals, yet nothing is known of the life-history of the commonest form.

We reproduce a very good photograph of a female March moth (*Anisopteryx aescularia*, Schiff.) laying her "egg band" on a twig.

The report from the Analytical Laboratory deals with the more interesting of the 377 samples sent in for analysis.

In the report from the Botanical Department, Mr. S. T. Parkinson describes some interesting experiments that will be new to many people in this country. It will be remembered that, in 1909, Prof. Molisch, of Prague, published a paper in which he advocated that perennial plants, while still in their resting stage, should be dipped in hot water prior to forcing. In the resting period he distinguishes between the "unfreiwillig" and the "freiwillig" rest; the former, being inherent in the nature of the plant, cannot be altered; the latter, being dependent on the external circumstances, can be shortened. By steeping the plant in hot water at the proper time the "freiwillig" period is therefore cut out, and its cells spring into activity, thus it has such a start over the untreated plants that it comes to maturity well before they do.

Fig. 2.—Photograph of "Dipped" (D) and Cont l (C) plants of Spirea. "Dipped" November 25; photographed December 13. From the Journal of the South-Eastern Agricultural College.

Without committing himself to this particular hypothesis, Mr. Parkinson has carried out numerous experiments, and finds that an exposure of about twelve hours to a temperature of 95° F., or, in the case of soft plants, such as seakale, to 85° F., just after the period of "deepest rest," *i.e.* the end of November or beginning of December, led to very rapid growth. Numerous photographs are given, one of which is reproduced in Fig. 2. Further studies of this interesting problem will be awaited with interest.

Experiments are recorded by Mr. Garrad on the growth of tobacco for nicotine extraction. Nicotine makes an excellent wash for fruit-trees and hops, but its price (12*s.* per lb.) is too high. Mr. Garrad shows that he produced it at 6*s.* per lb., which, if it turned out a normal cost of production, would make a profitable industry. Mr. Garrad's Indian experience has stood him in good stead, and a continuation of the work would be very useful.

Mr. E. S. Salmon's report makes very sad reading. It seems but a few years ago since he announced that a gooseberry disease had appeared in Ireland and must inevitably spread to this country, with alarming results, unless certain precautions were adopted. Unfortunately his words fell on deaf ears, and it is a matter of history that no steps were taken to exclude the disease; trouble that had not yet appeared could not rouse the authorities to action. When the disease finally came over its seriousness was at first denied, and now that many hundred acres are affected and the disease is rapidly spreading, a plan of campaign has been organised in some, *but not in all,* districts. Thus Kent is efficiently inspected by trained inspectors, while Surrey and Sussex are not.

If the serious losses now being incurred could teach all concerned a few elementary facts about plant diseases, the lesson would still be worth having, however dearly bought, but we seem to be in for equal or greater losses from a potato disease known as the Wart Disease or Black Scab. The disease is here and is spreading, yet nothing adequate is being done. It is not surprising that the Pests Committee of the Central and Associated Chambers of Agriculture should, in a communication to the Board of Agriculture, "earnestly recall your attention to the last paragraph of their report, dated December 1st, 1908, in which they suggested that the Board should appoint an advisory committee of experts to assist the Board in dealing with plant diseases generally, as recommended by the Departmental Committee on the Fruit Industry."

A JUNGLE FOLK.[1]

THE Veddas of Ceylon have long been regarded as one of the most interesting of the varieties of mankind, and one way and another a good deal has been written about them in various journals and books, but the information was usually scrappy and not always trustworthy. An exception must, however, be made to the careful work of John Bailey in 1863, and the sympathetic investigations of Hugh Nevill, whose valuable notes are to be found in a scarce journal, *The Taprobanian.* In "Ancient Ceylon" (1909), Mr. H. Parker gives a useful summary of our knowledge of the Veddas, together with the results of his own observations on the village Veddas. For the physical anthropology we are mainly indebted to Virchow (1881), who studied the craniology of the Veddas, and to the magnificent memoir, "Die Weddas von Ceylon," by the cousins Sarsin; this monograph deals also with their material culture, but the account of Vedda sociology is much less satisfactory. It was evident to ethnologists that the sociology and religion of the Veddas needed to be studied carefully by modern methods of sociological field research, as these people undoubtedly are little-modified representatives of a very ancient human stock, and there was a danger, owing to the very small number of the wilder bands and their gradual

[1] "The Veddas." By Dr. C. G. Seligmann and Brenda Z. Seligmann. With a chapter by Dr. C. S. Myers and an appendix by A. Mendis Gunasekara. Pp. xx+463+map. (Cambridge: The University Press, 1911.) Price 15*s.* net.

adoption of a more civilised mode of life, that their customs and beliefs might become obsolete. On being approached on the subject, the Ceylon Government, with their customary public spirit, voted a liberal grant for this purpose, and Dr. C. G. Seligmann was selected to undertake the research. He was accompanied by Mrs. Seligmann, and to her in no small measure must be credited the success of the expedition. The Veddas are a shy and intensely jealous people, but the presence of a woman in the party led to very friendly relations being established, and Mrs. Seligmann proved herself to be a first-class investigator in the field. Their results are now published as one of the Cambridge Archæological and Ethnological Series of the Cambridge University Press.

FIG. 1.—Kirikoraha ceremony. The shaman tracking the sambar (Henebedda). From "The Veddas."

Mr. Parker is inclined to believe that the forebears of the present few hunting Veddas were more civilised, and that the existing condition is a reversion to the forest life of their remote forefathers; the Seligmanns, however, regard the hunting Veddas as direct survivals of the primitive Veddas, and the traditions of a higher state of culture as mainly due to confusion between the Veddas and Kandayans of mixed Vedda descent, who until recently called themselves Veddas, or were known as such to their neighbours. A brief account is given of the various Vedda communities; the Danigala Veddas are the show "wild Veddas" described by so many travellers; although really well-off, they pose as poor, morose, wild men of the jungle—they are, in fact, professional savages.

The Vedda system of relationship is a late form of the kind known as classificatory; the working basis is the marriage of the children of brother and sister, but not of two brothers or sisters. Before marriage a man pays at least as much regard to his future father-in-law as to his own father, but after marriage the association between father-in-law and son-in-law becomes very intimate. The social system is an exogamic clan organisation with female descent. Two clans are regarded as socially superior to the others, and their members do not marry into the inferior clans. The Veddas greatly prefer living in rock-shelters to huts, but they shift their home two or three times a year as the season demands. Most of the caves shelter several families, but each family keeps strictly within its own limits. There are no puberty ceremonies for either sex, except among certain Veddas who have been much influenced by Tamils or Sinhalese. The Veddas marry young, and are strictly monogamous. A rigid sexual morality prevails, but at present, among the more sophisticated groups, an unmarried girl is allowed considerable liberty with regard to the youth allotted to her. The country is divided into hunting lands for the different groups, within which each individual has the exclusive hunting rights of a particular area or areas; when dying, a man generally gives his land to his sons, and not to his sons-in-law, but no landed property passes without the consent of the grown men of the group. Trespass is almost unknown. The religion of the Veddas is essentially a cult of the dead; with this is associated the cult of spirits, *yaku*, of certain long-dead Veddas who may be regarded as legendary heroes. The chapters dealing with the magico-religious practices and beliefs are of great interest and importance. The ceremonial dances are described and illustrated with great detail; the majority are pantomimic, and are performed with the object of becoming possessed by a *yaku*; the Seligmanns believe that there is no considerable element of pretence in the performance of the shaman.

Dr. C. S. Myers has a chapter on music, based on thirty-four phonographic records. In the Vedda music we seem to meet with the very beginnings of melody-music; there is no other people in whose music the gradual construction of music on such simple lines can be discerned. A number of Vedda songs have been transliterated and translated by Mr. A. M. Gunasekara, and Mr. Parker has done the same for the invocations. The senses of the Veddas were also tested. Enough has been said to show that this book

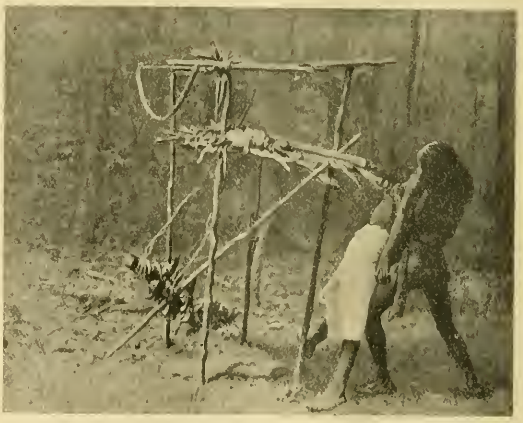


FIG. 2.—Bambura Yaka ceremony. The boar is at length killed; the possessed shaman collapsing into the arms of a supporter (Sitala Wanniya). From "The Veddas."

is of first importance, and it may be considered as the final word on the subject, as it is improbable that we shall ever learn much more about the Veddas. The Ceylon Government is to be congratulated in having secured the services of Dr. and Mrs. Seligmann for this important research. A final word of praise is due to the number and excellence of the photographs; those illustrating various ceremonies are of exceptional interest.

A. C. HADDON.

THE COAST EROSION COMMISSION.

IN July, 1906, a Royal Commission was appointed to inquire and report as to the encroachment of the sea on the coasts of this country, and as to what means are desirable for the prevention of such damage; also as to the reclamation of tidal lands as affecting the subject of unemployment. Two years later the duties of the Commission were extended to an inquiry as to whether it is desirable to make an experiment in afforestation as a means of increasing employment during periods of depression.

The Commission consisted of thirteen members, representing landowners, experts in coast defence works, geologists, lawyers, the Board of Trade and other Government departments. The Hon Ivor Guest was appointed chairman. The first report, containing the minutes of evidence heard in the earlier part of the inquiry, was issued in 1907; the second report on the subject of afforestation in January, 1909; that now issued being the final report containing the findings of the Commission.[1]

The witnesses who appeared before the Commission represented all branches of the subject, including representatives of the Board of Trade, local authorities and their officers having charge of the sea coast in England, Ireland, and Scotland, owners of land abutting on the coast, engineers having expert knowledge of sea defence works, and geologists. Committees of the Commissioners made inspections of various parts of the coasts where erosion was going on, and where reclamations had been made; and also of the works of sea defence in Holland and Belgium.

As the subject of coast erosion had not been dealt with by any previous Commission, the Commissioners thought it necessary to make an ample and thorough examination of the whole subject. The report is divided into an inquiry into the physiographical and geological conditions affecting the coast-line; an estimate of the extent of erosion and accretion of land; and where artificial reclamation has been carried out on the coasts and in tidal estuaries; engineering questions as to the type of work which has been adopted for sea defences; the central and local administration of the foreshore; and whether it is desirable to promote facilities for reclaiming tidal land; and also as to whether the defence of the coast is a national duty towards which grants of public funds ought to be made.

The inquiries of the Commission extended over five years, and the resulting report gives a very clear and able digest of the large amount of evidence taken. It deals with the subject in an exhaustive and comprehensive manner, and contains an able account of the technical considerations which should govern the design of works of defence. The finding of the Commissioners appears to be a fair exposition of the evidence brought before them, and it deals in an even-handed way with the rights of the owners of land abutting on the coast, on one hand, and of the State, as representing the other tax-paying members of the community, on the other.

The recommendations of the Commissioners are practically unanimous. There are reservations as to some of the subjects dealt with, the most important relating to the subject of the obligation of the State to protect the sea coasts.

The findings of the Commissioners may be summarised as follows:—

That there is a considerable amount of erosion and consequent loss of land taking place on certain parts of the coast; on the other hand, land is being reclaimed from the sea. Taking the last thirty-five years, it was shown by the evidence of the Ordnance Department that 6640 acres have been lost, while 48,000 acres have been gained by reclaiming tidal lands. This reclaimed land is due principally to the accretion of material brought down in suspension by the rivers. The amount and rate of erosion along the coast is governed by the nature and form of the coast. The natural protection of the coast is afforded by accumulations of sand and shingle derived almost entirely from the material eroded from the cliffs. The amount of beach material therefore depends on the amount of erosion going on, and the quantity is limited, and is not inexhaustible.

The material eroded travels along the coast in definite directions, due to the action of the tides, the wind and the waves. Its travel may be arrested by projecting headlands and river mouths.

Much damage to the coast has been incurred by the removal of this beach material in some places for road-making and constructional purposes.

The evidence shows that if works of protection are carried out with due regard to the local peculiarities of the district to be dealt with, and on sound engineering lines, erosion of the coast may be prevented. The fact also is disclosed that a very large amount of money has been wasted on groynes, sea-walls, and other defence works, owing to a want of knowledge of the conditions prevailing in the neighbourhood where the works were carried out; also that works designed solely with regard to the protection of a particular line of coast may lead to increased erosion on the coast to the leeward side, owing to the stoppage of the travel of the beach material. If the land to be protected is ordinary agricultural land, the cost of protection may be greater than the value of the land to be protected.

The Commissioners advise that the whole care of the coast should be placed under the administration of the Board of Trade, who should be constituted the central authority of the United Kingdom for the purpose of sea defence. That the Board should be invested with power to enable it to control the removal of materials from the shore, making it illegal to remove any sand, shingle, or stone without their previous consent being obtained; the approving of works of construction on the shore; the supervision of existing local authorities concerned with sea defences, and, where required, the creation of new authorities for the purposes of supervision of the coast to employ a staff of scientific experts to secure systematic observation of the movement of beach material and for watching the coast in order to prevent removal of such material where doing this would be injurious; also to sanction the borrowing of money by local authorities for defence works, and to determine the period over which repayment should be made. At present this duty rests with the Local Government Board, which only allow a period of ten years for groynes and twenty years for more solid works. This limit appears

[1] Third and Final Report of the Royal Commission on Coast Erosion. The Reclamation of Tidal Lands and Afforestation. (London: Published by his Majesty's Stationery Office, 1911.) Price 3s.

to the Commissioners to operate detrimentally in the case of local authorities.

With regard to the alleged obligation of the Crown to defend the coasts from the inroad of the sea, the Commissioners, with one exception, consider that the evidence laid before them does not warrant this conclusion, and that there is not any settled principle of the Crown or statute law to support the contention that there is a responsibility for sea defence resting primarily upon the nation at large; the fact that there is erosion in some places does not affect the nation generally, and there is not any ground for the contention that sea defence is a national service.

SEASONAL VARIATIONS OF MARINE ORGANISMS.

THE present short article has been written, not for the plankton specialist, but for readers who may have had their interest aroused by some reference in purely technical papers to seasonal variations. Aquatic organisms (vegetable and animal) may be divided into two groups, those which are fixed to the bottom or cannot leave the substratum, and those which are independent of it, and live swimming or floating in the water.

Of the latter, the pelagic organisms, some, such as fishes, swim about actively, whilst others are passive organisms, with but feeble organs of locomotion or none. They float about almost like inanimate objects, at the mercy of tides and currents, and they vary in size from microscopic flagellates up to large medusæ. These more or less passive pelagic organisms (both vegetable and animal) are what Hensen in 1887 characterised under the term plankton. The study of the plankton has advanced by leaps and bounds in the last few years, and fresh discoveries (often the results of new methods and ingeniously devised apparatus) have acted as stimuli to the work.

From being a qualitative science, planktology has become quantitative, and is becoming as exact in its methods as biometrics. Formerly the investigations were considered sufficiently intense and accurate if a net made of fine silk was pulled horizontally through the water, so that the planktonic organisms were filtered out and captured. Now, it is necessary to use other methods, to pass the water through special filters, and to centrifuge measured quantities in order to catch those exceedingly small creatures which pass quite easily through the finest silk cloth. These very small organisms are of supreme importance, for what they lack in size they make up for in numbers, and some of the most keenly discussed theories in marine biology of the last few years may have to be seriously modified when more detailed observations have been made on their occurrence.

Serial investigations have shown that the plankton varies both qualitatively and quantitatively through the different seasons. It is never absent even under an ice cover in fresh-water lakes, and just as the opening of the buds serves as an indication of spring, so the appearance of certain organisms tells of the approach of the same season in the waters. Summer and autumn are both equally well marked in the aquatic world, and this applies to the seas as well as to lakes and ponds.

Some organisms are always present, but most planktonic animals and plants appear at certain seasons, and then disappear, whilst others take their places. In fact, it is quite impossible to write an account of the plankton of any waters from a series of catches made in a period of a few weeks only. A plankton investigation must extend through at least one year, so that catches may be examined representative of all seasons. If such a research be carried out it becomes at once obvious that the plankton varies according to certain external conditions, amongst which might be enumerated, sunlight and temperature of the water, chemical constitution of the medium, and, finally, the motion of the latter, particularly as regards vertical currents.

The application of quantitative methods to the study of the marine plankton has shown that, contrary to all expectation, the colder waters of the globe are more productive than those of the tropics. Compared with temperate and Arctic seas, the open ocean of the tropics is a desert so far as the plankton is concerned, with occasional oases. In our own waters the quantity of plankton present varies enormously during the year. Catches made with a net hauled vertically under the same conditions average perhaps about 1 c.c. in volume during the early months of the year. In the short space of a week in March or April, this volume may rise to 40 c.c., or even more, and remain constant for a period of some weeks, falling eventually to about 1 or 2 c.c. again during the summer. It is of the utmost importance that the causes of these variations in the quantity of the plankton should be discovered. What determines the productivity of any particular region? Why is there an extraordinary increase in quantity during certain weeks of the spring and autumn? These are amongst the most fundamental questions in the biology of the sea.

If every year was the same so far as meteorological conditions were concerned, and the plankton variations of successive years were absolutely identical, we should never be able to do more than make speculations as to the causes of such variations. Nature, however, varies the meteorological and hydrographical conditions for us, and we find that there are also corresponding annual variations in the plankton. Thus the spring and autumn maxima of the latter may be earlier one year than another, or may extend over a longer period. It is the work of the planktologist to analyse these changes and endeavour to correlate plankton variations with hydrographical and meteorological conditions.

In the Irish Sea, for example, an attempt has been made by Prof. Herdman and others to arrive at some of the causes of the seasonal variations by taking serial plankton catches through a period of several years, the hydrographic conditions prevailing being also observed. It ought to be possible in this way to correlate certain biological and physical variations. It was found in the first years of this plankton investigation that the spring and autumn maxima were due to a large extent to an enormous increase in diatoms, an increase followed by the appearance of dinoflagellates. The copepods followed these spring dinoflagellates, and attained their greatest development in the early summer. This order of succession has held good throughout all the years of this investigation (1907–11). Whilst, however, the highest monthly averages were in April in 1907 and 1910, they occurred in May in 1908 and 1909. The two years, 1907 and 1910, resembled one another so far as meteorological conditions are concerned in having a larger amount of sunshine during the early months than was the case in 1908 and 1909; and the question arises whether this early sunshine was a determining factor in the early appearance of the vernal maximum.

It was expected that this year, 1911, would perhaps throw some light on the question, and whatever the result may be when the hydrographic and meteorological conditions are worked out, the plankton maximum has certainly been very different from that of any of the previous years.

Up to the present the cause of the vernal phyto-plankton maximum still seems to be wrapped in mystery, and the same may be said of the greater productivity of the cooler waters.

Several theories have been proposed from time to time by Brandt and others to explain the vernal maximum, and of these Nathanson's appears to be the most fundamental. This author believes that vertical currents, which aid in the circulation of food materials, are responsible for the productivity of the sea in plankton. These currents are always present at certain places, and there one can always rely on finding a rich plankton. They are also present at certain seasons in other larger areas of the sea, and in lakes, and these seasons correspond to the times of maxima.

It is most probable that this explanation is not sufficient alone, and that the sunlight, the temperature of the water, and the chemical constitution are also determining factors.

The conditions surrounding the plankton are very complex, and it will probably require many years of investigation before the predominant factors in the problem can be discovered.

The work is slow and laborious, but still it aims at the solution of one of the most important problems in the metabolism of the ocean. This is the point of view from which the planktonic work at the Port Erin Biological Station is being carried out under Herdman's direction, and similar work is being prosecuted by planktologists elsewhere. It has lately been asserted that the most important part of the food of aquatic organisms is derived from organic compounds in solution in the medium in which they are living. At the present time it is impossible to say with any certainty how far this thesis may be correct, but whether it be the case or not, the plankton still retains its importance as either the immediate or the ultimate source of those organic substances upon which all marine and fresh-water animals depend.

WM. J. DAKIN.

NOTES.

IT is announced in the July issue of *The Popular Science Monthly* that during his visit to Washington at the time of the annual meeting of the National Academy of Sciences Sir John Murray, K.C.B., F.R.S., presented a fund of 1200*l.* to the academy for the purpose of founding an Alexander Agassiz gold medal, which is to be awarded to men of science in any part of the world for original contributions to the science of oceanography.

WE regret to announce that Mr. W. I. Last, director of the Science Museum, South Kensington, died on August 7 at his residence, 11 Onslow Crescent, S.W., in his fifty-fourth year. Mr. Last was apprenticed in 1873 with Messrs. Hayward Tyler and Co., and when barely twenty years of age won the Senior Whitworth Scholarship; he held his scholarship at the works of Sir Joseph Whitworth, and at the same time he followed a course of study at the Owens College, Manchester, gaining numerous prizes during this period. In 1886 he was elected an Associate Member of the Institution of Civil Engineers, and in the following year the council awarded him a Watt medal and a Telford premium for his paper on setting out the curves of wheel teeth. In 1890, after some years spent in practical work at home and abroad, he was appointed to the post of keeper of the machinery and inventions division of the South Kensington Museum; shortly afterwards the naval division was also entrusted to his care. Recognising that objects which involved mechanical movement are most intelligible as well as most attractive, both to students and to the public, when shown in motion, he arranged numerous ways of effecting this under museum conditions. One of the best methods which he devised and introduced for this purpose was the supply of compressed air for working the objects by their own driving mechanism. The plan of sectioning objects to show the working parts of machines and details of construction was carried out by Mr. Last with much success. The collections have been very widely extended under his supervision. Mr. Last received his appointment as director of the whole Science Museum in 1904. The excellence of his work on the collections was the subject of comment in connection with the recent inquiry as to the museum.

THE death at Nice is announced, at the age of seventy years, of Dr. Louis C. De Coppet, distinguished by his researches on the solubilities of salts and the lowering of the freezing point of water by the presence of salts in solution.

WE are informed by the National Association for the Prevention of Consumption that it has been decided by the Rome authorities to postpone the International Congress on Tuberculosis, which was to have been held in Rome on September 24–30, to next April.

THE London County Council, on the recommendation of the Local Government Records and Museums Committee, has resolved that the whole of the objects of London interest collected by the Council from time to time, including the boat of the Roman period discovered on the site of the new County Hall, be offered on permanent loan to the trustees of the London Museum. The museum will be accommodated in the State apartments of Kensington Palace, which was placed by the King at the disposal of trustees for the exhibition of the collections. The accommodation at Kensington Palace is understood to be of a temporary nature, the intention being eventually to house the objects in a building worthy of London.

IT is announced in *The Times* that an experiment in the direction of utilising aëroplanes in the postal service of the country is likely to be undertaken shortly by the General Post Office. The proposal is for a regular aërial service for a limited period between London and Windsor. Arrangements have been made with a number of large firms for the fixing in their establishments of special "aërial" letter-boxes, in which letters intended for the aërial service must be posted. Daily clearances will be made by postmen, and the collections will be dispatched to the central clearing house. Here the letters will be placed in sealed bags and conveyed by motor-van to the aërodrome at Hendon, where the bags will be securely fixed to the machines. The airmen will then start on the journey to Windsor, covering the distance of 21 miles in, it is estimated, half an hour. At Windsor the aëroplane staff will be responsible for the conveyance from the aërodrome by road of all the letters to the town post-office, where they will be dealt with in the usual way.

THE annual autumn meeting of the Institute of Metals will be held at Newcastle-on-Tyne on September 20–22. Sir C. A. Parsons, K.C.B., F.R.S., is acting as chairman of the local committee, and Dr. J. T. Dunn as honorary secretary. The meeting will open at 10 a.m. on Wednesday, September 20, when the members will be welcomed at Armstrong College by the Lord Mayor of the city, Sir W. H. Stephenson, and the local committee, after which a series of papers will be read and discussed, Sir Gerard A. Muntz, Bart, president, being in the chair. In the afternoon members will have the opportunity of visiting shipbuilding, engineering, metallurgical, and electrical works in the neighbourhood. In the evening there will be a reception of the members and their ladies, followed by a conversazione, in the Laing Art Gallery, by invitation of the Lord Mayor. On Thursday, September 21, papers will be read and discussed at a morning session of the institute, and in the afternoon there will be further visits to works. For September 22 the Tyne Improvement Commissioners have placed a steamer at the disposal of the local committee for a voyage to the mouth of the river and back.

THE ninth annual meeting of the South African Association for the Advancement of Science was held at Bulawayo on July 3–8, under the presidency of Prof. P. D. Hahn. The meeting was attended by members from Cape Town, Johannesburg, Salisbury, &c. The sectional presidents were as follows:—Section A, Rev. Father Goetz, S.J.; Section B, A. J. C. Molyneux; Section C, F. Eyles (Rhodesia); Section D, G. Duthie. In addition to the presidential addresses, numerous papers were read before the various sections. In particular, Mr. R. N. Hall's papers dealing with the Zimbabwe ruins gave rise to considerable discussion. Papers were read before Section A on electric clocks, by Prof. H. Bohle; aviation in South Africa from a meteorological point of view, by R. T. A. Innes; atmospheric electricity observations, by Prof. W. A. D. Rudge. Many interesting excursions were arranged by the local Bulawayo committee. The Khami ruins and various Bushman haunts were visited under the guidance of Mr. R. N. Hall. A pilgrimage was made to Rhodes's lonely grave in the Matopos, and after the conclusion of the meeting several days were spent at the Victoria Falls.

IN the July issue of *The Quarterly Review* Mr. E. Clodd contributes a useful criticism of totemistic theories under the title of "Primitive Man on his Origin." While cordially welcoming Dr. Frazer's monumental treatise on totemism and exogamy, he is unable to accept his explanation of the origin of totemism from the Arunta theory of conception, mainly on the ground that it does not account for the clan totemism, which is admittedly of primary importance, and because, so far from being the most primitive, the Arunta are probably the most advanced of the Central Australian tribes. He is inclined to prefer Mr. A. Lang's solution that at the earliest period the groups were nameless; that later on they obtained soubriquets chosen from their fancied resemblance to this or that object; "no more than three things—a group animal name of unknown origin; belief in a transcendental connection between all bearers, human and bestial, of the same name; and belief in the blood superstitions—was needed to give rise to all the totemic creeds and practices, including exogamy." Needless to say, this solution involves certain special difficulties, of which Mr. Clodd is fully aware. The result of the discussion is to increase the feeling of doubt if any single solution hitherto advanced of the complex group of facts labelled as totemistic offers a reasonable explanation of them.

THE Journal of the Gypsy Lore Society continues its useful task of studying the eastern European groups of this interesting race. We have two articles of special importance, one an account of the Gypsies of Central Russia by Mr. D. F. de l'Hoste Ranking, the second of the organisation of the South German Gypsies by Mr. E. Wittich. The predatory habits of the Russian group amply account for the fear and hatred felt towards them by the rural population. On the other hand, in Germany their moral standard seems to be decidedly higher, and their tribal organisation provides for the control of social order by the trial of offences committed by members under the superintendence of their chief at an annual assemblage held in Elsass, where the proceedings are conducted in secret session. This festival, however, often ends in a general free fight between rival members of the tribe, who take this opportunity of gratifying their feelings of revenge for bloodshed or other injuries. If a reconciliation of such quarrels is effected it is done by the exchange of glasses charged with their favourite liquor. The tribal code of social morality, with its curious system of taboos, one being that a man who eats or drinks out of a vessel which a Gypsy woman has touched with her dress or stepped over becomes an outcast, will be of much interest to students of primitive usages.

IN the same issue of the Gypsy Lore Journal Mr. J. Teutsch describes a curious form of primitive lathe, revolved by a string, which is used by Gypsy spoon-makers at their settlement in Kutusch, north of Kronstadt. The bowl of the spoon is first shaped with a set of knives and scrapers. The handles are then turned in this rude lathe, the woman worker decorating them with a series of circular stripes and bands by pressing against the wood as it revolves a rag soaked in a green dye and moistened in saliva. The method furnishes some analogies to that used by the Indian makers of so-called "Benares toys," in which, by means of a similar rude lathe, pieces of lac of various colours are pressed against the toy as it is revolved, the heat produced by this friction causing the lac to become partially melted, and leading to the deposit on the wood of thin streaks of colour.

DR. DANIEL STARET communicates to the current number of *The Psychological Review* an interesting experiment upon the influence of suggestion, or unconscious imitation, on handwriting. More than a hundred persons were investigated by the following method. Each person was provided with a set of five sheets, on the first of which was written the instruction: "We desire records of your handwriting. Will you accordingly write out the words and sentences presented on the pages given you. Kindly do this without further questioning or reflection." The second sheet contained a short paragraph of typewritten material, the subject's written copy of which provided an illustration of his (or her) normal handwriting. The third sheet was of vertical, the fourth of slanting, script; the fifth contained unusually large script, all taken from American "copy-books," and written out by the subjects of the experiment. The measurements of the slope of the subjects' handwriting were subsequently made by means of a scale of variously inclined lines drawn on transparent paper, which was superimposed on the handwriting: three letters, *l*, *f*, *p*, were selected for measurement. The size of the letters was determined by measuring their horizontal width, the lengths of entire words being measured and divided by the number of letters. All the subjects who were investigated appeared to be (unconsciously) susceptible to this form of imitation, women showing a greater tendency towards imitation than men, and those persons who showed a large amount of change in slope also showing a large increase in the size of the letters. The more "vertical" writers were, of course, influenced more by the sloping than by the vertical copy; the opposite relation obtained with the more "slanting" writers.

THE composition of Indian yams, as furnished by chemical analysis, is discussed by Mr. D. Hooper in a short note published in the Journal and Proceedings, Asiatic Society of Bengal (vol. vii., No. 3). Compared with potatoes, yams contain a larger proportion of fat and a smaller proportion of carbohydrates. The alkaloid dioscorine was detected in the tubers of several species, notably *Dioscorea daemona*; it appears that cultivation tends to reduce the amount of alkaloid.

Under the title of "Album général des Cryptogames," a new and elaborate iconograph arranged by Dr. H. Coupin is being published by the Librairie générale de l'Enseignement, Paris. It is announced that the work will deal with algæ, fungi and lichens, and that every genus and most of the species will be illustrated. A beginning is made with the lowest organisms, and the first volume, containing fifteen plates, illustrates eighty-three species under thirty-seven genera representing the family Chrysomonadineæ and part of the family Dinoflagellatæ; under the genus Gymnodinium seven species are illustrated in thirteen figures. The text is limited to a brief description of the figures, habitat, generic synonyms, and a reference under each species to the literature where fuller information can be found. The price of each part is 2.50 francs, but no estimate of the number of parts is offered.

An article on the formation of anthocyanin in plants, communicated by Miss M. Wheldale to *The Journal of Genetics* (vol. i., No. 2), provides a carefully reasoned discussion of the chemical processes involved with the view of substantiating a proposed hypothesis explanatory of the mechanism underlying the phenomenon of soluble pigment formation. The arguments are based upon data derived from observations upon the general distribution of pigment, its formation, the conditions which lead to its appearance, and the enzymes detected at the time of its production. According to the hypothesis formulated, the soluble pigments of flowering plants, collectively termed anthocyanin, are oxidation products of colourless chromogens of an aromatic nature which occur in combination with sugar as glucosides; the process of formation of glucoside and water from chromogen and sugar is reversible; the chromogen can only be oxidised to anthocyanin after liberation from the glucoside, and the process is controlled by one or more oxidising enzymes.

From the report recently to hand on the work of the Edinburgh and East of Scotland Agricultural College, it appears that all the classes are overcrowded, and the lack of accommodation is now causing serious inconvenience. The fact that the number of students last season exceeded all previous records shows that useful work is being done, and is taken as an indication that, with better accommodation and with a college farm, even better work could be turned out. Bulletins are also issued by Mr. Bruce on potatoes and on grass land, demonstrating the kind of return that may be expected from applications of artificial manures.

An interesting bulletin issued by the Nyasaland Department of Agriculture shows the great progress that has been made in the development of the cotton industry. The total export of cotton from the Protectorate is valued as follows:—

		£
1903	... ...	3
1904–5	... ...	5,914
1907–8	... ...	13,999
1908–9	... ...	28,355
1910–11	... ...	52,853 (eleven months only).

According to Mr. McCall, the director, there is still the possibility of much further growth. Some of the problems connected with the extension of the crop are discussed in the bulletin.

In making provisional estimates of the yields of crops, it is customary in the United States and in Canada to express the condition in terms of a hypothetical "normal" or "standard" crop. Mr. H. D. Vigor discusses the method in a recent issue of the Journal of the Royal Statistical Society, and shows that it has no sound statistical basis, since the standard for measurement is largely constructed in the imagination of the individual reporter. The various difficulties that arise when statisticians attempt to make deductions from the results are dealt with, and it is shown that a sounder method would be to express the probable yield as a percentage of the average yield during some convenient preceding period.

We have received from Mr. J. B. Rorer, mycologist to the Board of Agriculture, Trinidad, his report for the year ended March, 1911, in which it is stated that the cause of two troublesome cacao diseases, the canker and black rot, has been successfully traced. It appears that both diseases are caused by one and the same fungus, *Phytophthora faberi*. A bacterial disease of bananas and plaintains is also described by him, and the organisms have been isolated; they are similar to *B. solanacearum*, and are provisionally being called *B. musae*. Much attention is given to the mycological problems of the West Indies in *The Agricultural News*, the official organ of the West Indian Agricultural Department. Descriptions are given in several of the recent issues of miscellaneous fungi found during the past few months, some of which have not yet been identified.

One of the most promising methods of effecting improvements in agriculture is to bring to the notice of experts and of farmers those practices that are found useful elsewhere. It does not follow that a plan must necessarily succeed in any one place because it has been found beneficial in another, but a discussion of the factors cannot fail to be fruitful. The *Bulletin de la Société d'Encouragement pour l'industrie nationale* periodically publishes very interesting accounts of the agriculture of particular countries or districts, several of which have been referred to in these columns. In the current volume a good description of Canadian agriculture has appeared, and also of the agriculture of the Saint Brieuc district of Brittany. The method is one that might usefully be adopted more widely, and has in the past been used with great advantage in this country.

Public opinion in Australia is awakening to the harm done—to put it on no higher level—by the ruthless extermination of birds which modern millinery seems to demand, and to which heedless sportsmen contribute in no small degree. The matter is now being taken up by *The Journal of Agriculture of South Australia*, and in recent issues coloured pictures of protected birds and their eggs are given, with brief notes on description, habitat, food, &c. "The killing of our wading birds each year," it is stated, "not only renders South Australia ever more prone to plagues of grasshoppers, but is most certainly a prime cause of the decline of our fish resources. . . . In a day one ibis was found responsible for the destruction of 2410 grasshoppers, or so-called locusts. Yet each season this lovely and useful bird, together with numbers of cranes, spoonbills, and egrets fall victims. . . . It is the decimation of such birds which leads to the ever-increasing multitudes of crustaceans that destroy fish-spawn and young fish hatching out." We wish our contemporary success in its crusade.

In *The Agricultural Journal of India* (vol. vi., part ii.) Mr. Keatinge continues his account of the rural economy of the Bombay Deccan, dealing now more particularly with capital. A high rate of interest prevails for several reasons: capital is scarce in the country, and there is no organisation enabling the cultivator to get into touch with the money markets of the towns; security is not always good, and the money-lender incurs some social odium. In consequence, a man raising a mortgage on good land has even in favourable circumstances to pay 9 per cent. interest, while in less favourable circumstances he may have to pay up to 24 per cent., and on personal security the rates go up to 100 per cent. There are two papers on cotton, one by Mr. G. S. Henderson on the exotic cottons in Sind, and one by Mr. P. Venkayya on the Cambodia cotton, a hardy long-stapled annual, yielding lint of a superior white colour. An interesting summary of the cotton investigations now in hand by the United Provinces Department of Agriculture is given by Messrs. H. M. Leake and A. E. Parr in part i. of the same journal; these fall under two headings, the production of an improved type or types suited to the conditions of the Provinces, and their introduction into general cultivation.

The growing importance of the Suez Canal is shown by a Parliamentary paper recently issued, which gives the return of the shipping passing through the canal for the years 1908, 1909, and 1910. The net tonnage of the past year shows an increase of nearly three million tons as compared with 1908. The gross receipts in 1910 were the largest reached. The percentage of the British vessels amounted to 62·9 as compared to those of all other nations, Germany being second with 15·5 per cent., both showing an increase over previous years, while the remaining 21·6 per cent., representing all other nations, remain practically at the same rate.

The annual report of the conservator of the River Mersey shows that since the commencement of the dredging and deepening of the bar at the mouth of the river upwards of 161 million tons of sand have been removed, the quantity for last year being $18\frac{1}{3}$ million tons. The minimum depth of water maintained in the centre of the dredged channel is 30 feet 3 inches. Dredgers are now being employed in deepening the channel off the Askew Spit, the revetment on the south side of Taylor's Bank having been completed in November last. The report also states that during 1910 nearly two million tons of silt were dredged from the channel of the Manchester Ship Canal, the whole of which would have found its way into the estuary of the Mersey had not the canal works interposed.

Four years ago a scheme of irrigation was inaugurated for supplying water for agricultural purposes in a district in Canada near Calgary. The area of the district to be irrigated covers three million acres, and involves the construction of 4500 miles of canal, of which 1500 miles have now been completed. The main canal is 17 miles in length and 120 feet wide at the water-level, and is supplied from the Bow River. Storage is provided by a reservoir 3 miles long by half a mile wide, with a depth of 40 feet. The total cost of the whole work is estimated at three million pounds. In other parts of Canada also extensive irrigation works are in progress, notably in the fruit districts of Columbia. In this district the rainfall ranges only from 9 to 10 inches as a maximum, falling to as little as 2 inches in dry seasons. Without irrigation the land in this dry district would be worthless. The area of Canada which is being opened up for fruit farming by irrigation extends over 30,000 acres.

Communication No. 122 from the physical laboratory of the University of Leyden contains a paper by Prof. Kamerlingh Onnes on the disappearance of the electrical resistance of mercury at the very low temperatures obtained when liquid helium boils under reduced pressure. The resistance of the mercury filament in the liquid state at 0° C. was 173 ohms; in the solid state at the same temperature it would, if its temperature coefficient of resistance remained constant, have a resistance of 40 ohms. At 3° absolute its resistance had sunk below 3×10^{-6} ohms, that is to say, one ten-millionth of its resistance at 0° C. The resistance of constantin (eureka) remained nearly constant over the same range of temperature. In a second paper Prof. Onnes and Mr. A. Perrier show that paramagnetic and diamagnetic substances the magnetic susceptibilities of which at ordinary temperatures vary inversely as the absolute temperature at these very low temperatures, deviate considerably from Curie's law.

In the Bulletin for 1910 of the International Association for Promoting the Study of Quaternions and Allied Systems of Mathematics, in addition to the usual list of members and the additions to the bibliography during the preceding year, there are some reviews by Prof. J. Birnie Shaw, the secretary. The most important is the critical examination of Burali-Forti and Marcolongo's books on their new notation for vector analysis. Prof. A. Macfarlane, the president, communicates a short address, followed by a paper on the unification and development of the principles of the algebra of space. Here the author gives a well-arranged argument in favour of his system of what might be called versorial analysis. He corrects Hamilton's view of the quaternion exponential, and develops what is undoubtedly a self-consistent system, in which the square of the vector is kept positive, and associative flexibility is obtained by the introduction of the imaginary. Complexities of an unexpected kind seem to spring out of his method, but as a piece of analytical reasoning it is of great interest. No illustrations are given of the practical value of the method.

A small self-contained machine for the grinding and polishing of metal specimens for microscopic examination has been brought out by Messrs. R. and J. Beck, Ltd., and the apparatus possesses certain advantages which should render it particularly useful to metallurgists. The whole machine is carried on a small iron bed-plate, and consists essentially of a small enclosed electric motor of a substantial type and the polishing spindle proper; the motor drives a counter-shaft, and from this the drive is by a range of three-speed pulleys to the polishing spindle. The polishing discs themselves are detachable from the spindle, and run in a carefully designed casing, which not only serves to catch the spent polishing materials, water, &c., but also serves as a rest to the hand of the operator, and in an emergency saves the specimen from injury if it should accidentally escape from the operator's fingers. The attachment of the polishing cloth to the discs takes the somewhat novel form of a fairly stiff steel spiral spring acting as a species of garter, and, provided that the spring is strong enough to resist the centrifugal action at high speeds, this forms a most convenient form of attachment for both cloths and papers. With the addition of a suitable rheostat for controlling the speed of the motor, the machine should prove equal to all requirements for metallurgical polishing, although the use of separate machines

—in separate rooms, if possible—for grinding and polishing, respectively, is to be advocated.

Two years ago it was shown by Ramsay and Usher that a solution of thorium nitrate, left to itself for some months, gave off a certain quantity of carbon dioxide, and that under the action of the radium emanation the thorium solution gave off this gas much more rapidly. The view was put forward that the carbon of the carbon dioxide might have been produced during a transformation of the atoms of thorium by the action of the radium emanation. In the *Comptes rendus* of the Paris Academy of Sciences for July 24 M. Herschfinkel gives a description of a repetition of these experiments. The production of a trace of carbon dioxide by the solution of thorium nitrate left to itself, and the increase of this amount under the influence of the radium emanation, were confirmed. It was, however, found that oxidation of the thorium nitrate with a solution of potassium permanganate also gave rise to the production of carbon dioxide, and this in spite of the great care taken in preparing a pure salt. The conclusion is drawn that the appearance of carbon dioxide under the conditions of this experiment cannot be taken as any evidence of the production of carbon from atomic transformation of the thorium.

An article on scientific management and efficiency in the United States Navy, by Walter B. Tardy, appears in *The Engineering Magazine* for July. Less than 3 per cent. of all the shells fired in the battle of Santiago by the American fleet hit the enemy. There is no record that a single 12-inch or 13-inch shell took effect. The ranges were less than 3000 yards. Recently the *New Hampshire* used the old *Texas* as a target, firing at ranges from 10,000 to 11,500 yards, and landed whole salvos on the *Texas* whenever she wished. The *Michigan*, an all-big-gun ship, recently made twenty-two 12-inch hits at ranges of 10,000 yards while steaming at 15 knots, the target being only 60 feet long by 30 feet high. She fired forty-eight 12-inch shells, the percentage of hits being about 45; the shots were fired at the rate of about two per minute per gun. Organisation and strict attention to details are responsible primarily for the great improvement shown. Among other matters, coaling has received considerable attention, and the rate has been improved from 30 or 40 tons per hour to 200 tons per hour for the entire coaling period; some ships have taken on and trimmed as much as 350 tons per hour for the entire coaling period, with a record of about 550 tons for the best hour.

OUR ASTRONOMICAL COLUMN.

Rediscovery of Encke's Comet, 1911*d*.—A telegram from the Kiel Centralstelle announces that Encke's comet was discovered by Dr. Gonnessiat at the Algiers Observatory on July 31. Its position at 15h. 54·5m. (Algiers M.T.) was R.A. = 7h. 27m. 54·5s., dec. = 26° 54′ 6″ N., and its brightness was estimated as being about equal to the tenth magnitude; this position lies in Gemini very little south of Castor and Pollux.

Owing to its faintness and unfavourable position, it was not expected that this famous comet would be easily detected at this return; only under the most favourable conditions has it ever become a naked-eye object. The comet is famous as being the first short-period (3·3 years) comet for which the periodicity was established, and also for its very slow but persistent acceleration, which was held to be a demonstration of the existence of a luminiferous æther. According to M. Bosler and others, its brightness varies with the sun-spot activity through the eleven-year period.

Stellar Parallaxes.—Dr. Schlesinger's discussion and summary of his parallax results obtained with the Yerkes 40-inch refractor—the seventh paper of the series—appears in No. 1, vol. xxxiv., of *The Astrophysical Journal*; only a few of the more interesting points can be noticed here. The results for four helium stars included in the programme confirms the proper-motion results in pointing to the fact that this class of stars is situated at an enormous distance from the earth, so much so that, taking averages, a fourth-magnitude helium star is probably as distant as the ninth-magnitude stars in the same region of the sky. Of these four, three give negative and one slightly positive parallaxes; no other star measured gave a negative value.

A practical point elucidated is that with such an instrument as the Yerkes telescope the number of parallaxes that may be determined per annum, with an average probable error of ±0·013″, is about the same as the number of fine nights.

Of the twenty-six stars given in the tabular summary, three, Groombridge 34, P.M. 2164, and Krüger 60, have parallaxes greater than 0·2″; the mean values for these three are 0·266″, 0·282″, and 0·252″ respectively.

During the minute examination of sources of error it was shown that measuring the plates in duplicate adds only 10 per cent. to their weights; such measurements were early discontinued. In some cases a rotating disc was employed to reduce the brightness of the parallax star, and the final probable errors show that no increased error was thereby produced.

Prominences in 1909.—Prof. Ricco's valuable summary of the Catania prominence observations for 1909 appears in No. 6, vol. xl., of the *Memorie di Astrofisica ed Astronomia* (June, p. 83). Compared with 1908, especially with the latter part of that year, the frequency and dimensions of the prominences showed an increase in 1909. Slight differences are seen in the mean latitudes, and the maximum frequencies—in 10° zones—occurred in 20°–29° N. and the 30°–39° S. latitudes. This was the only maximum in the southern hemisphere, but in the northern there was a minor maximum in the zone 50°–59° N. The mean daily frequencies were 1·84 for the northern and 1·81 for the southern hemisphere, while the respective mean heliographic latitudes were 31·9° N. and 27·5° S. On 8 per cent. of the days of observation no prominences were seen during the first half of the year, while only two days (2 per cent.) yielded no prominences during the second half.

The Algol System RT Persei.—Contribution No. 1 from the Princeton University Observatory is a monograph, by Mr. R. S. Dugan, dealing with the observations of the Algol variable RT Persei made at the Halsted Observatory with the 23-inch telescope during 1905–8. After describing and discussing the observations, Mr. Dugan concludes that there is undoubtedly a secondary eclipse, that the two stars are practically equal in size, and that the reality of the light-changes between eclipses is fully guaranteed by the probable error.

Jupiter's Faint Satellites.—Observations of the fainter satellites of Jupiter are being kept up at the Transvaal Observatory. Four good exposures were made during April and May, but on one plate only is J viii to be found. Images of J vi appear on all the plates, and it is estimated that this object is at least two magnitudes brighter than J viii. The places given as yet are not final, but, brought up to the equinox of date, they show good agreement with those given by Dr. Crommelin's ephemeris. Observations of twelve minor planets, five of which are suspected to be new, were made during the satellite observations; temporarily the new ones have been designated T_1–T_5, and their positions are given with the above in Circular No. 8 of the Transvaal Observatory.

The Brightness of Comets 1908 III. and 1910*a*.—The variations in the brightness of Morehouse's comet and in that of comet 1910*a* have been investigated in detail by M. Orlow, who publishes the results in No. 4513 of the *Astronomische Nachrichten*. Eliminating the terrestrial distance, he finds confirmation of the result that a comet's brightness varies more than is expressed by the formula $1/r^2\Delta^2$. The ratio $1/\Delta^2/r^4$ is nearer the observed results, the index of r in the case of comet 1910*a* being 4·6.

PROBLEMS IN SEISMOLOGY.

A GENERAL report of the recent meeting of the International Association of Seismology was given in NATURE of July 27, including Prof. Schuster's presidential address, which touched illuminatively upon the broad problems of the physics of the earth's crust. The following supplementary notes are intended to give a fuller account of the many subjects which were discussed by the seismologists.

Particularly interesting was the report presented by Dr. Hecker, formerly of Potsdam, now of Strassburg, on the tidal strains produced in the crust of the earth. Hecker's well-known results have been supplemented by similar work carried out at Dorpat by A. Orloff, who also gave an account of his measurements of the deformation of the earth's crust under the action of the moon. The method of both sets of experiments is to search for a lunar periodicity in the movements of sensitive horizontal pendulums. If the earth were rigid, these movements, in so far as they are due to the influence of the moon on the vertical at any locality, can be calculated. The experimental results give, however, a deflection of the vertical which is only two-thirds of the calculated value. This is explained on the assumption that the earth's crust yields to the tidal action of the moon. Hecker's and Orloff's results show, moreover, that the force acting on the pendulum is a larger fraction of the moon's force when it acts towards the east or west than when it acts towards the north or south. In other words, the earth seems to be more rigid towards forces acting east or west than towards forces acting north or south. Sir George Darwin suggested that this might be due to the effect of the earth's rotation; and the problem thus presented has been worked out with great skill by Prof. Love in his Adams prize "On some Problems of Geodynamics." He finds that Hecker's result cannot be explained in terms of the earth's rotation, and proceeds to invoke the direct gravitational influence of the tidal wave in the Atlantic Ocean upon the vertical at any neighbouring locality or the pressure effect of the same wave on the bed of the ocean. The International Association propose to follow up the inquiry by establishing new stations in suitably chosen localities, such as Paris, because of its contiguity to the ocean, and a station in the Russian Empire far removed from the Atlantic. The installation of instruments in South Africa, say at Johannesburg, and at some place on the American continent, would also provide results which, in conjunction with the others, might lead to the complete solution of the problem. In carrying out this work the Seismological Association is to be associated with the International Geodetic Association, and funds have been voted for the purpose.

It has thus been established beyond a doubt that the earth's crust yields appreciably to the tidal action of the moon. The measurement of this yielding demands the use of delicate instruments of a type familiar to seismologists, and used by them in the investigation of earthquake movements. Every large earthquake starts tremors through the earth, and these are caught and recorded at a large number of stations in many parts of the globe. Prof. Milne, working through the Seismological Committee of the British Association, was the first to show the value of such a seismological survey; and now it may safely be said that no observatory is complete without a self-recording seismograph. Within the last few years great advances have been made in the perfecting of instruments for registering movements of the ground, and among those who have increased the precision of these instruments Prof. Wiechert and Prince Galitzin are worthy of special mention. Prince Galitzin exhibited at the congress his form of vertical motion seismograph, which utilises the same method of magnetic damping which is characteristic of his horizontal pendulum. The instrument is thus made aperiodic, so that the relative motion of the ground is faithfully recorded. The record is obtained by the action on a delicate galvanometer of induced currents set up in a coil which moves with the boom of the seismograph relatively to a strong magnetic field. The galvanometer is also made aperiodic. Prince Galitzin explained his method of finding the epicentre of an earthquake from records obtained at one place on his two horizontal pendulums. The interval between the arrival of the first and second phases of the preliminary tremors gives, as Milne and Oldham showed years ago, the *distance* of the epicentre. Galitzin has now shown how we may get the *azimuth* from the first indications of the seismograms obtained with aperiodic horizontal pendulums. The ratio of these first displacements in the east-west and north-south records gives the tangent of the azimuth angle referred to the meridian. There is an ambiguity as to the direction along which the epicentre lies, whether, for example, it is N.N.E. or S.S.W.; but this ambiguity is quite removed when the vertical component is obtained. The precision of the method depends upon the fact that the instruments are damped accurately so as just to be in the aperiodic state. By a large number of examples Prince Galitzin showed that the estimation of the position of the epicentre in cases in which the method is applicable was as satisfactory as by the usual method of comparison of times from two or more stations.

The interpretation of the times of transmission of earthquake tremors to places at various distances from the epicentre is one of considerable importance in seismological studies. The curve which shows the relation between distance and time—the hodograph, as many now call it—is not yet known so accurately as one would wish, a fact which was emphasised by Prof. Reid, of Baltimore. Prof. Wiechert's ingenious discussion of inferences to be drawn from the form of this curve has led him to a theory of the constitution of the earth which differs in some respects from other similar theories. To take into account the peculiarities of the hodograph, and especially the flattening of it at mid-stations, which has already engaged the attention of Milne and Oldham, Wiechert finds it necessary to construct the earth of three layers differing in elastic properties, the central core being, in his opinion, made of nickel-iron. A special feature of Wiechert's discussion is the account he takes of the intermingling of disturbances which have travelled to the same station, the one directly, the other after one reflection at the surface of the earth. The theory is admittedly approximate, and may require correction as our knowledge of the hodograph becomes more certain; but the mathematical reasoning by which Wiechert attacks the problem will always have its value apart from the details of any conclusion to which we may be temporarily led.

These three lines of research—tides in the earth's crust, determination of epicentres from observations at one station, and inferences as to the structure and physical properties of the inner parts of the earth—probably bulked most largely in the discussions of the congress. But many other points of interest were touched upon, such, for example, as the elastic properties of rocks, for the measurement of which Dr. Oddone gave a remarkably simple experiment and calculation based on Hertz's expression for the compression of a sphere during impact. Again, in connection with the cause of the microseismic movements of the earth's surface, Prof. Schuster and Mr. Morris Airey exhibited an instrument designed to count the number of waves which beat on the shore. The increase of pressure due to the passing of a wave was transmitted by means of a hydrostatic and electric arrangement, so as to make the recording pen move always with a slight definite motion in one direction at right angles to the motion of the strip of paper on which the record was taken. After 120 minute and individually imperceptible movements were made, the pen moved back automatically to the original position. The record was therefore a series of diagonal lines the inclination of which to the motion of the paper was greater according as the waves came faster. In the records which were shown the period indicated was about six or seven seconds for each wave. This is one of the commonly recurring periods in microseisms.

The idea of measuring the intensity of an earthquake shock by the overturning of blocks is an old one, and engaged the attention of Milne and West in the early 'eighties. Omori also constructed from these indications a dynamic scale. Prince Galitzin showed how the indications might be greatly improved by providing the blocks with edges like the projecting covers of a book. When set oscillating the block executes movements the amplitudes and periods of which diminish in such a way that resonance effects are prevented. By experimenting on a movable platform, Galitzin found that the acceleration of the enforced movement was the determining factor in the overthrow of each block.

Prof. Reid, of Baltimore, described a new method of estimating the intensity of an earthquake, the fundamental proposition being that the energy associated with an earthquake was proportional to the square of the area within a given isoseismal line.

Mr. Napier Denison, of Victoria, Vancouver, gave an account of his observations of secular movements of the horizontal pendulum, and made a strong claim for Victoria as a place well fitted for seismological work.

Prof. Omori, of Tokyo, described some of the recent volcanic and seismic phenomena of Japan, the most interesting being the rise of a new hill during the eruption of Usu-san in Hokkaido, and the increasing activity of Asama Yama, a volcano in the centre of Japan which rises to a height of 8000 feet. The dull red contents of the crater have been steadily rising in level for some time, and fairly large blocks of stone have been projected from it. A station has been built on the flank of the mountain, and seismographs installed in it. The character of the tremors is markedly different according as they do or do not accompany a volcanic eruption.

In their less strenuous moments the delegates and their friends enjoyed to the full the hospitality of Manchester, more especially the Lord Mayor's reception in the Town Hall; Prof. Schuster's garden-party at Kent House, when a remarkably good photograph was taken of all attending the congress; and the closing dinner given by the University Council, when Prince Galitzin, in a humorous impromptu speech, proposed the health of Prof. John Milne, whose characteristic reply was a fitting close to a great conference.

THE MIGRATION OF A RACE.[1]

THE theory of a relationship between the numerous languages spoken in the islands of the Indo-Pacific Ocean from Madagascar and Sumatra to the Philippines, and thence far eastward to Melanesia and Polynesia, is almost universally accepted. But the connection of these languages with the Asiatic Continent, their origin, and the means by which they reached their present settlements, are still uncertain.

In the volume before us Mr. Churchill essays to trace the migration of the Polynesian people from their first home on the borders of Indonesia, through Melanesia, to Nuclear Polynesia, that is, to the region round about Samoa, Tonga, and Niue. Dealing with the languages only, he recognises two streams of voyagers who have left traces of their passage in the loan words adopted from their speech by the Melanesians with whom they came in contact; these words being most numerous in the languages of the islands along the coasts of which the Polynesians passed, and less frequent in the languages more remote from their route.

One stream of these primitive Polynesians, or Proto-Samoans, passed north of New Guinea, by way of the Admiralty, Bismarck, Solomon, and Santa Cruz Archipelagoes to Samoa. Another stream came southward through Torres Straits, by the south-eastern shores of Papua, through the New Hebrides to Fiji. In Nuclear Polynesia the two streams resumed their ancient fellowship, and thence despatched colonies to Hawaii, New Zealand, and the Far Eastern Pacific.

Later, there came upon these Proto-Samoans a swarm of kindred people whose origin and migrations Mr. Churchill regards as indefinite and obscure, and to whom he gives the name—Tongafiti—by which they are known in Samoan history. The Tongafiti are considered to have left no definite trace of a passage through Melanesia, though their presence in Nuclear Polynesia is clearly evident. The origin and migrations of the Tongafiti are not discussed in the present volume.

In his earlier chapters the author devotes some attention to the two most prominent theories yet put forth as to the settlement of the Oceanic peoples, namely, those of Dr. Macdonald and Dr. Thilenius. The former refers the island races to an immigration from Arabia, and affirms their languages to be modern representatives of a Semitic tongue (*cf.* NATURE, March 19, 1908, p. 460). The latter regards the Polynesians as entrants into the Pacific by way of the Micronesian Islands, and sees in the Melanesian Islands, and the Polynesian settlements bordering them, the meshes of a net which has caught the drift of castaways blown westward from their homes in Eastern Polynesia. In his second chapter and elsewhere in his book Mr. Churchill utterly demolishes the Semitic theory of Macdonald, mainly on the grounds of illogical and forced etymologies, and perverted definitions of words. Mr. Churchill finds difficulties and fallacies in the argument of Thilenius, chiefly with regard to the ascription of feeble navigating powers to the Polynesians, and to the unlikely survival of castaways among an anthropophagous people.

Mr. Churchill regards the Proto-Samoans as a seafaring race, who, driven by some expulsive force, set out from Indonesia in double canoes. The principal difficulty in their navigation was the victualling of their vessels, and this led to coasting voyages wherever there were coasts to follow. When supplies ran short, a food colony was established on a suitable island until a sufficient crop was raised to carry the voyagers farther on. For these food colonies there were three requisites—a sufficient water supply, an encouraging area of soil for tilth, and an autochthonous population insufficient in number, or too weak, to prevent the settlement of strangers. Mr. Churchill considers the eastward impulse to have ceased in Bismarck Archipelago and Torres Straits, so that the crop settlements tended to become, in suitable places, permanent colonies. Also, as the fleet kept to windward in the seas along which they passed, the lands which became fixed settlements (as, *e.g.* Nuguria, Liueniua, Sikayana, Aniwa, and Futuna) would be found on the windward side of the archipelago with which they are associated. The apparent exceptions, Rennel and Bellona, though leeward of the Solomons, are, however, on the weather side of the voyagers in the southern stream.

Mr. Churchill bases his evidence of this migration upon an examination of the Polynesian words contained in the languages of the Solomon and New Hebrides islands. From comparisons of the material available to him, which are given in an appendix on data and notes, and the Polynesian content therein, set forth in a series of elaborate tables, the author deduces the amount of likeness shown by the individual languages to Polynesia. His method in the comparisons is sound and accurate, and a very welcome contrast to the wild guesses of some writers on the subject. But the deficiencies and imperfections of his material are a source of serious error. For a proper estimate of Polynesian likeness the vocabularies compared should be of equal size and range of signification, else the presence or absence of certain words would unduly exaggerate or diminish the likeness. Mr. Churchill's tables show this. He gives the coefficient of likeness to Polynesian of Belaga as 100, whilst Nggela, of which Belaga is a dialect, is given only 80. So also the likeness of Nguna to Polynesian is expressed by 93, whilst that of Sesake (the same language, Sesake being a colony from Nguna) is only 76.

Mr. Churchill makes no comparisons of grammar. All the Polynesian words present in Melanesia are regarded as loans, but if this is so, it is remarkable that many of the languages have borrowed 80 or 90 per cent. of Polynesian vocables without borrowing a single grammatical form. In some cases, not pointed out by Mr. Churchill, grammatical forms which survive in Polynesian have been preserved more fully in Melanesian languages which are not on the supposed migration route.

The backward track deduced by Mr. Churchill breaks off short at Moanus (Admiralty Island) in the north, and at Motu (New Guinea) in the south, and he leaves the starting point of the Proto-Samoans in a waste of empty sea, where non-Polynesian and non-Melanesian languages occupy the whole seaboard. He states that "only a few of

[1] "The Polynesian Wanderings." Tracks of the Migration deduced from an Examination of the Proto-Samoan Content of Efaté and other Languages of Melanesia. By W. Churchill. Pp. ix+516. (Washington: Carnegie Institution, 1911.)

the vocables in Melanesia for which we have discovered Polynesian affinities are found to carry that affinity back to Indonesia." He is "ready to pronounce the decree of Divorce upon Malay and Polynesian." Other judges of Indonesian will scarcely concur in this judgment.

It is impossible in the limits of this notice to give an adequate exposition of the value of Mr. Churchill's book to the student of Oceanic linguistics and ethnology. It is not only suggestive of points for discussion, but provides also material upon which the argument may be based. There is a bibliographical appendix, two maps, and a useful index.

SIDNEY H. RAY.

SCIENTIFIC PROGRESS IN THE UNIVERSITY OF OXFORD.

THE annual report of the delegates of the University Museum, lately published, contains a very complete record of the scientific work done in the several departments of the museum during the year 1910. In the department of physiology, special attention is directed to the establishment of an advanced practical course in physiological optics, under the direction of Prof. Gotch and Dr. Burch. A considerable amount of the requisite apparatus was made in the laboratory workshop. Prof. Arthur Thomson (human anatomy) announces that instruction in physical anthropology has now been systematically organised. The report of the Linacre professor of comparative anatomy (Prof. Bourne) also shows much evidence of steady progress. The list of additions to the collection is a long one, and numerous important memoirs have been published by members of the department during the past year.

Prof. Poulton submits a lengthy and interesting account of the work done in the rooms assigned to the Hope professor of zoology. A very fine collection and library of Oriental and British entomology, chiefly Hymenoptera, was presented by Mr. G. A. James Rothney; and other important accessions were received from numerous donors, among whom were Mr. Herbert Druce, Commander J. J. Walker, Mr. J. H. Watson, Mr. S. A. Neave, Mr. W. A. Lamborn, and the Hon. Walter Rothschild. Special attention is directed to bred specimens received from Mr. A. D. Millar, of Durban, which prove that the conclusion tentatively arrived at by Mr. G. A. K. Marshall in 1902, that *Euralia mima* and *E. wahlbergi* are dimorphic forms of the same species, is in accordance with the fact. The collection of British Rhynchota, Hemiptera, and Homoptera belonging to the late Edward Saunders, and presented by the professor and Dr. G. B. Longstaff, is described as one of the most important additions ever made to the British collection in the department. Among the original memoirs published by workers in the department are Mr. H. Eltringham's important monograph on African mimetic butterflies and Mr. R. Shelford's contributions to the Genera Insectorum.

Noteworthy additions have been made to the anthropological collections contained in the Pitt-Rivers Museum. The energy of the curator, Mr. H. Balfour, who has paid three special visits to the Victoria Falls of the Zambezi, has resulted in the acquisition of a far more complete collection representing the archæology of that region than exists anywhere else. Other important accessions have come in from the Belgian Congo, British East Africa, West Africa, the Dordogne, and the Isle of Wight. In the department of experimental philosophy, Prof. Clifton reports that an extension of the laboratory is absolutely necessary, the only alternative being to restrict the number of students.

The report of the Wykeham professor of physics (Prof. Townsend) records the transference of the laboratory furniture and apparatus from the temporary quarters in the old museum to the fine new building provided by the generosity of the Drapers' Company. The new premises have been found to be excellently adapted for giving practical instruction, and also for research work. In the department of chemistry, Prof. Odling notes the starting of a new course of advanced practical organic chemistry under Dr. Chattaway, and the publication of several important memoirs dealing with researches conducted in the chemical laboratory. These include Dr. Chattaway's work on chlorine, Mr. Marsh's on the solution of haloid double salts in organic solvents and on the halogen derivatives of camphor, and also the investigations by Mr. Lambert and his pupils on the wet oxidation of metals. The report mentions that as a result of the work still in progress, it is hoped later to establish sufficient facts to warrant putting forward a modification of the present views on the subject of the corrosion of metallic iron.

A valuable consignment of rocks and fossils has been sent to the geological department from Peru, where Mr. J. A. Douglas is engaged in using the excellent opportunities for geological study now being afforded by several important railway cuttings. The expenses of the investigation are being borne by Mr. W. E. Balston, University College, and the consignment that has been already received is the first of many that may be expected as a result of Mr. Douglas's labours. Besides the usual field-work conducted by Prof. Sollas in the country about Oxford, an excursion, attended by sixteen students, was made to the Siebengebirge and the Eifel. Much work has been done by Miss Byrne and others on the rearrangement of the collections. A long series of specimens illustrating the history of the pleistocene epoch is in course of arrangement, and the work is rapidly approaching completion.

Like other heads of departments, the professor of rural economy (Prof. Somerville) finds himself somewhat embarrassed for want of room. The laboratories of botany and chemistry included in his department have been taxed to their utmost capacity to provide accommodation for the students. For the needs of the department of mineralogy, provision has been made by the allotment of a portion of the northern room of the old Radcliffe library, lately occupied by the Wykeham professor of physics. Many additions are recorded to the collections of specimens and the stock of apparatus, and some important researches have been carried on by Prof. Bowman, his pupils, and assistants.

A remarkable feature in many of the departmental reports that have now been briefly noticed, is the great and growing need of still further accommodation if the requirements of both teachers and students are to be satisfactorily met. Much has already been done; all departments alike tell the same tale of great and increasing activity in scientific work. Much still remains to do; but the document before us gives good hope for the future, for it contains abundant evidence that the ancient University of Oxford is becoming more and more alive to its responsibilities in the matter of scientific progress, as regards both teaching and research.

ADVANCES IN REPTILIAN PALÆONTOLOGY.

IN the July number of *The American Naturalist* Dr. O. P. Hay reopens the discussion with regard to the position of the limbs in Diplodocus and other sauropod dinosaurs, criticising the views of those who assert that these reptiles carried themselves in elephantine fashion, and maintaining his own opinion that the general pose was more after the crocodilian style. In regard to what may be called the elephant pose, it is pointed out that since a straight femur appears to have characterised the Proboscidea from the beginning, its occurrence in the modern representatives of the group may be regarded as a primitive feature, rather than an adaptation to the support of great bodily weight. At the conclusion of his arguments with regard to the pose of the sauropods, Mr. Hay expresses doubts as to whether the erect bird-like posture attributed to the carnivorous dinosaurs of the Jurassic is really true to nature. "The extraordinary development of the pubic bones of Aristosaurus, the expanded and ankylosed distal ends of which reached nearly half-way to the forelegs, seems to me to indicate that these animals, when in repose, had a prone position, resting much of the weight on the pubes, and that when running their legs straddled considerably."

In reference to the opinion of Dr. Matthew that Sauropods were too bulky to have lived on land, it is added that "the law to which he gives expression does, of course, prescribe a limit to the size an animal can attain, but who has yet determined what that limit is?"

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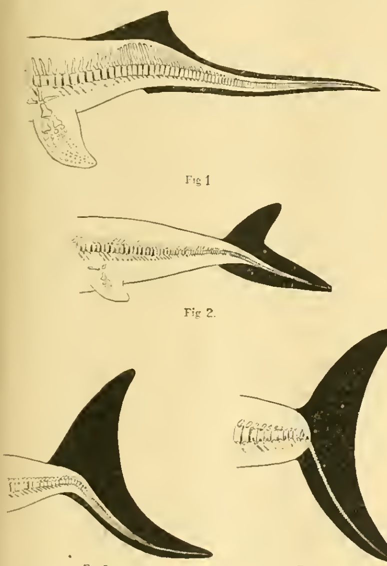
Museum, Dr. Broom contributes an illustrated article on the dinosaurs of the Stormberg beds. Seven generic types, namely, Euskelesaurus, Hortalotarsus, Gyposaurus, Gryponyx, Massospondylus, Ætonyx, and Geranosaurus, are recognised, of which the third, fourth, sixth, and seventh are described for the first time. The first six are referable to the carnivorous group, but the last is characterised by the presence of a predentary bone to the mandible. This feature suggests that the horizon of the Stormberg beds from which it was obtained is of Lower Jurassic, in place of Triassic, age; and, even so, Geranosaurus will be the oldest known type with a predentary.

The angulated outer and rounded inner surface of the terminal segment of the second hind toe in Gryponyx, Massospondylus, and Ætonyx indicates that the investing horny claw had an edge adapted for combing or scraping; and it is suggested that it was employed for cleaning the skin and scales. If this be so, the dermal covering was probably unlike that of crocodiles or lizards; and it may be that the scales were long and narrow, with intervals of soft bare skin between them. Such a skin would certainly require cleansing with the claw after the reptiles had been hunting on the muddy banks of lakes.



Tail-fins of Ichthyosauria.

FIG. 1.—*Mixosaurus nordenskjoeldi.*
FIG. 2.—*Ichthyosaurus quadriscissus* (young).
FIG. 3.—*Ichthyosaurus quadriscissus* (adult).
FIG. 4.—*Ichthyosaurus trigonus posthumus.*

In the same issue Dr. C. W. Andrews describes portions of the skeleton of a plesiosaur (*Plesiosaurus capensis*) from the Uitenhage beds of Cape Colony. The species, which belongs to the group of small forms represented in the European Wealden by *P. degenhardti* and *P. valdensis*, is the first plesiosaur known from South Africa. The occurrence of a member of the group in that country is of special interest, in view of the possibility that the Sauropterygia may have taken origin from a form related to the therocephalous anomodonts of the South African Permian.

In this connection reference may be made to the identification by Mr. H. Fuchs (*Anat. Anz.*, vol. xxxviii.) of a septomaxillary bone in the skull of the peba armadillo. In a review of this discovery by Mr. F. Müller in *Naturwissenschaftliche Wochenschrift* for July 9, 1911, it is pointed out that a septomaxillary has been hitherto known in amphibians and certain reptiles, in which it forms an ossicle on the side of the nasal capsule. Recently it has been identified in certain fossil reptiles—notably the Theriocephala and Theriodontia. Among mammals, it occurs not only in the peba, but likewise in the hairy armadillo (*Dasypus villosus*), where it is represented by an undetermined bone described by Dr. Broom. It has not yet been definitely identified as a separate ossification in other mammals; but Gaup considers that it is represented by the so-called extra nasal process of the maxilla, although Fuchs considers that in the aforesaid armadillo both this process and the septomaxillary are present. Be this as it may, the identification in armadillos of an element common to amphibians, anomodonts, and certain other reptiles is a feature of prime importance in regard to the anomodont ancestry of mammals.

The description of an embryonic, or newly born, specimen of *Ichthyosaurus quadriscissus* from the Lias of Holzmaden, Württemberg, in which the outline of the body and fins is preserved, has led Dr. E. Fraas, in *Mitt. aus dem kgl. Naturalienkabinett, Stuttgart*, to give an interesting account of the evolution of the tail-fin in the ichthyosaurs. That the specimen on which the investigation was based is extremely young is rendered evident by the great relative size of the head, which is equal to one-third the entire length, whereas in the adult it is less than one-fifth. The earliest known type of tail-fin in the ichthyosaurs occurs in *Mixosaurus nordenskjoeldi* from the Muschelkalk of Spitsbergen, in which, according to Mr. H. Wiman's figure in Bull. Geol. Inst. Upsala, vol. x., 1910, it takes the form of a low falcate fin in the basal third of the tail, continued as a marginal expansion along the whole of the rest of the tail, both above and below. In the young of *I. quadriscissus* the falcate portion and the marginal fringe are increased in height so as to form a fin approximating to the heterocercal type, with the extremity of the vertebral column bent down into the lower lobe. In the adult of the same species the increase in the size of the fin and the degree of flexure of the vertebral column are intensified, thus producing an approximation to the homocercal type. A further stage is displayed by *I. trigonus posthumus*, of the Upper Jurassic Limestone of Solenhofen, in which the fin is almost completely like that of a homocercal fish, while the flexed terminal portion of the vertebral column has diminished in relative size, with a marked increase of the angle of flexure. One step more and it would have vanished. A somewhat similar grade is presented by Opthalmosaurus of the Oxford and Kimeridge Clays. It should be added that in the hind paddle of Mixosaurus the metatarsal and phalangeal bones retain an elongated contour, and do not form a mosaic-like structure. R. L.

LONG-DISTANCE RADIO-TELEGRAPHY.

A VERY interesting paper by Mr. L. W. Austin, entitled "Some Quantitative Experiments in Long-distance Radio-telegraphy," has recently been published in the Bulletin of the Bureau of Standards (Reprint No. 159). The paper describes a complete investigation of the relationship between the current in the receiving aërial and the distance between the transmitter and receiver, the observations being mainly by the shunted telephone method. Although this method is not so accurate as the direct method, it is probably the only one available for use on board ship at long distances. Some years ago Mr. J. E. Taylor and the present writer carried out similar experiments over short distances up to 60 miles, using a thermo-galvanometer directly in the aërial. Mr. Austin has greatly extended the range, and has carried on the experiments up to a distance of 1200 miles between the two stations. The results confirm the proposition put forward by Mr. Taylor and the writer that the current in the receiving aërial varies inversely with the distance except for one important particular, namely, Mr. Austin finds, with much longer distances that he has worked over, that it is necessary to take into account the absorption, and therefore his formula contains an exponential term to allow for this.

A perhaps still more important discovery mentioned in the paper is that of Dr. Louis Cohen, that if the reduction in the strength of the received current due to absorption be written e^{-Ad}, then A is inversely proportional to the square root of the wave-length within the limits of accuracy of the experiments.

Mr. Austin again checks Mr. Marconi's statement that the received signals are proportional to the height of the two antennæ, and adding to this the observation that they also vary inversely as the wave-length, he obtains a complete formula giving the received current I_K in terms of the transmitted current I_S, the heights of the two antennæ h_1h_2, the wave-length λ, and the distance *d*. The formula is

$$I_K = 4\cdot25\frac{I_S h_1 h_2}{\lambda d}e^{-\frac{\cdot0015d}{\sqrt{\lambda}}}.$$

Where the currents are in amperes and the lengths in kilometres, the two constants 4·25 and 0·0015 may depend on the conditions under which the experiments were made, and it will be of great interest if other wireless workers will check the formula against their results and see how closely it is applicable. It must not be expected that this formula will be closely confirmed by every observation. Mr. Austin's own observations show that this is not the case. In spite of the wide range of values he has dealt with, the observations do appear to group themselves round the smooth curves given by his formula.

The formula refers only to flat-topped aërials and to general day conditions. Mr. Austin remarks that the night signals are entirely irregular, being, in general, stronger than the day signals, and this he assumes is due to there being much less absorption at night, that is to say, the inverse distance law is then more nearly obeyed, even for very long distances.

It is perhaps of interest to compare Mr. Austin's formula with the measurements in the *Monarch* tests. Putting the data into Mr. Austin's formula, and taking the wave-length at 250 metres, which was approximately the case, the received current at a distance of 60 miles given by the formula is 590 microamperes, whereas it was actually only about 50 microamperes. It is evident, therefore, that the constant 4·25 is too large for this case. One reason for this may be the great difference in the type of aërial used, Mr. Austin's formula applying to a flat-topped aërial, whereas a straight aërial was used for the Holyhead-Howth experiments; another reason, the Howth aërial had a higher resistance.

The absorption coefficient, however, seems to fall in very well with the *Monarch* experiments, neglecting the short distances, which are irregular. Taking the slope of the curves for the *Monarch* crossing from Howth to Holyhead, the absorption is rather less than that given by Mr. Austin, but the slope of the curve for the *Monarch* returning from Holyhead to Howth indicates a slightly greater absorption.

A number of tables are given in the paper to facilitate the use of the formula in practice. These tables show how extremely important it is to use a long wave-length for long distances; for instance, for transmission over a distance of 2000 miles, with a wave-length of 1000 metres and two flat-topped aërials 450 feet high, 490 amperes is required in the transmitter, whereas at 6000 metres only 105 amperes is necessary. There are still, however, many obscure points in the long-distance transmission which Mr. Austin's formula does not account for; for instance, Mr. Marconi pointed out at the Royal Institution a short time back that there were two minima near sunset and sunrise in the curve representing the strength of the received signals across the Atlantic, and also two maxima. Can this be accounted for purely by variation in the absorption coefficient, and, if so, does the absorption coefficient during the minima bear the same relationship to the wave-length as that given in Mr. Austin's formula? Do the two maxima correspond to practically no absorption, or are they higher values than would be obtained if no absorption existed as if waves were concentrated, as Mr. Austin seems to consider possible?

Whether the formula turns out to be strictly right or not, it should form a good basis on which to compare different wireless systems, and it constitutes a real advance in the published knowledge of long-distance radio telegraphy.

W. DUDDELL.

EXPERIMENTS ON AËRIAL PROPELLERS.[1]

AN article in the April *Bulletin de la Société d'Encouragement* deals with some experiments on aërial propellers made by MM. Legrand and Gaudart, with the aid of a grant from the society. The greater part of the article is a discussion on the methods adopted by other experimenters for expressing their results. M. Legrand objects to the three coefficients usually adopted in expressing the results of propeller experiments, namely, "pitch," "fraction of pitch in each blade," and "percentage slip." He objects to the use of "constructional pitch" (which is usually taken as the pitch of the pressure face chords), as it is not constant for all parts of the blade in modern propellers. He also objects to the use of the pitch corresponding to no thrust, as this is not constant for all speeds; but in our opinion this latter is constant enough for all practical purposes.

M. Legrand's objection to the use of the coefficient "fraction of pitch in each blade" is that it is not definite for a given propeller; as, in modern propellers, it is not the same for all co-axial, cylindrical sections of the blades. This objection, however, is entirely overcome by using "disc area ratio," which is equivalent to "fraction of pitch," and is also absolutely definite for any given propeller. The objection advanced against the use of "percentage slip" is that the pitch not being definite, or the same for all parts of the blade, the slip is also indefinite.

Efficiency curves by Géber and Dorand are quoted, in which efficiencies at constant rotational speeds are plotted against translational speed. If, however, efficiencies at constant rotational speeds are plotted against percentage slip, and the pitch used in the reduction of the experimental results be stated—the percentage slip being equal to $100\left(\frac{\text{pitch}\times\text{revs.}-\text{translational speed}}{\text{pitch}\times\text{revs.}}\right)$—it is readily seen that the two sets of curves are equivalent and derivable from each other. Also, plotting against percentage slip has the advantage that it brings all the efficiency curves close together.

It is generally admitted that the indefiniteness of the pitch of a propeller is a disadvantage; but it seems, as yet, to be the best "coefficient" that can be used to give a general idea of the type of a given propeller. M. Legrand does not give any substitute for "pitch," and, in connection with his own experiments, differentiates between a propeller with a big pitch and one with a small pitch.

The experiments were carried out on full-size propellers, mounted on actual aëroplanes and driven by a 50 h.p. Gnome engine. The thrust was registered during the whole flight on an autographic diagram from a Richards dynamometer, working in conjunction with a flexible mounting for the propeller. An error is admitted of at least 2 per cent. of the maximum thrust in the calibration of the dynamometer. The rotational speed of the propeller was measured by means of a direct reading tachometer, and is probably correct to about 1 per cent. But the power absorbed was measured by assuming that the brake h.p. of the Gnome engine, at a given speed, did not vary during the course of a series of experiments. By this method of measuring, we should estimate the probable error on the measurement of power to be anything up to 10 per cent. The speed of translation of the machine was measured by means of an ordinary U tube, measuring the air pressure in a converging cone. This was calibrated by flying round a measured aërodrome, taking the speed with a watch. So that, taking into account the difficulty of flying exactly over the course and of reading a water-gauge on a vibrating aëroplane, the translational speed is probably not correct to closer than 3 per cent.

[1] "Études expérimentales sur les hélices propulsives Aériennes." By M. Legrand (Bulletin de la Société d'Encouragement pour l'Industrie Nationale, April).

The results given are very meagre, and are as follows :—
[he efficiencies varied between 53 per cent. and 69 per cent. [he thrust fell off in flight about 33 per cent. from the 'alue with the aeroplane anchored. The rotational speed of the engine increased in flight from 0 per cent. to 15 per ent. above the speed with the aëroplane anchored, depending on the propeller. The experiments are to be continued vith the aid of a further grant, and we may therefore xpect more complete results of tests with the addition of nore particulars of the propellers tested than are given in he present article.

It is to be hoped that the experimenters may improve the ccuracy of their apparatus, so that their results may be f real scientific value, and not merely for the purpose of ifferentiating between a good propeller and a bad one.

FRANCIS H. BRAMWELL.

PHOTOGRAPHY IN SURVEYING.

FOR the last half a century continued efforts have been made to utilise photography in the preparation of ccurate plans of country, and thereby economise some of he time expended in the detailed measurement of every eature and object. A photographic negative provides an ccurate record of the area included in it, contains much etail which measurement alone cannot give, and is always vailable for future reference. On the other hand, the mployment of photography requires certain technical knowedge, and a good judgment in the selection of stations and iews; it is best suited to regions of considerable relief, ut even then patches of ground are liable to be omitted ltogether from the views, and such omissions are not ecognised until the work is plotted; lastly, it necessiates considerable skill in the drawing office to get he best and most complete results from the field-work. 'hotogrammetry has, therefore, developed most rapidly in ountries where mountainous districts offer favourable onditions for its employment, and where the season available for field-work is limited. France, Italy, Germany, ustria, Switzerland, and Canada have all made use of his method in topographical surveys, despite its drawacks. Mr. A. O. Wheeler[1] describes in general terms the nethods which are employed in Canada under the direcon of Dr. Deville, the Surveyor-General of Dominion ands, and employed by Mr. Wheeler on Dr. Longstaff's ecent expedition in British Columbia. But the labour ivolved in utilising the information collected by the amera has always hindered its wider employment in urveying, so that we welcome a new method of automatically reproducing it on a plane surface, which is described y Prof. E. Brückner.[2]

Some years ago Dr. C. Pulfrich, of the firm of Carl eiss, of Jena, produced his stereomicrometer, by which ie coordinates of points represented on a pair of stereoraphic plates were determined, and their positions defined, that they could be plotted on a plan. In this instruient the plates are fixed, and the movements of the index ointers are measured. A further development was the ereocomparator, in which the plates are movable, and ie points to be measured are brought under fixed marks, i this case the objectives of a stereoscope. By suitable iechanical arrangements the coordinates of any point on ie picture and the stereoscopic parallax are readily deterined, thus providing the necessary information for lotting the point measured. Lieut. von Orel, of the lilitary Geographical Institute in Vienna, conceived the lea of automatically recording the data thus measured, nd the necessary modifications have been made to the ereocomparator so as to enable the data to be plotted iechanically on a sheet of paper. This instrument is illed the stereoautograph, and in it the movements of the lates and the stereoscope of the stereocomparator are ommunicated to flat rulers resting on the drawing-board, nd by their aid the positions of points are plotted on the lan. Not only is the horizontal projection of the detail fected in this way, but contour lines representing the elief can also be drawn.

Plans on a scale of 1 : 25,000 can be accurately produced in this way, and even one on the scale of 1 : 10,000 showed but slight differences from a precise measured survey of the same on this scale. The apparatus is said to be capable of producing a map sheet 35 cm. by 25 cm. of a mountainous region to the scale of 1 : 25,000 in about ten days' work, so that it promises to be of great value in reproducing the work of travellers and explorers who will take the necessary photographs. Photogrammetric methods do not apply where surveying is organised so as to utilise a *personnel* of moderate technical ability, where each individual carries out a single stage of the work only; but where skilled technical assistance is available, and each surveyor executes as complete a survey as possible of a given area, then stereophotogrammetry, simplified by Lieut. von Orel's instrument, seems to offer great possibilities, especially when conditions of work and of surface relief are also favourable.

Though primarily adapted to topographical representation, some have tried to adapt photography to large-scale (cadastral) work, and M. J. Gaultier has proposed methods for its employment. But the indoor work of the necessary precision is tedious and costly, so that in a recent paper[1] he proposes for such work an instrument which he names the "topometrographe." This is of the nature of a plane table for precise work, stoutly built and carefully levelled, on which a base-bar is clamped. This carries the pivots of two rulers set at a distance apart corresponding to the base line used. These rulers are set at any desired angle with the base-bar by means of divided circles, and their intersection locates the apex of the triangle. Very considerable accuracy is claimed for the method, which is to be based on a network of third- or fourth-order triangulation; but its effectiveness would appear to be restricted to special cases, where such elaboration in the field is compensated for by economy in the office.

[1] *Geographical Journal*, June.
[2] *Mitt. d.k.k. geographischen Gesellschaft in Wien*, Bd. 54, No. 4.

[1] *Revue Scientifique*, May 6.

BIRD-NOTES.

FROM the point of view of forest-conservation much interest attaches to Mr. F. E. L. Beal's report on the food of American woodpeckers, published as Bulletin No. 37 of the biological division of the U.S. Department of Agriculture. The report is based on the examination of the contents of a large number of stomachs of sixteen species of these birds; but since the number of specimens examined was much smaller in some cases than in others, it is quite probable that some modification of the order in which these species are tabulated according to the nature of their food may be necessary in the future. Another element of uncertainty in this respect is due to the rapidity with which the vegetable food of the cambium-eating species passes through the stomach.

As the forests of the United States, like those of other countries, have a host of insect enemies, among which wood-boring beetles are pre-eminent, any natural agency that will assist in keeping these pests in check is of the highest value. In the case of wood-boring beetles, woodpeckers occupy the first place as destroyers, and among these the two species of the three-toed genus Picoides are the most valuable. In the typical *P. americanus* no less than 94·06 per cent. of the food consists of animal matter; while as regards its insect-food, 71·05 per cent. consists of beetles and the remainder of ants. Most of these beetles are wood-borers, although a percentage consists of harmless species. Ants also are deleterious to trees, since they often take possession of the borings from which beetles have been extracted by woodpeckers, until they in turn are routed out by these birds. Woodpeckers are frequently charged with inflicting damage on sound trees; but the charge, except in the case of the American group of sapsuckers, is considered to be unfounded. As regards sapsuckers, which feed on cambium, these certainly do inflict damage, which in some cases may be serious although, on the other hand, they consume legions of ants.

The colouring of the Jack snipe forms, according to Mr. F. J. Stubbs in *The Zoologist* for July, an absolutely perfect protective adaptation. In some localities the only means by which the bird can be detected when squatting in its proper haunts is by looking for a couple of curved blades of faded grass of a brighter hue than any indigenous to the district. When detected, such supposed grass-blades are the yellow head-stripes of the snipe. If surprised on a patch of green turf or other inharmonious background, the bird will sometimes run and squat on the mud near a patch of herbage close at hand.

It is announced in the July number of *British Birds*, by Mr. A. H. Meiklejohn, that a breeding colony of fulmar petrels has established itself in Berriedale Head, Caithness, the only other nesting haunt on the mainland being Cape Wrath, Sutherland, which was first discovered to be the resort of these birds in 1901. The most southerly breeding-place in the British Isles is Barra.

Certain erratic lights observed at night on the hillsides at Villierstown ferry, Cappoquin, Ireland, during last winter, by Miss M. E. Dobbs and the local ferryman are tentatively attributed by the former, in an article published in *The Irish Naturalist* for July, to luminous owls, this opinion being based on the assertion of the aforesaid ferryman that the lights are due to birds. In a supplementary article published in the same issue, Mr. C. B. Moffat, after quoting additional testimony to the belief that birds are their source, suggests that these strange luminous emanations may be a form of *ignis fatuus*. It is true that the latter is generally a more flickering type of light, but one resembling Miss Dobbs's description is reported from the Donabate estuary, unless, indeed, the natives mistake a bird for a phantom. But Mr. Moffat goes even further than this, and suggests that the whole story of luminous owls, which, it will be remembered, was first reported by Sir Digby Pigott in a letter to *The Times* for December, 1907, may possibly turn out to be a myth. He notes, however, that an apparently similar luminosity has been attributed to bitterns and certain herons, especially an American species, but states that even this testimony is not definitely accepted by naturalists.

Among the contents of the July number of the Journal of the South African Ornithologists' Union is an article by Mr. C. F. M. Swynnerton on nests and eggs from Mount Chirinda, southern Rhodesia.

IONISATION AND CHARGED SMOKE PARTICLES.

IN the *Sitzungsberichte der k. Akad. der Wissenschaften* of Vienna, vol. 120, part i., Drs. V. F. Hess and G. v. Sensel discuss the results of a series of experiments on the ionisation of the atmosphere made by them during August and September, 1909, on an island separating the two branches of the Danube near Vienna. The observations were made from 9 a.m. to 9 p.m., and the curves for the diurnal variation show marked minima about 5 p.m., both for the positive and for the negative ions. The main object of the authors was to investigate the connection between the ionisation and the meteorological elements, but the period of observation was too short for the conclusions to be regarded as final. The principal results are briefly as follows. For low atmospheric pressure the excess of positive ionisation has double its value at ordinary or high pressures, and a similar difference exists between the values for falling and for rising barometer; the total number of ions, and the number of negative ions, decreases as the temperature increases—a result exactly opposite to that found by Simpson and Gockel: the number of ions is greater for clear than for cloudy sky, especially if the cloud is nimbus: the number of ions is less when the wind comes from the direction of the city; and it is independent of the relative humidity, a result also different from those of Simpson and Gockel, who found that the ionisation decreased as the humidity increased. The recent establishment of systematic observations of the ionisation at some of the principal observatories ought to permit of a fuller discussion of the questions treated in this paper, which will prove valuable in indicating the observations which are specially desirable.

The same number contains a discussion by Dr. K. Przibram of experiments on the charge carried by smoke particles, in the light of Cunningham's correction to Stokes' formula for the connection between the limiting velocity and the radius of the particle. Careful series of experiments on smoke of different substances indicated a definite tendency for the charge to depend on the radius of the particle, and led the author to conclude that the particles could carry charges less than the adopted value for the charge on the negative ion, or that certain factors entered into the motion of charged particles through a gas which had not yet been allowed for. In a note added after the paper had been printed, the author states that owing to a criticism by Regener, he repeated some of the experiments with the plates of his condenser closer together, when he found much less dispersion in the values for the charge. Consequently, the conclusions founded on the earlier experiments may be subject to modification.

HIGH-PRESSURE WATER-POWER WORKS.[1]

THE utilisation of high-pressure water-powers represents the latter portion of the wonderful and rapid development which has occurred in hydraulic works during the last twenty years. Such powers are necessarily situated in mountainous districts, and may be at some considerable distance from thickly populated centres where a demand for power exists. Comparatively low falls were more in use until the question of long-distance high-tension electrical transmission could be looked upon as a sound technical and commercial proposition, and this has only been satisfactorily solved within the last few years.

Hydro-electric stations do not lend themselves very readily to hard-and-fast rules. It by no means follows that what has shown itself to be satisfactory in one case will be equally satisfactory in another. Engineers of every branch are represented in work of this kind, besides surveyors, architects, miners, railroad men, and in some cases geologists and also meteorologists have to be consulted. High-pressure plants usually work out considerably cheaper than low-pressure plants for the same power, but a long transmission line may so increase the capital outlay on the former that a low-pressure station near the consumer is preferable. A very great advantage possessed by high-pressure plants over other types is the readiness with which the irregular flow of rivers may be regulated to supply a constant-power demand by means of storage reservoirs and weirs. The whole rainfall of a district may thus be utilised. Storage, however, increases the cost of a station very considerably. The greater the head of water, the more rational will a storage reservoir be, since the same quantity of accumulated water will represent a proportionately larger store of energy.

Too little attention is usually devoted to the pipe-lines and conduits carrying the water from the lake or river to the turbines. Not a few engineers consider that the pipe-line is a secondary part of a hydraulic power-plant. Pipe-lines are often built by engineers who are experts in the choice of material and in the manufacture of a pipe, but who do not understand the essentially important functions which a complete pipe-line, and especially a high-pressure pipe-line, has to fulfil. The general arrangement, the relative dimensions of different parts of the pipe-line, the methods of anchoring and placing of fixed points, are all such important factors that they can only be properly determined by the turbine builder.

The Necaxa power-station of the Mexican Light and Power Co. is supplied with water under a head of 1312 feet from a reservoir having a capacity of 1500 million cubic feet. The first part of the scheme, commenced in 1903, consisted of the construction of a large earth dam above the falls of the Necaxa River to form the storage reservoir which supplied the power-station with water for about 50,000 horse-power. The dam has a maximum height of 197 feet, length 1270 feet, and greatest breadth at the base 951 feet. An earth dam was selected as the type most suitable for a country periodically liable to earthquakes. Two feeder pipes 6 feet in diameter start from the intake tower in the lake and pass through a tunnel which emerges below the dam wall. These pipes are made of riveted plate, and pass to a receiver pipe which is under a pressure head of 177.8 feet. Six high-pressure pipes descend from the receiver to the power-house. Sluice valves are provided at the receiver to control each pipe, and air pipes are laid from behind the valves on each high-pressure pipe up the hill to a height

[1] Abstract of a paper read at the summer meeting at Zürich of the Institution of Mechanical Engineers by Mr. L. Zodel, of Zurich.

above that of the reservoir level. The six pressure lines are composed of welded pipes 30·7 inches external diameter, and have a thickness varying between 0·39 and 0·87 inch. The maximum static head is 1417 feet. The turbines are Escher, Wyss and Co.'s impulse wheels, each designed to generate 8200 horse-power at 300 revolutions per minute.

The company has greatly increased the water available by diverting the Texcapa, Tenango, Nexapa, and Xaltepuxtla Rivers into the Necaxa reservoir by means of an extensive system of tunnels through the dividing ridges. The catchment area has thus been raised to 154 square miles, and can shortly be further increased by another 77 square miles by bringing in the large Laxaxalpan stream. The present storage capacity of the entire system is about 4220 million cubic feet of water.

As a first step to enlarging the power-house, the capacity of each of the existing six turbines has been raised to 11,000 horse-power by fitting new runners and new nozzles. The velocity of the water in each of the six pipe-lines was thereby increased to the exceptionally high figure of 18 feet per second, a velocity which has not been found to be injurious in any way. Two new units of similar design and by the same makers have been installed; these are each of 16,000 horse-power, and are supplied with water through a new pipe-line system. The total capacity of the station is now 98,000 horse-power. The electrical energy is transmitted a distance of 93 miles to the city of Mexico and to other towns.

The power works of the Rio de Janeiro Tramway, Light and Power Co. are supplied from the largest artificial reservoir formed by a dam wall at present in existence. It has a total volume of 7840 million cubic feet. The length of the lake is 17 miles. The dam is of the arched concrete type. The gross maximum head at the power-house is 1015 feet. There are six impulse-wheel turbines, built by Escher, Wyss and Co., each generating 9000 horse-power at 300 revolutions per minute. The generators supply three-phase current at 6000 volts and 50 cycles, which is stepped up through transformers to a line voltage of 88,000 for transmission to Rio de Janeiro, the distance being 55 miles.

Some very difficult work had to be carried out on the pipe-line of the power-plant at Tyssedalen, near Odda in Norway. The Ringedals Lake provides an ideal natural storage reservoir at an elevation of 1426 feet above and 2·17 miles distant from the fjord at the edge of which the power-station is situated. A regulating tunnel from the Ringedals Lake discharges into the little Vetle Lake immediately below, which forms a second small regulating basin. A tunnel 11,200 feet in length passes through the mountain to the penstock chamber, from which the pipe-line leads down to the power-house. The tunnel is driven through granite for the whole of its length, and was completed in two years. The erection of the pipe-lines was work of a very difficult character. The total length is 2360 feet, and the pipes reach an angle to the horizontal of 55 degrees.

A typical high-pressure power-station in Switzerland is that of the Kraftwerk Brusio Company, which utilises the water of the Poschiavino River in the Canton Grisons on the south side of the Alpine chain. About 55,000 horse-power are developed, the greater part of which is transmitted to the industrial districts of northern Italy over a transmission line of 93 miles. The total head available is about 3280 feet, and is used in two stages. The upper lies between the Lago Bianco, on the Bernina Pass, and the Lago di Poschiavo, giving an effective head of 1970 feet for the Robbia station. The lower is between the Poschiavo Lake and the Italian frontier at Campo Cologno, where the head obtained is 1375 feet.

The River Siagne rises in the Alpes Maritimes province of south-eastern France to the north of Cannes. A power-station is situated near the village of St. Césaire, and utilises a fall of about 1142 feet of the Siagne; about 14,000 horse-power are available. The high-pressure pipe-lines of this plant have demonstrated in a most drastic manner what the consequences of incorrect design can be. The original pipe-line had to be abandoned after a few months' running on account of unsatisfactory working of the plant, and an entirely new pipe-line had to be built on totally different principles, in spite of the fact that the chief dimensions of the pipes were perfectly correct and amply sufficient for the conditions of head and discharge, and, moreover, were not altered in the second pipe-line. The principal faults were owing to the following:—(1) Too great a length of the upper portion, under low pressure, with pipes of small thickness, whereby a continual working or respirating phenomenon became apparent in this part of the pipe-line. (2) Insufficient fixing or anchoring of the pipes in the lower portion of the line, and a most curious position of the distributing pipe, in which very harmful vibration, combined with displacement of the pipes, could take place on sudden variations of water velocity or shocks in the pipe-line; this might easily lead to a burst, especially in the case of riveted pipes. (3) Unsuitable dimensions of the connecting pipes between the distributor and the turbines, with their length too great and their diameter too small, resulting in considerable accentuation of the pressure variations.

French engineers in general build pipe-lines without expansion joints; a large number of such high-pressure pipe-lines are now in continuous operation in France. This design must be characterised as irrational, especially in view of the demands made at the present day on the pipe-line of a central station with continually and rapidly changing water velocities.

THE SCIENTIFIC STUDY OF NAVAL ARCHITECTURE IN GERMANY.[1]

It may sound strange if, in the land of ships—the land that has probably done most towards the practical and scientific development of the whole domain of shipbuilding—I take upon myself to describe the aims of scientific study in Germany and the methods which it is now adopting.

Apart from small unimportant beginnings, the real nursery for scientific study in the various domains of naval architecture in Germany has been the institution now known as the Königliche Technische Hochschule zu Berlin, in Charlottenburg. Since 1904 the Königliche Technische Hochschule in Danzig has likewise taken part in this work. The naval architectural departments of both these colleges have the same end in view, namely, the training of the young men who will later in life take a successful part in the building of the mercantile and naval fleets of Germany.

In accordance with the system adopted in all the technical colleges in Germany, it is a preliminary requirement for the admission of the students to the Charlottenburg technical college, that they should have passed the matriculation examination of a Gymnasium, Realgymnasium, or Oberrealschule. As these schools comprise nine forms, it follows that candidates for admission to technical colleges must be between eighteen and nineteen years of age. Since a further qualification is a practical training of one year at a shipyard of recognised standing, the age of the candidate is increased by six months—often by a whole year. To this must be added the period of military service, which is required of every physically and mentally sound German citizen, but which, in the case of an educated man who has obtained his volunteer certificate, is restricted to one year. For those who contemplate a career in the higher ranks of the Imperial naval construction department, the period of practical work and the year of service are spent in naval establishments, that is to say, in an Imperial dockyard and on board a naval training ship respectively, before the course of study at the technical college is entered upon. It may thus be said that the course of study begins when the student is twenty-one, and that it has been preceded by a certain period of preparation in the practical work of shipbuilding or marine-engine building.

The course of instruction is arranged in the following manner:—Within the department for naval architecture a distinction is made, in the first instance, between the professions of naval architect and marine engineer. The course of instruction itself in almost all the subjects comprises lectures and tutorials or "practices," the object here kept in view being that what is taught in the former is put into practical shape in the latter. It is a general principle

[1] From a paper read before the Institution of Naval Architects on July by Prof. O. Flamm.

in the German technical colleges, that so far as possible no lectures are to be delivered without the accompanying tutorials.

In all the departments devoted to different professional branches, the course is a four-year one. At the conclusion of the second year, the preliminary examination for the degree or diploma is held, the final examination being taken at the close of the fourth year. The first two years are principally devoted to the more general studies in mathematics and natural science subjects, although a beginning is made with the introductory lectures and tutorials in the main subjects at the outset of the first term. But whereas the general subjects at first take up much more of the student's time than the special subjects, this proportion gradually alters as the course proceeds till it finally becomes reversed.

Another feature of the arrangement of the studies is that the lectures are, so far as possible, delivered during the earlier terms, while the drawing-office work gradually assumes greater importance as the course proceeds. This is intended to give the student in his last year as broad a base as possible for designing and applying what he has learnt from the lectures.

The primary object of the course of instruction during the first two years is to give the student a general grounding on the broadest possible lines in mathematics and natural science subjects, and concurrently therewith to introduce him to the elements of his special subject, so that, after passing the preliminary examination, he may devote himself in a higher degree to the direct study of his profession during the last two years.

In the course of these two years, then, the tutorials gradually take the place of the lectures, and the professional study proper is gone into in detail. The student of naval architecture is engaged in designing and working out the plans of merchant and war vessels, and in studying the arrangement and working of shipyards, while the marine engineering student is at work on marine boilers, reciprocating, turbine, and internal-combustion engines. In addition, auxiliary engines and propellers are thoroughly gone into.

Students in each branch concern themselves with the other just so far that, in their respective parts of the work on one and the same vessel, they can completely understand one another, and give due consideration to each other's requirements.

The domain of airship construction and aërial navigation, which is closely related to naval architecture, has been included in the province of the latter, and it may be of interest to mention that quite a number of the first designers and engineers who have specialised in airship construction were formerly students in the department of naval architecture.

One of the important aims of science as applied to naval architecture is directed to the keeping of the rules of the classification societies in general accordance with the latest advances in knowledge. This refers chiefly to the arrangement, scantlings, and riveting together of the structural parts of the hulls of vessels, and to the application of the laws of mechanics, statics, and dynamics. A second aim is that the rules of these societies, which are gradually gaining in authority, shall be prevented from developing into crystallised and inelastic ordinances which interfere with the scientific development of ship design.

Both for instructional purposes and for scientific research work, suitable laboratories are nowadays of the very greatest value. In all branches of engineering, there are many questions the solution of which by pure analytical methods is impossible, and which therefore can only be dealt with by practical experiment. To what excellent use in this way have not the existing testing laboratories in almost all countries been put! At the Technical College in Charlottenburg the mechanical engineering section in particular has established numerous laboratories, and they have been of the utmost value both from the educational and from the industrial point of view.

The Technical College at Charlottenburg now possesses twenty laboratories, which serve the purposes of the research work of the professors as well as those of instruction. A short time ago a project for the installation of a second laboratory for the civil engineering section for the investigation of hydraulic questions was unfortunately rejected by the Prussian House of Representatives. It is a remarkable circumstance that in the entire establishment the section for shipbuilding and engineering should be the only one which has no laboratory! It must be admitted that this is very much to be deplored, and that the course of instruction as well as the solution of engineering problems is immensely impeded thereby. It may readily be understood, therefore, that the naval architectural section is doing its best towards the early attainment of an establishment of this kind so as to close up the gap in its structure.

My endeavours are directed to the establishment of a suitable naval architecture laboratory in which experiments may be made on the action of the screw propeller, and in which the gross and net amounts of work done by the latter, *i.e.* its efficiency, may at the same time be determined. Further experiments will then be made to determine the effect on each other of several screw propellers arranged abreast, or one behind the other, and also the effect exercised on them by the rudder. We shall then know whether it is possible to design high-speed propellers of high efficiency, and our knowledge over a wide range of under-water phenomena will be available for further advances in this branch of engineering. Students should take part in all inquiries of this kind, so that the results may benefit succeeding generations of engineers and enable them to play a leading part in the scientific progress of their time.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A REUTER message from Simla on August 3 states that Lord Crewe has accepted the scheme for a Mohammedan University at Aligarh, provided adequate financial support is forthcoming.

WE have received from the Department of Technology of the City and Guilds of London Institute the programme for the session 1911–12, containing regulations for the registration, conduct, and inspection of classes and examination of candidates in technological subjects, and for the award of teachers' certificates in manual training and domestic subjects. We notice that the names of the two examinations held at the end of the session have been changed from "ordinary grade" and "honours grade" to "grade I." and "final examination," corresponding, in a sense, to the two new examinations in science subjects instituted by the Board of Education under the names of "lower" and "higher"; but in certain subjects there are first- and second-grade examinations before the final examination can be taken. The list of subjects in which examinations are to be held in 1912 numbers seventy-nine, as compared with seventy-eight during the present year. The new subject is entitled "Heating and Lighting," and covers very fully the science and technology of these important processes. All inquiries for information in connection with the recognition of classes in technological subjects, examinations, and inspection should be addressed to the Superintendent, Department of Technology, City and Guilds of London Institute, Exhibition Road, London, S.W.

THE eighth annual report of the Education Committee of the City Council of Manchester for the year 1909–10 gives much interesting information as to the progress which is being made in the various grades of education administered by the committee. In the Municipal School of Technology the number of individual day and evening students enrolled for the session ending July 31, 1910, was 5018, as compared with 4988 for the same period in 1907–8, an increase of 30. The number of individual students enrolled in the day departments was 733, as compared with 780 for the session 1908–9. The class entries for the session were 11,071, against 10,500 for the session 1908–9. These figures do not include the class entries in respect of students in the day departments of the school. During the session, 200 students in the day departments of the school were enrolled as students of the Victoria University of Manchester in the faculty of technology, 97 with a view to qualify either for the degrees of Master and Bachelor of Technical Science, and 103 for the certificate in technology. A large amount of original work was carried out by members of the staff and the more advanced students pursuing post-graduate courses in the various departments. Much of the work has been embodied in papers read before scientific societies, and published in the scientific and technical Press. The full record affords proof that the school compares favourably in the matter of research with other institutions of a similar character. Under the regulations adopted by the committee, a considerable number of tests and commercial investigations have been carried out during the year, chiefly in the departments of engineering and chemistry.

THE new handbooks containing the arrangements for the session 1911–12 at University College, London, in the faculty of engineering, the school of architecture, and the faculty of medical sciences have now been published. The college is a university centre for preliminary and intermediate medical studies. Its faculty of medical sciences comprises the departments of physics, chemistry, botany, and zoology (the preliminary medical sciences), also the departments of anatomy, physiology, and pharmacology (the intermediate medical sciences), and the departments of hygiene and public health and of pathological chemistry (post-graduate study). Each of the departments is also equipped for more advanced work, and provides facilities for research. The faculty of engineering, including the departments of mechanical heating and ventilation, electrical, civil and municipal engineering, is intended to provide for students wishing to devote themselves to engineering a systematic training in the application of scientific principles to industrial purposes. The courses are also suited to the requirements of students who intend to enter for appointments in the Indian Public Works Department, engineering department of the General Post Office, department of the director of engineering and architectural works in the Admiralty, Patent Office, and other similar services. The departments have been recognised by the Board of Trade as providing suitable technical training for marine engineers. Facilities are provided for post-graduate and research work in all the subjects. All communications should be addressed to the Provost, University College, London.

SOCIETIES AND ACADEMIES.

EDINBURGH.

Royal Society, June 19.—Prof. Bower, F.R.S., vice-president, in the chair.—M. Jules **Cardot**: Les Mousses de l'Expédition nationale antarctique écossaise. These were collected in various localities visited, and included a number of new species and genera.—Dr. J. **Aitken**, F.R.S.: Some nuclei of cloudy condensation. Some years previously the author, when enumerating the dust particles in the air at certain regions of the West Highlands remote from centres of population, had noticed from time to time a sudden, and at first inexplicable, increase in the number of dust particles. A recent study of the phenomenon had shown that the increase was due to the sunning of the material on the foreshore of neighbouring islands and coasts. The paper discussed the probable causes of this production of dust particles, and described a number of experiments on the direct effect of sunlight upon various substances.—Dr. A. A. **Lawson**: Nuclear osmosis as a factor in the mechanism of mitosis. A study of the spore mother-cells of Disporum, Gladiolus, Yucca and Hedera, and the vegetative cells in the root tip of Allium, has revealed a series of stages in the development of the mitotic spindle which has hitherto been overlooked. They are important and critical stages concerning the fate of the nuclear membrane, and are to be found in the early prophase, preceding the organisation of the equatorial plate. Contrary to the generally accepted view, it has been found that the nuclear membrane does not break down during spindle formation, but behaves as a permeable plasmatic membrane should behave under varying osmotic conditions. The interpretation of these stages throws an entirely new light on the problem of the "mechanism of mitosis," and necessitates a revision of the accepted views of nuclear phenomena. It goes to prove that osmotic conditions are active factors in the formation of the acromatic spindle.—Dr. A. G. **M'Kendrick** and Dr. Kesava **Pai**: The rate of multiplication of micro-organisms: a mathematical study. Assuming the law that the rate of increase of fast-growing organisms is proportional to the number of organisms present and to the concentration of the food-stuff, the authors express this in the mathematical form $dy/dt = by(a-y)$. At the beginning, y is small compared with a, so that the constant ab is equal to the rate of change of log y. From the graph which gives log y in terms of time, the value of ab may be readily obtained, and from the indications of the experiments the limit a towards which y tends may be inferred. The quantity also gives by a simple calculation the period of a generation. The numbers calculated from the integrated expression were found to be in good agreement with the numbers obtained by direct measurement.

July 3.—Dr. Horne, F.R.S., vice-president, in the chair.—Prof. A. H. **Gibson**: The resistance to flow of water through pipes or passages having divergent boundaries. The rate of loss of head in water flowing steadily along various types of expanding tubes was the object of the research—such types as circular pipes with uniformly diverging boundaries, rectangular pipes with two sides parallel and the other pair uniformly diverging, trumpet-shaped pipes with the curved boundary made so that the square of the speed fell off uniformly with distance, &c. In this last-named form there was a distinct reduction in the loss of head in a given length as compared with the loss in uniformly diverging tubes. The divergence which gave greatest efficiency was from 10° to 16° in the rectangular pipes, and from 7° to 10° in the circular pipes.—Dr. W. T. **Gordon**: The structure and affinities of *Metaclepsydropsis* (*Zygopteris*) *duplex* (Williamson). This Carboniferous fern was first recorded by Williamson in 1874, when he was investigating the structure of fossil plants from Pettycur, Fife, numerous petioles of the fern being discovered among his specimens. The same species had since been obtained near Régmy, in France; but in all these cases only fragments of petioles and pinnæ were discovered. Recently, however, stems and roots have been found at Pettycur. In a silicified mass of material several pieces of stems were obtained in close association with innumerable fragments of petioles and pinnæ. Certain emergences from the stem were noted, and an examination of the petioles soon established a series showing a continuous variation from the normal petiole trace to a trace which was identical with these emergences. In this way it was proved that the stems and petioles belonged to one and the same species. The stem stele is very simple in structure. The axis consists of a circular cylinder in which the outer zone is composed of long stout tracheides, while the inner zone is formed by a mixture of long narrow tracheides and conjunctive parenchyma. The stem emits petiole and root-traces at long intervals, and occasionally bifurcates dichotomously. In the theory of the medullation of the zygopterid stele, this stem is of some importance, since it exhibits a stage closely similar to that shown in the stem of *Ankyropteris corrugata* (Williamson). Like some other members of the Zygopterideæ, *A. corrugata* has a biseriate arrangement of the primary pinnæ, while in *M. duplex* and others a quadriseriate distribution of these appendages is shown. In both the quadriseriate and biseriate divisions it is now possible to arrange the stems in a series which demonstrates the gradual medullation of the stems, and is, at the same time, compatible with the geological age of the specimens:—

	Quadriseriate division	Biseriate division	
Lower Carboniferous	(1) *Diplolabis römeri* (2) *Metaclepsydropsis duplex*	(1) No known stem	
Upper Carboniferous	(3) *Etapteris diupsilon* (*Lygopteris Grayi*)	(2) *Ankyropteris corrugata*	
Permian ...	... ...	(3) *a. Ankyropteris scandens* *b. Ankyropteris Decaisnei* *c. Ankyropteris Brongniarti*	These three probably the same species

In each division the stems with the same number, (1), (2), (3), are at first sight practically indistinguishable, but it will be seen that the medullation in the biseriate division is geologically later than in the quadriseriate.—W. G. **Robson**: Laboratory note on a simple method of finding the radius of gyration of a body. When a body is suspended symmetrically by a bifilar suspension, its moment of inertia about the vertical axis through its centre of mass can be expressed very simply in terms of the period of oscillation about that axis and the period of oscillation as a pendulum in the plane perpendicular to the bifilar.

NEW SOUTH WALES.

Linnean Society, May 31.—Mr. W. W. Froggatt, president, in the chair.—Prof. T. D. A. **Cockerell**: The bees of the Solomon Islands. Only one species of bee (*Nomada psilocera*) had been recorded from the Solomon Islands up to the end of last year. Mr. Froggatt's collection, obtained in 1909, comprised representatives of fifteen undescribed species, referable to the genera Meroglossa, Halictus, Nomia, Crocisa, Anthophora, Cœlioxys, Megachile, and Trigona. The Solomon Islands evidently possess a strong Indo-Malayan element; but Mr. Froggatt's collection brings out the fact that there is also an Australian element, the striking representative of which is Meroglossa, now for the first time recorded from outside Australia.—H. J. **Carter**: Revision of Pterohelæus (continued) and of Saragus, with descriptions of new species of Australian Tenebrionidæ. The tabulation of the described species of Pterohelæus is continued, together with descriptions of five new species, bringing the total up to eighty-two. A tabulation of the species Saragus is also given, and descriptions of five new species, increasing the total to fifty-five. Sixteen new species of other groups of the Tenebrionidæ are described, including two for which new genera are proposed.—E. **Meyrick**: Revision of Australian Tortricina (concluded). The concluding portion of the revision deals with the two families Eucosmidæ (19 genera, 149 species) and Chlidanotidæ (2 genera, 3 species). The former is largely developed throughout the northern hemisphere, but is less conspicuous in Africa and South America, whilst in Australia and New Zealand it is inferior in numbers to the Tortricidæ. The real extent of its inferiority is, however, partially disguised by the number of species of Indo-Malayan type (especially in the genus Argyroploce) which have penetrated into Queensland. The family Chlidanotidæ is a curious one, comprising at present only a few small genera of Indo-Malayan origin.

June 28.—Mr. W. W. Froggatt, president, in the chair.—Dr. T. H. **Johnston** and L. **Harrison**: Notes on some mallophagan generic names.—T. **Steel**: The fertilisation of *Pittosporum undulatum*, Andr. The previously observed occurrence of two kinds of flowers borne on separate trees is confirmed, the one kind being male and the other female. The former are characterised by the conspicuous stamens, which are aborted and inconspicuous in the latter. Occasionally ripe seed-vessels containing fertile seeds have been noticed on staminiferous trees, and the flowers from which these were derived have been traced. These flowers were found to have shortened barren stamens, the anthers being shrivelled and non-dehiscent. In no case were staminiferous flowers found on female trees.—E. C. **Grey**: Contribution to a knowledge of the chemistry of blood. No. 1. Globin sulphate and globin from ox blood. (1) 100 c.c. of ox blood yields 16·79 grams of globin sulphate, which is equivalent to 15·43 grams of globin. (2) The globin from ox blood is more basic than that from the hæmoglobin of the horse. (3) The sulphate of globin precipitated from solutions containing varying concentrations of sulphuric acid is of constant composition, containing 8·08 per cent. sulphuric acid. (4) The percentage of nitrogen found in the globin sulphate is 14·9, from which the calculated percentage of nitrogen in the globin from the blood of the ox is 16·03 per cent. (5) The globin precipitated by trichloracetic acid was found to contain 0·45 per cent. sulphur.—Dr. R. **Broom**: The affinities of Cænolestes (Marsupialia). Thomas regarded this South American form as a diprotodont, not closely allied to any of the living forms, but more nearly related to the existing marsupials of Australia than to those of America. Miss Dederer, Gregory, and Sinclair, while agreeing that Cænolestes should not be placed in the Diprotodontia, prefer to relegate it to a distinct suborder, the Paucituberculata. After reviewing the evidence, the author concludes that as Cænolestes differs from the typical polyprotodonts only in tooth-specialisation, it should not be removed from the Polyprotodontia, but merely be made the type of a distinct family, or section at most.—P. **Cameron**: A collection of parasitic Hymenoptera (chiefly bred) made by Mr. W. W. Froggatt in New South Wales, with descriptions of new genera and species. Part i. Seventeen species, referable to the families Chalcididæ, Braconidæ, Evaniidæ, and Ichneumonidæ, are described as new.

CONTENTS.

THURSDAY, AUGUST 17, 1911.

A POLYGLOT DICTIONARY OF PLANT NAMES.

A Dictionary of Plant Names. By H. L. Gerth van Wijk. Part i., pp. xxiv+710. Part ii., pp. v+711–1444. (Haarlem: Published by the Dutch Society of Sciences, 1909–1910.)

THIS is one of those books that cause wonderment and admiration—wonderment, because it will be used, we should say, by comparatively few persons, and admiration of the author, who has devoted so much of his life to the service of the few, the work having been some twenty-five years under compilation.

"It is so planned that it will enable one to find the name by which a plant is known in four modern languages, if one knows the Latin name, and also to find the Latin name, if only the name in one of these four languages is known."

The languages chosen are English, French, and German, "to which the editor naturally added Dutch names."

In the first volume, now under review, the Latin names are alphabetically arranged, followed by the names used in English-speaking countries, or used in works written in English; by the names used in French-speaking countries, or used in books in the French language, &c. The author's aim has been to include the vernacular names of wild and cultivated plants, of varieties and subvarieties, of parts of plants now or formally (formerly) used in medicine or industrially, and of flowers and fruits; also the scientific names given to parts of plants which are, or were, used in medicine, &c., &c. This, of course, is an immense task, and a task that could scarcely be accomplished in a critical manner by one person. Therefore, if we say that Mr. Gerth van Wijk has achieved only a partial success, it must not be regarded as unkind or ungrateful criticism. To be generally useful a polyglot dictionary of any subject should be compiled on methodical and discriminating principles. The casual inquirer requires assistance where the student can find his way, and the mere heaping up of names is of little service to him. By casual inquirer we mean a person who has to consult a dictionary in connection with his occupation, profession, or pleasure, and for whom it is necessary that the information offered should be presented in an easily intelligible and practical form.

Now, it may be assumed that nearly everybody of the reading community comes under this category. A selection of examples of treatment will be of more service than general criticisms. As a component of pasture herbage, and as a weed, *Achillea millefolium* is one of the commonest herbaceous plants in the temperate regions of the northern hemisphere, and it has a correspondingly large number of names. In addition to the common English names, milfoil and yarrow, about thirty other English names are cited; they are mostly, however, of quite local application. These are arranged in alphabetical order, beginning with arrowroot, and continuing with the equally unfamiliar and unused bloodwort, camil, cammick, cammock, carpenters'-grass, dead man's daisy, devil's nettle, dog daisy, and so on. Then follow the French names, about equal in number, and the German, occupying a solid column, and numbering upwards of one hundred and fifty! Passing the less numerous Dutch appellations, we come to the officinal Latin designations of parts, as *capitula achilleae, folia millefolii,* &c., and nearly one hundred German names in relation to medicinal properties, some of them repetitions from the main list.

With all this great wealth of German names there is nothing to show which are in common use, or generally accepted as book names. No doubt a very large proportion of these names are either book names or of quite local use, and many of them mere dialect variants, of interest only to the etymologist. We have not Pritzel and Jessen's "Die deutschen Volksnamen der Pflanzen" before us at present; but Mr. Gerth van Wijk seems to have copied everything. The same in English; but although we miss all reference to Holland and Britten's "Dictionary of English Plant Names," we think the author must be indebted to it. Selecting another common plant, the daisy; there are four columns of foreign names, mostly German and Dutch. The dandelion occupies another two pages, and in this way the 1444 pages are filled with names without distinction, save that those in commoner use are printed in spaced type.

Of course, an author is at liberty to make the book of his mind, and it is perhaps scarcely legitimate to suggest that he should have done something else; but if he had taken the popular names (not translated names) from the leading "floras," pharmacopœias, and publications on economic botany, he might have produced a useful work. We are told by the author that the second volume is to contain the popular names in alphabetical order, with the Latin names appended. Has he estimated, we wonder, the amount of expansion these solid columns of names will undergo when each one begins a separate line? Well, the pagination would be tripled, at least! It should be added that what the author has set himself to do he has done very well. Errors are not prominently frequent, but there are names puzzling enough, and some apparently impossible. The nomenclature of the "Index Kewensis" has been followed so far as possible for the Latin names, and the position is this: knowing the Latin name of a plant, it is easy to arrive at the lists of popular names; but supposing it is wished to find the equivalent of poppy, apart from its Latin name, in French or German, the dictionary does not help us; nor will the second volume supply this kind of information. Indeed, to attempt this now in the author's plan would extend the work beyond imagination; yet, after all, this is just the kind of information that most of us want, and turning up common names, such as daisy and poppy, in ordinary French and German dictionaries, the ordinary equivalents are found.

W. BOTTING HEMSLEY.

PROBLEMS OF WATER SUPPLY.

The Geology of Water Supply. By Horace B. Woodward, F.R.S. Pp. xii+339. (London: Edward Arnold, 1910.) Price 7s. 6d. net.

THE geology of water supply is one of those applied subjects which are extremely difficult to treat of adequately within the limits of a small volume, inasmuch as geology constitutes only one of the factors which have to be taken into consideration, and the part which it plays varies with so great uncertainty that each individual case must be dealt with practically on its merits. It may be said at once, however, that we have here an extremely useful book, one which sets forth with great clearness the main geological features to be recognised by the engineer, chemist, or physical geographer when confronted with a problem of water supply, and indicates to him the critical point where the geological doctor must be sent for. The examples quoted in illustration of general principles are naturally mostly taken from the British Isles, but there are many of great interest from other parts of the world, particularly from the United States and the British Dominions beyond the Seas.

After an introductory chapter and some general remarks on rainfall and atmospheric impurities, the author states some general geological considerations, and proceeds to describe the modes of dispersal of rain on the surface and underground, special reference being made to rivers and underground channels, swallow holes, pipes, bournes, dumb-wells, and springs. Then follows a chapter on surface sources of supply, which include storage of rain-water, supplies from springs, streams, and rivers, ponds, dew-ponds, and lakes and reservoirs. The geological interest increases in the next chapter, on underground sources of water supply—wells of all kinds—and then follow three chapters on the water-bearing strata of England, working backwards through the geological record. The succeeding chapter, on prospecting for water, applies the information already provided to the selection of sites for wells and borings, having regard to the quantity and quality of water required, the geological uncertainties underground, and, incidentally, to the belief that trustworthy aid can be obtained from various methods of water divining. This is, in our opinion, the most valuable chapter in the book; the hints as to the examination of particular districts and the diagrams illustrating local peculiarities which may be met with are extremely clear, and will form a useful warning to the non-expert of the danger of trusting too much to apparent simplicity of structure.

The next section of the book concerns itself with the water supply in polar, arid, and other regions, and in islands, where special conditions arise; a non-geological chapter refers shortly to the quality of water and the examination thereof by chemical and bacteriological analysis; and, lastly, we have a chapter of great interest on mineral waters, *i.e.* waters which contain in solution more than the 60 or 70 grains per gallon which marks the "potable" limit.

A final chapter adds to the growing body of evidence which may one day be deemed sufficient to justify the constitution of a National Water Board, which would enable "the various independent authorities dealing with the conservancy of rivers, with canals, drainage, sanitary matters, and water supply," to act to some extent in concert.

A useful glossary and bibliography and a satisfactory index are appended.

In reviewing a suggestive book of this kind it would, of course, be easy to embark upon a discussion of many things which, as the author is always careful to point out when he comes to them, are still largely matters of opinion, but space forbids more than the mere laying of emphasis upon one or two points. We note the need for further investigation of the conditions of percolation, and the solvent action of water in a permeable formation such as limestone. Where the limestone formation is exposed it would seem that, the solvent power of the percolating water being quickly lost, solution takes place chiefly along cracks or joints, which are opened out into fissures, caves or underground channels being formed where the rock material is strong, and subsidence occurring where it is weak; but where the permeable formation is overlain by an impermeable, it appears that percolation takes place with great slowness, and water obtained by boring through the upper strata is not quickly replaced from a distance. The analytical work of Mr. W. W. Fisher and Dr. J. C. Thresh in the oolites in Oxfordshire and the chalk under London is extremely significant; it suggests important conclusions in connection with, *e.g.* the lowering of the water-table under London, the outflow of water from the chalk in Kent and Hertfordshire and in other parts of England where similar structures occur.

With regard to maps showing underground contours, we agree that contours delineating the upper surface of covered water-bearing formations are valuable, and that an extension of work similar to that of Mr. W. H. Dalton is desirable. But we think that Mr. Woodward underestimates the usefulness of maps representing underground water-contours, which give much information as to the direction of flow of underground water and its variations from time to time under varying rainfall and pumping.

We note few slips, but it may be worth pointing out that the New River derives much of its supply from an intake from the Lea, and the Glencorse reservoirs largely supplement the Crawley springs in contributing water from the Pentland Hills and Edinburgh.

H. N. D.

PARASITISM.

Survival and Reproduction: a new Biological Outlook. By H. Keinheimer. Pp. x+410. (London: J. M. Watkins, 1910.) Price 7s. 6d. net.

THE plentifully quoted pages from the writings of Darwin, Kropotkin, and others contained within the structure of this book form far more than its skeleton. Their presence justifies the statement that the work contains many luminous passages and much translucent information.

That part of the work which spatially connects the unmistakably clear words of penetrative genius and the brilliantly facetted phrases of clever men, and which is contributed by the author, is, however, of another kind: rather fluorescent than luminous, and by no means transparent.

Not that the author is without some literary deftness and incapable of pressing home a plain fact in a convincing manner. Thus, for instance, where he acknowledges his indebtedness for embodying so large a part of Geddes and Thompson's well-known work on "Sex and Evolution," explaining that it would be mere presumption on his part to attempt to do again what they have already done far better than he could do. Reading the book, it is soon clear that this is true, and, as of great relevance, a truth as well stated although otherwise evident. That it is stated well no one will deny.

The author's own meaning is presumably contained in the commentary paragraphs that follow each of these lengthy quotations. The redundancy of reiterated references to "parasitism" contained within these comments is reminiscent of a well-known dialogue between two dramatists unfortunately departed to the nether-world and there contesting their respective excellences in metrical statement. Entitled to one line with which to conclude his fellow competitor's heroic verse, one candidate secures a repeated success by the use of always the same phrase, some such simple phrase as "and I lost a little oil-can."

From these reiterated comments it would appear that parasitism is responsible for many things, chiefly perhaps for "the passing of natural selection." This is by no means surprising when the author's comprehensive concept of "parasitism" is fully grasped. The term is defined as connoting

"Every condition whereby one organism lives predaceously, stealthily, or indolently, *i.e.* retrogressively, by the work of others. In view of the dynamic interdependence of life, the epithet must also apply to all transitory phases of violation of fundamental laws of assimilation and division of labour, even the highest and most strenuous organisms occasionally being guilty of such transgressions."

To this definition there are, however, so many numbered corollaries that "parasitism" is by no means understood until wider reference is made. Briefly, let it be said that there is the whole work to refer to.

Herbert Spencer, so it would seem, has anticipated this intellectual venture in a somewhat remarkable manner. Thus the author quotes his explanation of the limits to cell-growth in terms of an increasing disparity between mass and surface, and appends the following comment: "Herbert Spencer here very lucidly, though unwittingly, states the case of pathology and parasitism, and consequent limitations."

The author deliberately stating this case, so it would seem, is by no means so clear, and as a consequence places difficulties in the way of that criticism which he foresees apparently without fearing.

"Anyone honestly wishing to challenge my views is, of course, very welcome to do so. But if criticism is to be effective, it must state categorically in what particulars I am wrongly interpreting observed facts, and must also show that my physiological position is unsound."

This statement may become more pregnant when the author has detailed these particulars, and provided a view of his physiological position.

J. S. MACDONALD.

THE DIVINING ROD.

Graf Carl v. Klinchowstroem. Bibliographie der Wünschelrute. Mit einer Einleitung von Dr. Ed. Aigner: der gegenwärtige stand der Wünschelruten-Forschung. Pp. 146. (München: Ottmar Schönhuth Nachf., 1911.)

THIS book contains a fairly complete list of the various publications in regard to the divining-rod, beginning with the work of R. P. Bernhardus, published in 1532, and ending with papers issued during the current year. This list extends over 103 pages, and the contents of each book or paper are indicated by a brief note following the title of the publication.

The list is naturally more complete in respect of German publications than of any others; there is a useful index giving the names of the various authors who are mentioned. The thanks of those who are interested in the matter are due to Graf von Klinckowstroem for the care he has taken in collecting the information and presenting it in useful form. There is also an interesting introduction by Dr. Eduard Aigner, of Munich, who endeavours to sum up impartially the present condition of matters in connection with research on the action of the divining-rod. He points out quite correctly that the attitude of those who refuse to investigate the matter at all is just as absurd as that of their opponents, who are willing to accept all the claims of the "diviners" without further investigation.

Dr. Aigner also points out that a certain percentage of failures does not necessarily prove that the "diviners" do not possess the powers they claim, for if these powers have any real existence, they may be conditioned by circumstances at present unknown to us, and one may be at times asking the "diviners" to perform experiments under impossible conditions.

An explanation of the recorded successes of "diviners" is suggested, which presupposes the power of the "diviners" to recognise the difference produced in the atmosphere by the presence of water, metals, &c. The most important argument in favour of this is based on the investigations of Dr. Kurz and Prof. Gockel (*Physikalische Zeitschrift*, x., p. 845) and of T. Wulf (*idem*, x., p. 997), in which a lessening of the gamma-radiation over water is said to be proved. This lessening is said to take place over quite insignificant water-sources.

If this view were correct, it ought, of course, to be possible to produce a physical apparatus capable of replacing the "diviner," and several articles of this kind are on the market. The reviewer has applied for permission to test some of these, but he has not so far succeeded in inducing those concerned to allow him to do so. Dr. Aigner says that successes of one form of apparatus are spoken about, but that they do not appear to have been verified by competent authority.

The reviewer is of opinion that further experiments are desirable, and that these should be directed mainly towards ascertaining whether or not the movements of the "diviner's" rod are caused by any influence outside himself. The experiments are difficult to carry out, because it is clearly fair that the conditions should be those acceptable to the "diviner"; these vary greatly, few "diviners" being entirely in agreement when asked to describe clearly the extent of their powers.

J. Wertheimer.

DIOPHANTINE ANALYSIS.

Diophantus of Alexandria: a Study in the History of Greek Algebra. By Sir T. L. Heath, K.C.B. Second edition, with a Supplement containing an Account of Fermat's Theorems and Problems connected with Diophantine Analysis and some Solutions of Diophantine Problems by Euler. Pp. vii+387. (London: Cambridge University Press, 1910.) Price 12*s.* 6*d.* net.

THIS is far from being a mere reprint of the first edition; in fact, it is in great part a new work, which, in conjunction with Tannery's critical edition of the "Arithmetica," makes Diophantus at last accessible to the ordinary reader.

The introduction, besides giving a historical account of Diophantus, the MSS. of his works, and the writers who have dealt with them, contains most interesting and valuable sections on Diophantus's notation and methods of solution. As to the first, we are astounded, as in the case of Archimedes, at the ease with which enormous numbers are computed, in spite of the cumbrous Greek notation. An instance in point is the famous cattle problem (attributed to Archimedes), which is briefly discussed on pp. 121–4. Its solution involves the Pellian equation $t^2-4729494u^2=1$, and according to Sir T. Heath's calculations, the value of one of the unknowns of the problem would be a number containing 206,545 digits. Of the methods of Diophantus not much can be said, because he uses so many ingenious devices to suit different problems; but we may note his dexterity in choosing his unknown quantity, and his curious plan of "working back" by a sort of rule of false position. A good example of the latter is v. 29 (p. 224): "To find three squares such that the sum of their squares is a square," where it will be seen that an insufficient assumption is corrected and modified in a sort of tentative way until a solution is found.

It would be unprofitable to go into any detail here on the nature of Diophantine problems in general; to appreciate them it is necessary to read Diophantus, Fermat, and Euler. By a very happy inspiration, the present volume has been made to include all the notes of Fermat upon Diophantus, and extracts from his correspondence with Frénicle and others; besides this we have solutions of seventeen Diophantine problems by Euler, which are models for those who feel inclined to work in this fascinating field. There can be little doubt that there are still numbers of arithmetical problems to be solved by Diophantine methods, and Fermat's method of reduction (*descente*) for proving the impossibility of certain indeterminate equations awaits rediscovery and development. Moreover, the theory of algebraic forms and symmetric functions ought surely to lead to new arithmetical applications of a Diophantine type. To give an example of the sort of thing we mean: Let x, y, z be three variables; we have identically

$$\Sigma x(y-z)^3=(y-z)(z-x)(x-y)(x+y+z).$$

Now put $x, y, z=\xi^3, \eta^3, \zeta^3$, and suppose that $\xi^3+\eta^3+\zeta^3=m\xi\eta\zeta$; then the previous identity leads at once to

$$A^3+B^3+C^3=mABC$$

with

$$A, B, C=\xi(\eta^3-\zeta^3),\ \eta(\zeta^3-\xi^3),\ \zeta(\xi^3-\eta^3).$$

This is a partial sample of what Fermat would call a *descente*; of course, it is now well known as the theory of residuation of points on cubic curves, but it is interesting to see how it results from an elementary algebraic identity, and there are still arithmetical problems in this connection which do not appear to have been solved.

It may interest those who are unacquainted with the subject to give one typical Diophantine problem and its solution. The problem is "To find two positive integers such that their sum is a square, and the sum of their squares a biquadrate." One solution is (4565486027761, 1061652293520), and it has been proved by Lagrange that, as Fermat "confidently asserted," this is the simplest solution. More exactly: the same problem may be put in the form, "Find a right-angled triangle such that the hypotenuse and the sum of the sides are both squares," and Fermat's assertion was that the above solution gave the smallest of such triangles.

In conclusion, it may be remarked that there is a *crux* in the Greek text which does not seem to have been finally disposed of. After putting the problem, "To find two numbers such that their sum and product are given numbers," Diophantus adds the condition, "the square of half the sum must exceed the product by a square number." ἔστι δὲ τοῦτο πλασματικόν. It would be possible to translate this, "This is artificial" (as opposed to "natural"), but there does not seem to be any point in this. On the other hand, to translate "This can be seen from a model" would give good sense, because we should only have to replace a diagram in Euclid by a corresponding arrangement of counters; unfortunately, this seems to read more into the text than is legitimate. Neither of these alternatives is proposed in the note on p. 140; the editor prefers, on the whole, Xylander's *effictum aliunde*, which is not far in sense from "artificial," in the context. The same phrase occurs in two other places, and in each case we can give a quasi-geometrical arrangement of counters to show that the condition is necessary; so far, this is in favour of the second alternative suggested above.

G. B. M.

A TEXT-BOOK ON HELIOTROPISM.

Light and the Behaviour of Organisms. By Prof. S. O. Mast. Pp. xi+410. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd., 1911.)

THE question of the influence of light upon organisms must have appealed to the inquiring mind ever since a moth was seen to fly into a candle or a plant was observed to bend towards the sun. The closing of many flowers at night coinciding with the opening of others would have also been arresting movements to many unknown observers. But how subtle the influence of light may be has only comparatively recently been appreciated. The bending of plants towards the sun may readily be explicable on the ground of the importance of light in the preparation of the plant-food, but the hydroid zoophytes were discovered to possess the same property of bending towards the source of light, although they do not find thereby any known assistance to their maintenance. Larvæ of many diverse marine animals are also strongly attracted by light, and these, again, make no use of it so far as is known. Many animals, indeed, prefer rays of a particular region. As Lord Avebury showed years ago, the common Daphnia, if covered by a spectrum, aggregates under the green and yellow rays; ants, on the other hand, aggregate chiefly under the red and green rays, showing a special avoidance of violet and ultra-violet rays. Such varied and definite susceptibility seems quite unintelligible unless it is connected in some way with well-being, and no one has as yet shown any such correlation. The problems, then, of the meaning of the attraction or repulsion which light exerts are evidently very diverse, and the work of Mr. Mast is devoted to their analysis and consideration.

The first section contains an interesting historical summary of observations chiefly upon plants. Ray was apparently the first to suggest an explanation of the movements of plants, which he attributed to the flow of sap, being attracted to the problem by the sensitive mimosa then recently introduced from America. Early in the nineteenth century de Candolle reversed the daily periodic sleep-movements of leaves by exposing them to a new light rhythm—an interesting anticipation of F. Darwin's work. Many other points of interest are raised, including a discussion of the use of such terms as "tropism," originally the relation between the bending of a plant and the source of stimulation.

In part ii. the author sets out an account of his experiments on certain plants (Plumules of Indian corn and leaves of Tropæolum), and arrives at the conclusion that differences of light-intensity are responsible for the movements (observed by a special "light-grader"), but the method of regulating the movements is still a mystery. The section on the light-responses of unicellular plants and animals includes some original observations, as does that upon cœlenterates and various larval forms of higher animals. The general summary of this section is given on pp. 228–235, and includes a useful analysis of the work of many writers. The third part of the book is concerned with general considerations—the adaptive nature of light-responses, the phenomenon of aggregation in different intensities, and so on. This section and the last (which deals with reactions of animals to different wave-lengths) are very diffuse, and might well have been considerably shortened, as in many cases the discussions are not capable of leading to any definite solution; and if the excuse be offered that "behaviour" in its broadest sense was the subject of treatment, then surely the problem of colour-adaptation might have been mentioned. The points that emerge from this work are that there are many striking movements towards or away from the source of light which are quite unintelligible unless animal metabolism is favourably effected thereby, and we have no reason to suppose it is; and, secondly, that the way in which these orientations are effected is equally obscure. The book is written by a pupil of Jennings, who has done so much to analyse the behaviour of the lower organisms. It contains a very useful bibliography, and should prove helpful to that increasing number of experimental biologists and psychologists who are interested in the behaviour of organisms.

F. W. G.

PLEASANT PATHS OF NATURE.

The Airy Way. By George A. B. Dewar. Pp. vii+253. (London: Chatto and Windus, 1910.) Price 6*s.* net.

IN a delightfully breezy volume Mr. Dewar plays lightly on the word "airy" in its varying application, straying, by the way, into the rapid-running waters—the fishes' airy way. Following two most interesting chapters on flight and one on the watery way, the contents of the rest of the volume may be sufficiently indicated by the chapter headings dealing with the airy moor and links, the fritillaries' airy way, the airy lane and common, rooks in the airy way, and "my airiest downs"—a year's observations on the chalk. Field naturalists will be grateful to the author for his gift of conveying impressions in a few words—impressions which many may have felt, but could not perhaps express so aptly.

A few quotations from this pleasant book will serve to illustrate the pertinence of his remarks and the accuracy of his observations. Of the swift, a bird for which he has a great admiration, he says that it *is* flight, and is fitted with two scythes to cut and sweep through the air. Of the start of birds from the ground he writes:

"Hide behind a hedge or wall, and, when every pigeon beak is down, tap your stick on the ground. As you tap—whilst sound is still coming from the stone—every bird is in the air. You would as soon try to reckon the time between the hammer striking the cap and the discharge of the cartridge as reckon the time between the stick striking the stone and the discharge of the pigeon party."

And of the salmon:

"No man swims if a salmon swims. The keeping afloat, and the slow movements of a man in comparatively still water, should not be given the name we give to the swift, sure, glorious action of the salmon in the fury of storming streams. Does a man who sits in a flying machine which makes its way through the air 'fly'? If so, the swift and the merlin and eagle have an action for which we should find another name. One thing such acts have in common—progress. They have little else."

Mr. Dewar says truly that though no date in a calendar can end or begin winter, yet there are some natural events—small touches, but sure—that end one season and begin another. One of them is the nest—with the eggs—of the earliest song-thrush. "The nest may be set in a winter hedge, and a return of iron days and nights kill the work and prevent other thrushes starting on their nests for weeks to come. It does not signify. The first thrush nest found in March in the thorn or ivy, the clay dried, the eggs laid, ended winter." But he does not do the fly-catcher justice when he says it can squeak, and has besides a fretful monosyllable or so, and there is his music. It is true that the fly-catcher very rarely sings, and that many people have apparently never heard the song; but it does really sing occasionally for all that. How one wrong letter will alter the look of a sentence, and even puzzle the reader for a moment! We notice "swallow" written for "sallow" in one place, and "root" for "rook" in another.

TEXT-BOOKS OF PHYSICS.

(1) *Mechanics and Heat: a Text-book for Colleges and Technical Schools.* By W. S. Franklin and Barry Macnutt. Pp. x+409. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1910.) Price 7s. 6d.

(2) *A Text-book of Physics.* By H. E. Hurst and R. T. Lattey. Pp. x+638. (London: Constable and Co., Ltd., 1910.) Price 8s. 6d. net.

(1) WITHIN the last half-century much experience has been gained as to the methods which can be used most profitably in the teaching of science; nevertheless, there is still much diversity of opinion as to the best method to be used. Followers of the heuristic school maintain that a student should build up his knowledge of science by his own unaided exertions, the function of a teacher being to guide the student's mind insidiously toward the correct path. Has any teacher ever attempted to proceed severely on these lines? It may be doubted. So far as the teaching of physics is concerned, such an attempt would be so ridiculously futile that no one could have made it seriously. Ideas such as those connoted by the words "energy," "potential," "entropy," and a host of similar expressions could scarcely be derived by any student, even if he were of the type that might develop subsequently into a Kelvin or a Rayleigh. Quite apart, however, from the question of possibility, it may be argued that no student has received a satisfactory training unless he has learned to profit by the knowledge which has been accumulated by others. Dismissing, then, the claims of the heuristic system as enunciated by its most rigid adherents, the question arises, To what extent is a student necessarily dependent on personal observation, and to what extent is it profitable for him to imbibe ideas directly from his teacher? No general answer can be given to this question, since so much must depend on the personalities of both the student and the teacher; but if it be accepted that science is the study of real phenomena, it must follow that the practical work done by the student must be sufficiently extensive to give him a clear idea of the phenomena which he investigates. Not only the nature of the experiments, but the order in which they are performed, is of importance. Most of the difficulty experienced by students in becoming acquainted with the dynamical properties of solids and fluids is due to the practice of studying the laws of statics exhaustively before the laws of motion have been mastered; much of the time now spent in the experimental study of statics might be devoted with advantage to the performance of simple experiments designed to illustrate the laws of dynamics. In a systematic course of study an accurate and comprehensive knowledge of mechanical principles should be gained as early as possible, for most of the exact sciences cannot be mastered without such a knowledge.

Messrs. Franklin and Macnutt have advisedly devoted the first 269 pages of their text-book to the study of the mechanical properties of solids and fluids; such subjects as virtual work, the properties of rotating bodies (including the gyrostat), the analysis of the stresses called into play by straining an elastic substance, and the fundamental laws of hydrodynamics are dealt with in a simple but illuminating manner. A few errors may be noticed. The action of the Pitot tube cannot be deduced from the force exerted by a jet of liquid impinging normally on a plane. The velocity of stream, as measured by a Pitot tube, should be equal to $\sqrt{2gh}$, where h is the height at which the liquid stands in the tube, instead of $\sqrt{gh}$, as given on p. 260. The depression of the surface of the water escaping from the central outlet of a laboratory basin is not essentially due to rotation of the water; even when the water approaches the outlet radially its velocity must increase and its pressure must diminish. In general, however, the treatment of the subject is excellent, and the student is afforded an opportunity of becoming acquainted with many interesting phenomena connected with engineering practice, which are not generally mentioned in books devoted to the theory of mechanics.

The second part of the book is devoted to the study of heat. The first and second laws of thermodynamics are discussed fully, and the most interesting properties of solid liquids and gases are dealt with in passing. The graph given on p. 401 exhibits the rate of cooling of a teapot as compared with that of a Dewar's vacuum flask, and is interesting as showing that the rate at which the teapot loses heat is scarcely affected by radiation, being due almost entirely to convection and, to a small extent, to conduction. How many teachers, it may be wondered, have explained that a silver teapot loses heat more slowly than a porcelain one, on account of the high reflecting and consequent low radiating qualities of polished silver?

(2) Messrs. Hurst and Lattey have written this book for students preparing for the Preliminary examina-

tion in physics in the Oxford Natural Science School; the general standard adopted is somewhat lower than that required for the examinations in physics for the Intermediate B.Sc. of the University of London. The book has been carefully written, and the diagrams are well drawn and reproduced. A large assortment of questions (without answers) is given at the end of each chapter. For the rest, there is not much to distinguish this book from many others on the market. The ordinary ground is covered in a trustworthy but somewhat uninspiring manner, and very little attention has been devoted to display. One or two errors may be mentioned. Ohm's law cannot be proved by the aid of experiments conducted with the potentiometer, as stated on p. 520; the use of the potentiometer is based on the truth of Ohm's law. One of the diagrams on p. 466 indicates that when a charged body is suspended inside an insulated metal can, the distribution of the lines of force radiating externally from the can depends on the position of the body inside the can. This conclusion is well known to be inaccurate. A very bad example is set to students on p. 16, where it is stated that—

"A velocity of 20 miles per hour was gained in 15 minutes; if the acceleration had been uniform, $\frac{20}{15}=1\dot{3}$ miles per hour had been added in each minute, or $\frac{1\dot{3}}{60}=0{\cdot}02\dot{1}8\dot{3}$ miles per hour in each second."

One of the first things that should be impressed on a student of physics is that recurring decimals have absolutely no meaning with regard to physical measurements.

E. Edser.

EXPERIMENTAL PSYCHOLOGY.

Lectures on the Experimental Psychology of the Thought-Processes. By Prof. E. B. Titchener. Pp. ix+318. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1909.) Price 5*s*. 6*d*. net.

A Text-book of Psychology. By Prof. E. B. Titchener. Part II. Pp. ix+303–558. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1910.) Price 6*s*. net.

In these books Prof. Titchener has made two valuable additions to the list of excellent psychological text-books that already stands to his name. The first takes its place by the side of his "Lectures on Feeling and Attention" as another detailed and advanced discussion going to the very heart of general psychological theory; the second is the completion of a new "Text-book of Psychology," intended to take the place of his well-known "Outline."

The lectures on thought-processes are five in number, in which are discussed the general function of mental imagery and its relation to thought, "objective reference" as the universal characteristic of consciousness, the modern methods employed in the experimental investigation of the thought-processes (by Marbe, Binet, Watt, Ach, Messer, Bühler, &c.), and the general conclusion as to the existence of a distinct "thought-element" to which most of these investigators find themselves driven. Titchener finds this conclusion unjustified by the facts, and to be explained, partly at least, by a confusion of the psychological with the logical point of view. "Cortical set," *i.e.* a purely physiological factor, together with a residuum of mental imagery, a residuum so inappreciable that it escapes introspection, are to be looked upon as the more probable factors in the make-up of so-called "imageless thought" than any ultimate thought-element.

The first lecture contains an excellent account of the difference between modern psychological sensationalism and the older sensationalism of the associationist school. Whether the difference is so fundamental as Prof. Titchener imagines it to be is perhaps doubtful. When, *e.g.* he writes: "The experimentalists, on the other hand, aim to describe the contents of consciousness not as they mean but as they are," one may perhaps be allowed to demur. Would not such a complete abstraction of mental process from meaning make a theory of knowledge impossible? A distinction so rigorously drawn between psychology and epistemology or metaphysics really implies a denial of the existence of the latter sciences. In Lecture II. an analogy for the reference to an object implied in all thought is taken from physical organisation.

"Every constituent part of an organism points to and implies all the other parts. In the same way the ideational process which is the vehicle of conceptual meaning is involved in a network of reproductive tendencies; it points to and implies all the special ideas that fall under the concept in question."

Is it not more accurate to say that the "reference" and implication in the former case is explicable on the analogy of that in the latter, and not *vice versa*? The complete identification of "meaning" and "context" may solve many difficulties, but does it not raise still greater difficulties in doing so? Such doubts as these may arise in perusing the lecture, but Titchener does really come to close quarters and grapples with the central difficulty in a way that does much to justify his unshakable faith in psychology and its competency to include the whole field of mental life.

The later lectures are an excellent description and criticism of experimental work on thought. The conceptions of *Bewusstseinslage* and *Aufgabe* are fully explained and the exact position of the problem up-to-date made clear. In the "Notes," which fill more than 200 pages, the original authorities are extensively quoted, and many points are discussed in much greater detail. The entire book will be found of the utmost value to the advanced student.

The "Text-book of Psychology," Part II., deals with Perception Association, Memory and Imagination, Action, Emotion, and Thought, all in a clear and straightforward way. The descriptions are based upon experimentally-determined data, and give an excellent idea of the extent to which Experimental Psychology has widened and deepened the more general science. Very full references for further reading are given at the ends of the chapters. By the device of type of two different sizes the book has been made suitable both for the beginner and also for the more advanced student.

W. B.

OUR BOOK SHELF.

The Art of the Goldsmith and Jeweller: a Treatise on the Manipulation of Gold in the Various Processes of Goldsmith's Work, and the Manufacture of Personal Ornaments, &c., &c., for the Use of Students and Practical Men. By T. B. Wigley, assisted by J. H. Stansbie. Second edition, revised and enlarged. Pp. xii+264. (London: C. Griffin and Co., Ltd., 1911.) Price 7s. 6d. net.

THE work of the goldsmith and the jeweller, like that of many other craftsmen, has undergone a striking change of late years. Formerly the goldsmith was an artist making his own designs, and working them out with infinite patience and cunning, but seldom finding himself bound down to routine. He served an apprenticeship and was taught the various branches of the craft. Now that vast quantities of cheap jewellery of all sorts are manufactured, largely by the use of machinery, the workmen, even if something more than mere machine-minders, are engaged on some one special branch and learn no other. Such a system, of course, threatens the artistic side with extinction, and the establishment of technical schools and the production of such books as this one under review, revealing the mysteries of the ancient craft, become a necessity.

Mr. Wigley, with his long experience as headmaster of the Jewellers' and Silversmiths' Association Technical School, has the advantage of knowing what teachers and students require, and has written a very useful book. It is not detailed enough for students without demonstrations, but for the same reason it would not be painfully tedious to practical men, and would be by no means out of place in the workshop.

Details, however, are not lacking. Students are warned against certain pitfalls with almost meticulous care. As an instance, there may be cited the remark on p. 36, in dealing with the preparation of gold alloys:—"In adding decimal quantities together it is important to keep the decimal points under each other." On the other hand, some workshop knowledge is assumed, as on p. 70, where we are told that a lathe may be used for "turning pillars and small fittings, milling bezels, knurling edges of stud backs, sawing off joints, &c.," none of these terms being explained.

The book does not give an accurate picture of the industry as it exists to-day, as it leaves out of account most of the labour-saving machines and large-scale manufacturing methods. Moreover, the artistic side is not so persuasively presented as in Wilson's "Silver Work and Jewellery," and little space is devoted to history, but the book seems exactly adapted for those preparing for the technological examinations of the City and Guilds of London Institute, and thus it thoroughly justifies its existence.

The Adventures of James Capen Adams, Mountaineer and Grizzly Bear Hunter of California. By Theodore H. Hittell. Pp. xiii+373. (London: T. Werner Laurie, n.d.) Price 6s. net.

As we learn from the introduction, this book has a somewhat remarkable history. It first saw the light at Boston, U.S.A., so long ago as 1860, but, on account of the breaking out of the civil war, only a comparatively small number of copies appear to have been issued, and its publication was soon discontinued altogether. The present issue is an exact replica of the original, and is thus out of date in the matter of typography and illustrations; indeed, in the case of the latter this is self-apparent, as they are in a distinctly "prehistoric" style. The remarkable history of the book is, however, by no means exhausted by the above, for Mr. T. H. Hittell, who took down the narrative from the lips of J. C. Adams in the autumn of 1856, is still alive, and has acted as editor of the present issue. In saying that the book is a replica of the original, it might have been mentioned that the introduction and a postscript are new. The latter gives an account of the last days of Adams, who joined Barnum's exhibition, and appears to have died soon after 1860, if not, indeed, at the close of that year.

Such interest as the book possesses for the naturalist is to be found in the circumstance that it relates to a period when the big-game fauna of North America still retained a considerable share of its original abundance; and it is specially noteworthy to find Adams describing how he once "rounded up" a herd of prongbuck (antelope), and actually killed some half-dozen with his knife. But Adams, although he had a try at game of every kind, appears to have devoted special attention to grisly bears, which he not only killed, but captured and tamed to such degree that they were used for carrying baggage on the march. The book is thus well worthy of the attention, not only of those devoted to sport, but also of those interested in animal-taming. R. L.

A New Law of Thought and its Logical Bearings. By E. E. Constance Jones. With a preface by Prof. Stout. Pp. viii+75. (Cambridge: University Press, 1911.) Price 2s. net.

MISS JONES's object in this brief essay is to propound "a certain analysis of categorical propositions of the forms *S is P*, *S is not P*, to show that this is the only general analysis which it is possible to accept, and to indicate its bearing upon logical science." We need propositions of these forms for significant assertion, and without them no satisfactory statement can be given of the three fundamental laws of thought. The first two of these are commonly formulated as (1) *A is A*, (2) *A is not non-A*, and the third sometimes as *A is either A or non-A*. Desperate efforts have been made by logicians to give a valuable meaning to *A is A*; but if *A is A*, interpreted as *A is A*, is retained as the first fundamental law, there is no possible passage from it to *A is B*. Lotze therefore gives up (theoretically) *S is P*. *A is A* tells us no more than *A is A*, and if we begin with it, we must also end with it, if we are to be consistent. We must, then, not begin with it, but with a law of significant assertion—assertion of the forms *S is P*, *S is not P*. If we start with the principle that *every subject of predication is an identity (of denotation) in diversity (of intension)* this law and the laws of contradiction and excluded middle do furnish a real and adequate and obvious basis and starting point of "formal" logic.

Miss Jones illustrates and applies her contention in a concise but interesting way, and Prof. Stout thinks that she makes out her case.

Electricity in Locomotion: an Account of its Mechanism, its Achievements, and its Prospects. By Adam G. Whyte. Pp. vii+143. (Cambridge: University Press, 1911.) Price 1s. net.

THE author gives in a very concise form a brief history of the first tramways and railways, and proceeds to show how the development of electric tramways has taken place in spite of great opposition from the æsthetic point of view, and also from causes arising out of the Tramways Act of 1870. The various systems of electric traction are carefully considered and the advantages of each fully discussed. Further chapters deal with the trolley omnibus, accumulator, electric traction, and regenerative control. The causes of failure of the accumulator-driven vehicle are adequately considered, and also the advantages of the trolley omnibus when acting as a feeder for electric tramways.

The latter part of the book is devoted to petrol-electric vehicles and electric railways, while a chapter is included which deals with electric traction curiosities. A full description is given of the system and working of the Metropolitan District Railway, the London, Brighton, and South Coast electrified line, and the "Underground" Tube combination and the other tubes.

With regard to the petrol-electric systems, some interesting facts are given dealing with its aspect with regard to marine propulsion as advocated by Messrs. Durtnell, Mavor, and others. The advantages of the system, if successfully applied to warships and liners, would be enormous, but at present it has not got very much beyond the experimental stages, though there is hope that it may prove its worth in the near future.

Finally, the monorail systems are described, together with some other general arrangements of self-contained generating stations on wheels, &c., making, with the previous chapters, an interesting summary of the history of electric traction from its commencement to the present day.

British Ferns: a Pocket "Help" for the Collector. By F. G. Heath. Pp. x+130. (London: Sir Isaac Pitman and Sons, Ltd., 1911.) Price 2s. net.

THE author's knowledge of fern species and their habitats has been manifested in previous publications, so that one is prepared to find this real pocket-book, measuring 6½ by 3¾ inches, a trustworthy and desirable acquisition when making an excursion in quest of ferns. Forty-five species are enumerated, but varieties with one exception are omitted. The descriptions are written primarily for the amateur collector, and serviceable assistance is provided in the illustrations. The information is tabulated under the headings frond length, description, usual habitat, and localities. The list of localities, given as fully as possible, represents an arduous piece of work. Certain introductory sections are prefixed, of which the two giving definitions and general habitats are most desirable and helpful, but the others are imaginative rather than scientific; it is not necessary to go beyond the statement that every point of the germ (sporeling) is equally ready to produce roots or a stem. Disregarding the first four sections, the book provides a compact, informative guide.

Aërial Locomotion. By E. H. Harper and A. Ferguson. With an introduction by Prof. G. H. Bryan, F.R.S. Pp. xii+164. (Cambridge: University Press, 1911.) Price 1s. net.

POPULAR handbooks on aërial navigation are now issuing from the press in a constant stream, and as their number grows the reviewer naturally judges of each new arrival by comparing it with its forerunners.

The exact public for which the little book under notice is intended is difficult to determine. The book is accurate, but it is dull; it is unattractive, and is poorly arranged. We cannot imagine the book being read for amusement, as the style is difficult to follow, or for information, owing to the absence of shoulder-notes, index, sectional arrangement, and other of the common aids to study.

Clarity of expression is lacking in very many places, while the sentence on p. 60, "If the elevator is carried normally in a different position during flight, all the conditions of flight are changed," is quite incomprehensible.

As has been said, the book is accurate, but it is scarcely calculated to attain its apparent object of interesting the public in the science of aëronautics.

Nature's Pageant: The Story of the Seasons. By Margaret Cameron. Pp. iv+120. (London: Blackie and Son, Ltd., 1911.) Price 1s.

THIS little book is an attempt to teach nature-study to children of seven years of age. They are supposed to read the simply-worded story, in which plants and animals talk, and to look at the pictures. In our judgment, nature-study lessons are of little value unless they are concerned with the observation of the objects themselves; and such attempts as are here given to combine information with imagination are not the best means of cultivating interest in literature or science.

Assaying and Metallurgical Analysis. For the Use of Students, Chemists, and Assayers. By E. L. Rhead and Prof. A. H. Sexton. Second edition. Pp. x+451. (London: Longmans, Green and Co., 1911.) Price 12s. 6d. net.

THE differences between this edition and the preceding one are not important. A few new methods are included, such as the determinations of copper and of iron by titanous chloride and the volumetric estimation of nickel by cyanide, but the text generally remains unchanged, and the merits and occasional defects of the book have not been modified. It is still one of the most useful works on the subject available.

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.*]

On the α-Ray Theory of Aurora Borealis.

IN a letter to NATURE of April 13 (vol. lxxxvi., p. 213) I gave reasons for the view that at least some of the forms of aurora borealis are caused by a type of rays which, as regards absorption by matter, follow the same law as α rays from radio-active substances. In the letter I also mentioned that the diurnal distribution of aurora apparently would require a negative charge of the rays.

My arguments which lead to a negative charge was based on the assumption that the simplest orbits, like that of (*a*), ought to occur more frequently than the more complicated, like that of (*b*), both of which are theoretically possible. This assumption, which indeed might seem legitimate, is not, however, a consequence of exact mathematical calculation, for the problem of finding the relative probability of the occurrence of the various possible orbits has not yet been solved.

Further, an exact determination of the diurnal distribution of aurora is made difficult through the effect of sun—and moonlight; but, even if we take it for granted that the aurora are most frequently found on the evening side, there is, so far as our present knowledge goes, no necessity for assuming a negative charge of the cosmic rays.

Moreover, the explanation of the thin drapery form, given by Störmer,[1] requires orbits like (*b*) having turned round the magnetic axis a great angle, and if such an orbit is going to strike on the evening side a *positive* charge is necessary. These matters will be more fully discussed in a subsequent paper.

There are some other points not mentioned in my previous note which are of considerable interest. In order to explain from the radiation theory the formation of thin drapery bands, a strictly homogeneous radiation is neces-

[1] Arch. des Sci. Phys. et Nat., 1907.

sary. Now we know that the α radiation given out during one radio-active transformation is, in fact, homogeneous.

A most peculiar property of aurora is the formation of parallel bands. It seems as if the bands were mutually connected in some way. When one band leads the others will form similar equidistant curves, and it is frequently observed that if one of the bands moves, the others will undertake a similar movement.

I think these most peculiar properties will be immediately understood if we assume each band to be produced by its own homogeneous radiation, and that the homogeneous radiations corresponding to the various bands start from the same source. If so, the various groups will be subject to the same conditions, with the exception that they will be slightly differently bent by the fields of force which they have to pass through on their way to the polar regions. If, therefore, one homogeneous bundle makes itself felt as a thin luminous band along the magnetic parallel, the rays from the other groups, having started under the same initial conditions, must give rise to bands similar in form, but with a difference in position, corresponding to the difference of stiffness of the various groups.[1]

Now the existence of homogeneous groups given out from the same source is a simple consequence of the α-ray hypothesis, because a number of different radio-active compounds will be formed through the atomic disintegration and eject groups of homogeneous α radiations.

In that way the auroral drapery bands should form a kind of *magnetic spectrum* of the α rays given out by some radio-active matter present at the sun. Thus a possibility opens out of studying and identifying the radio-active substances on the sun by examining the magnetic α-ray spectrum produced by the earth's magnetic field in the form of drapery bands.

In the following table is given the "magnetic auroral spectrum" of the radium family calculated on the assumption that the earth's magnetic field is that of an elementary magnet :—

Substance	$\phi_0=16{\cdot}5°$ d. km.	S_d	$h=120$ km. β
Radium	0	24	11·5
,, F	24	15	7·2
,, emanation..	39	25	11·9
,, A	64	69	33·0
,, C	133		

ϕ_0 is the angular distance from the magnetic axis to the radium band, which is farthest north, h is the height to which the draperies are supposed to descend, d is the distance from one of the bands to that of radium, S is the distance in km. and β the angular distance between successive bands. The draperies are supposed to be seen near the zenith at the height $h=120$ km. Any attempt at identification with actual observations is hardly possible with the material at my disposal, but such identification may be possible, *e.g.* through the development of the photographic methods. I think, however, that the values found are of the right order.

Summing up, I think we may say that, so far as our present knowledge goes, the properties of auroral drapery bands, and probably other forms of aurora, are well explained by assuming that they are caused by α rays from some radio-active substances on the sun. In order that the rays shall preserve homogeneity, it is necessary that the radio-active matter is distributed in extremely thin layers, and in such a way that the radiation gets out without traversing other kinds of matter.

The arguments in favour of the α-ray hypothesis are, in short, the following :—

(1) The straight-lined structure of the draperies is explained from the small scattering of α rays.

(2) The rapidity with which the luminosity stops at the bottom edge of the band is explained from the "range" of the α rays.

(3) The maximum intensity of the luminosity is explained from the variation of ionisation along the path of the α particle.

(4) The explanation from the radiation theory of the thin drapery bands is in favour of a positive charge, while the diurnal distribution of aurora gives at present very little information in this respect.

(5) The parallel drapery bands are explained from the fact that a mixture of radio-active substances formed by atomic disintegration gives out a mixture of homogeneous groups of α rays.

(6) Calculation of the height of aurora from the relation between velocity and range found by Bragg, Kleeman, and Geiger has shown that α rays with velocities of the same order as found for ordinary radio-active substances would get down to heights varying between 70 and 300 km., which is, indeed, the interval of height most frequently found for aurora.

(7) According to Störmer's calculations, the draperies, when formed by α rays, should appear at an angular distance of about 17° from the magnetic axis, which gives very nearly the right position of the auroral zone.

(8) Radiation of the β-ray type cannot explain the structure of the draperies on account of their great scattering, and being magnetically much softer than the α rays they do not give the right position of the auroral zone

(9) The spectrum of aurora has not yet been interpreted in terms of spectra physically known. This negative result indicates that the auroral spectrum owes its peculiarities, not so much to the gases present as to the peculiar way in which the light is produced.

In my opinion the spectrum should be produced by α rays penetrating through the upper strata of the atmosphere. It might be possible for those who possess a sufficient quantity of radium to examine the spectrum produced when α rays pass through rarefied gases.

L. Vegard.

University of Christiania, May 30.

[1] See Störmer's papers on corpuscular orbits.

Occurrence of a Fresh-water Medusa in Indian Streams.

Dr. Annandale's interesting announcement, in Nature of August 3, of the discovery of a fresh-water Medusa in streams of the Western Ghauts, emboldens me to mention that, at the beginning of the hot season of 1879 or 1880, I saw and handled one of these beautiful little creatures in the lake at Purulia, in Chota Nagpore.

This lake, as I remember it in those years—since when I have never had an opportunity of revisiting it—was a sheet of water of no very great size, and a maximum depth of about 24 feet, said to have been formed by damming the mouth of a wide and shallow ravine so as to catch and hold the ordinary surface drainage. Its flora and fauna were just those of an ordinary Indian "tank"; in the cold season it was used as a sort of port of call by wild-duck; and in the rainy season two little islets that rose above its waters became discordant and unfragrant nurseries of night-herons and snake-birds.

I caught the Medusa—there was only one—when taking my customary morning swim, and though I afterwards kept a look-out, I never saw another.

The few friends to whom I ever mentioned the matter always very politely changed the conversation; but Dr. Annandale's discovery now leads me to think that it might be worth while to look for medusæ in the pools of the Damuda, Subanrika, and Kasi Rivers, which run through Chota Nagpore on their way to the Bay of Bengal.

Heathlands, Belvedere, Kent. A. Alcock.

Interglacial Conditions in the South of England.

Recent observations here through excavations connected with the opening up of the district have enabled me to appreciate the importance of the letter which appeared in Nature (December 15, 1910, p. 206) from Mr. Hazzledine Warren on the "Arctic Plants from the Valley Gravels of the River Lea." He speaks of the evidence as leaving "no doubt that the Pleistocene age was closed by a partial return to glacial conditions, succeeding an epoch when temperate conditions prevailed." Reserving for the moment a discussion in any detail of the evidence now to hand in the upper Valley of the Stort (an affluent of the Lea), I merely wish, with your courtesy, to say now that the physical evidence bears out Mr. Warren's contention;

for we must, I think, recognise hereabouts a younger Boulder Clay as distinct from the "Chalky Boulder Clay" of the Herts and Essex plateau, along with interglacial deposits consisting largely of the outwashings of the older Boulder Clay.

It is easy to understand that a great latitudinal range of variations of climatic conditions in these lowland regions of south Britain would be necessarily contemporaneous with the more definitely marked *altitudinal* variations of the snow-line in the Alpine regions of Britain and Europe, whether from regional subsidence or otherwise. One may venture to say that we have here a record contemporaneous perhaps with that of the "Hessle Boulder Clay" or the "Purple Boulder Clay" (Brit. Mus. "Guide to the Stone Age," p. 8), and with the "Würm" (vierte Vergletscherung) of Alpine glaciation (Credner, "Geologie," tenth edition, p. 739); also Werth, *Globus*, Band xcvi., No. 15, p. 231).

A. IRVING.

Bishop's Stortford, August 9.

The Anti-kathodes of X-Ray Tubes.

THE special requirements to be fulfilled by materials adapted for use as anti-kathodes are somewhat exacting, and the range of such materials is therefore limited. It is, further, unfortunate that the platinum, tantalum, &c., are in general costly, and that the expense of X-ray tubes is hence, considering their life, high. In casting about for some means of avoiding this difficulty it has occurred to me that carborundum, a material now quite familiar as an abrasive, might be a suitable facing for the anti-kathode. Carborundum, being a product of the electric furnace, is exceedingly refractory; electrically it is a very bad conductor. Messrs. Helm have constructed for me a tube fitted with an anti-kathode from a square inch of carborundum grinding slip, and I have used this tube, so far as my limited laboratory means allow, with perfectly successful results. My coil is only of low power, and I have no means of making any comparative tests of a quantitative type. It seems likely, on theoretical grounds, that the emission from such a tube would be of low penetrative power, but, so far as I can judge, the tube does not seem to pass so readily into the hard condition.

My object in this letter is to bring this matter to the notice of others who are in a position to test the properties of carborundum as an anti-kathode material. If its radiation is of a low penetrative type, such a tube might have advantages in certain superficial treatments in electro-therapeutics, *e.g.* ringworm of the scalp, &c. I should be greatly interested in hearing of any experimental trial.

J. SCHOFIELD.

Technical School, Keighley.

The Action of Carbon Dioxide on Litmus.

I WRITE to direct attention to the inaccuracy of a common statement in elementary text-books describing the action on litmus of carbon dioxide in solution.

It is generally stated that the action of carbon dioxide is to turn litmus "wine red," while the fact is that carbon dioxide dissolved in distilled water turns neutral litmus red, just like any other acid.

The cause of the wine-red colour usually obtained is the presence of alkaline bicarbonates as impurities. That this is the case can be seen by adding a drop of ammonia or of sodium carbonate solution to the carbon dioxide solution, when the colour changes, first, from red to blue, and then, after an interval which depends on the amount of alkali added, to the wine red usually associated with the action. A weak solution of lime water acts similarly, and this would seem to give the genesis of the error, as if hard waters are used to make up the solutions the wine-red colour is produced.

The point may not be of the greatest consequence, but it does not seem to be generally known, and the columns of NATURE would seem to offer the best means of disseminating, to those whom it chiefly concerns, the knowledge of another "text-book" error.

M. M'CALLUM FAIRGRIEVE.

The Edinburgh Academy, July 26.

THE BUSHONGO: AN ETHNOGRAPHICAL STUDY OF THE CENTRAL CONGOLAND PEOPLES.[1]

IT is difficult to write an adequate review of this work, the result of Mr. Emil Torday's last expedition to central Congoland (1907–9), an expedition in which he was accompanied by Mr. M. W. Hilton-Simpson and a very clever painter, Mr. Norman H. Hardy. Mr. Torday has had the advantage of the collaboration of Mr. T. A. Joyce, of the British Museum and the Royal Anthropological Institute, and Mr. Joyce has been able to bring to bear on the compilation his exceptional knowledge of negro arts, implements, customs, religious beliefs, morals, laws, social life, games, songs, and folklore.

The water-colour drawings by Mr. Norman H. Hardy are, beyond all question, the best that have ever been executed so far in Negroland. They have the absolute fidelity of photographs, with at the same

FIG. 1.—A masked dancer of the Bangongo.

time an appreciation of composition and colour which makes them really works of art. Special instances to justify this praise are:—Plate 5, a masked dancer of the Bangongo (Fig. 1); plate 7, female dancers amongst the Bangongo; plate 8, a Bangongo embroideress; plate 9, a portrait of a Bangongo blacksmith; plate 11, Shika, a young girl of the Isambo tribe; plate 12, a young Bashilele man, with the profile of an ancient Egyptian (Fig. 2); and amongst the black-and-white drawings, plate 17, a study of a native engaged in the manufacture of vegetable salt (Fig. 3), together with certain interiors of houses. Three of the plates referred to are here reproduced in a reduced form.

[1] "Notes Ethnographiques sur les peuples communément appelés Bakuba, ainsi que sur les peuplades apparentées. Les Bushongo." By E. Tordey and T. A. Joyce. Annales du Musée du Congo Belge. Publiées par la Ministère des Colonies. Ethnographie. Anthropologie—Serie III: Documents Ethnographiques concernant les populations du Congo Belge. Tome II.—Fascicule I.—Coloured illustrations by Norman H. Hardy. Published by the Museum of the Belgian Congo, Brussels.

It must have been a subject of regret to Mr. Torday that Mr. Norman Hardy's health gave way, and that he was not able to remain with the rest of the party during the whole of the expedition. Otherwise, his album of absolutely truthful pictures of life and scenery in the heart of Congoland would have been even more complete than it is. Of course, the great part of the praise which critics may bestow on this splendid ethnographical work (which, I believe, is to be completed in a further volume), will be awarded to Mr. Emil Torday, who conceived the whole plan of the expedition, is exceptionally well versed in the study of the Negro, took the greater part of the photographs which so effectively illustrate this monograph on the central Congoland peoples, and has shown himself able for some ten or eleven

FIG. 2.—A young Bashilele man (with an "ancient Egyptian" profile.)

years past to penetrate remote parts of British Central Africa and of the Belgian Congo, where other Europeans would have found it dangerous and perhaps impossible to proceed, because they did not possess Mr. Torday's unique gift of discriminating sympathy with and understanding of the savage, the semi-savage, and the half-civilised negroid.

In the region more especially covered by this monograph on the Bushongo, a few great explorers, like Wissman, Wolf, von François, George Grenfell, and perhaps most notably the American missionary, Mr. S. P. Verner, have crossed Mr. Torday's paths, and owing to their writings we were not entirely ignorant of the existence of this remarkable "Bushongo" culture in central Congoland. The Bushongo—this seems a strange plural for a more or less Bantu people, but Mr. Torday is so accurate in other matters that we presume he has interpreted it correctly—were hitherto known as the Bakuba, and as such attracted markedly the attention of Grenfell and Verner. Mr. S. P. Verner, in a rather *décousu* book, which he published some years ago on his travels in Congoland, gave some very good descriptions of this aristocratic race or ruling caste, but it is possible that in his enthusiasm for them he somewhat exaggerated their physical approximation to non-Negro, Caucasian types. He made them out, apparently, to be lighter in skin-colour and more European in features than they are actually. Yet from Mr. Torday's photographs and Mr. Hardy's paintings one realises that there is some distinct infiltration of Caucasian strain in the Bushongo or Bakuba, and in such of the surrounding populations as those with whom they have mingled their blood. Livingstone noticed this more than sixty years ago in regard to the Baluba and

FIG. 3.—Native engaged in manufacture of vegetable salt.

Alunda, commenting repeatedly on their "Egyptian" profiles.

That the Bushongo brought with them at some unknown date an exotic culture into the heart of the Congo Basin, and that with their strain of Caucasian blood they further inspired the local negroes to evolve an art which in some respects is peculiar to central Congoland, cannot be open to doubt when all the facts and traditions collected by Mr. Torday are passed in review. At the present day the Bushongo speak a somewhat degraded Bantu language, much less purely Bantu than the beautiful speech of the Baluba, or than the Kongo tongue of western Congoland, or even the Bangala of the northern Congo. But in former times the speech of the ruling caste of the Bushongo was known as the Lumbila. This language ceased to be spoken about sixty years ago, but Mr. Torday was able to collect examples of it, and submit them to the writer of this review. These words of Lumbila are repeated in the work in question alongside the degraded Bantu dialect now spoken by the Bushongo. It is at once evident that the Lumbila is not a Bantu language, though it undoubtedly possesses a few borrowed words of Bantu origin. So far as I have been able to compare the fragments of this tongue with other groups of African speech, I find the only clear indications of relationship to be with certain languages of the Shari Basin, and perhaps with that vague group of Sudanese tongues to which belong the non-Bantu languages of the Upper Mubangi. Mr. Torday points out on p. 43 that the Lumbila name for river is Chari (in modern Bushongo, Nchale), which certainly recalls the widespread term for lake or river which we find in Shari, Chade, Chada (both of them terms for Lake Chad and for the River Benue).

I have pointed out in my own work on "George Green and the Congo," that this central Sudan word for a great water has penetrated far into the Congo Basin, reappearing in the name Nzadi, often applied to the western Congo, and the Portuguese Zaire. According to tradition, when the Bushongo arrived in central Congoland from their northern home they were a naked people, accustomed to eat durra corn and other millet-like grains unknown to the forest regions. Their ancient nudity would ally them more to the central Sudan and Nilotic peoples, for, strange to say, however barbarous and savage may be all the peoples of Congoland, even the Pygmies, absolute nudity in the male is almost unheard of, and is reprehended. The word Bushongo, according to Mr. Torday, means the people of the "Shongo," and "Shongo" is apparently the name for the iron throwing-knife, which was brought by the Bushongo with them in their immigration, and which only pentrates into the more northern half of Congoland. This throwing-knife in its origin is only a modification of the wooden boomerang, and in its metal form seems to have originated in the Tibesti Mountains. Indeed, there is a good deal in the work under review, as well as in the reviewer's own researches, which tends to indicate a direct southward migration into the heart of Congoland from Kanem and Tibesti; and it is probable that from this direction comes the slight Caucasian infiltration of blood, which, as the Tibesti region of the negroid Teda or Tibu peoples, was probably Caucasianised from the direction of ancient Egypt, would explain the striking outcrop of Pharaonic face outlines occurring and recurring ever and again amongst the more aristocratic types in central and southern Congoland outside the great forests.

According to a Bushongo tradition, the first chiefs of the Bushongo (who are at present settled between the Sankuru and the Kasai) were white or semi-white, but the term white is constantly applied by the negroes to races of pale-yellow or reddish skin, like the Arabs and the Fula. Mr. Torday thinks that the southward march of the Bushongo may have been part of the same series of racial convulsions as the invasion of northernmost Congoland by the Azande (Nyam-nyam). The Bangongo and Bangende tribes, nowadays so much affiliated with the Bushongo, would seem traditionally to have arisen from a mingling north of the Sankuru River between the invading Bushongo and the pre-existing Basongo-meno, and there is obviously a relationship between the Bushongo and the Bashilele, and even an infiltration of Bushongo elements (the reviewer would add) amongst the Baluba and Alunda. Perhaps even the civilisation of the old Kingdom of Kongo, founded by a legendary hunter named Kongo, may have a Bushongo origin. It is interesting to note that a totally different Bakongo people exists in the vicinity of the Bushongo territory in central Congoland, several hundred miles separated from the better-known Bakongo of the region between the Crystal Mountains and the Atlantic Ocean. The original word Kongo seems to have meant a metal spear, and consequently a hunter, and may even be related to the term Shongo, applied to the throwing-knife.

An interesting point made by Mr. Torday was the apparent establishment of the fact that when the pygmy Batwa, of the dense forests, have been established for some generations outside these forests in the open country under the protection of the Bushongo, their stature sensibly increased, so that at last their descendants were indistinguishable in physique from the other short-legged, long-armed, prognathous forest negroes of nearly normal stature.

In a succession of chapters after the first (which deals with the origin and relationships of the Bushongo) is given a full account of the elaborate government and administration of justice amongst the Bushongo and allied peoples. The long list of court functionaries reminds one of Uganda and other equatorial African kingdoms. The social life of the Bushongo, their morality (which in some respects is very high—see the admirable moral precepts set forth on pp. 85–6), their ideas of property and inheritance, commerce, sports, dances, warfare, distinctions of relationship, and forbidden degrees of affinity in marriage, their sexual life, religion, magic, funeral customs, industries, and arts, domestic animals, agriculture, building, costume, mutilation, skin decoration (tattooing), folklore, and languages are fully described and illustrated. A great deal of space is given up to the description of the really wonderful arts and industries of the Bushongo and allied peoples—their wood-carving and their beautiful woven cloths, their metal-work (very elaborate), and pottery. The linguistic information concerning the Bushongo, Bakongo, Bangongo, Bangendi, and Basongo-meno languages, will be of great interest to students of the Bantu family. This work is, in short, splendidly complete, with one exception. It is ethnological rather than anthropological, and it would have been additionally interesting if Mr. Torday had been able to include photographs of the many types of skull that he has collected, and other pictures, measurements, and descriptions, showing more clearly the physical conformation of the various peoples he has otherwise described so minutely. From the various numerous photographs and pictures one is able to deduce to some extent what is not actually described in words—namely, the physical features of these races of central Congoland; and it is interesting to note here and there a type of physiognomy occurring which is also met with on the northern Congo and in the central Sudan, namely, quite a Caucasian type of face amongst the men, with a fairly abundant growth of beard and moustache, very bushy head-hair (except where this has been removed artificially), and little of the negro but the dark skin. H. H. JOHNSTON.

THE FRENCH ANTARCTIC EXPEDITION.[1]

ONE of the problems of most far-reaching importance in the Antarctic is the nature of the southern border of the Pacific, for while we remain in complete ignorance of its structure no theory of the formation of the Pacific, the greatest geographical unit on the globe, can be more than a provisional hypothesis.

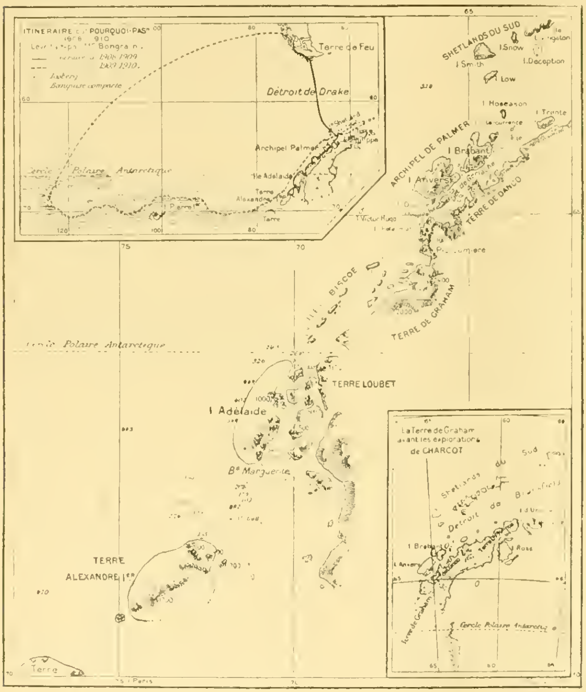
Cook's description of his view from his furthest south in the Southern Pacific suggests that he had

[1] Institut de France: Académie des Sciences. Rapports Préliminaires sur les Travaux exécutés dans l'Antarctique par la Mission commandée par M. le Dr. Charcot de 1908 à 1910. Pp. x + 104. (Paris: Gauthier-Villars, 1910).

reached the margin of an ice-clad land; but as he thought otherwise it would be rash to lay stress upon a different interpretation of the facts he described. The best clues as to the southern border of the Pacific have been obtained from Graham Land; but though the recent expeditions in that area have revealed the structure and character of the South Shetlands and of the north-western part of Graham Land, there has been no modern extension of geographical knowledge far to the south-west. The Peter I. Land of Bellingshausen, and the Adelaide Island of that stout-hearted whaler Bisco, remained the only sure evidence of the westward extension of the land.

Geographers accordingly waited with keen interest the return of Dr. Charcot's expedition, which forced its way for more than 50° westward into the unknown. A preliminary report of the results has been issued by the French Academy of Sciences, prefaced by a short summary by Prof. Joubin, of the Oceanographic Institute. Dr. Charcot describes the general course of the expedition. It left Punta Arenas, in Patagonia, on the *Pourquoi-Pas?*, on December 10, 1908. It spent the first summer in geographical and other work in Graham Land, to the west of the region so well explored by the Belgian and Swedish expeditions. It wintered on Petermann Island, one of the islands of the Palmer Archipelago, at the south-western end of Gerlache Strait. At the close of the winter it returned for stores to Deception Island, one of the South Shetlands, and was there generously supplied with coal by whalers of the "Sociedad ballenera Magellanes." The expedition thence started south-westward, and, passing Graham Land, pushed westward into the South Pacific. It passed to the north of Peter Island, and kept along the latitude of about 70° S. from 72° W. to 124° W. The end of the season and the approaching exhaustion of supplies compelled the badly damaged *Pourquoi-Pas?* to return to South America.

Dr. Charcot describes the western lands he explored as penetrated by a network of fiords filled with ice. The most important of the new lands explored is a group of islands which he calls Alexandra I. Land. Still further into the unknown he saw another land which he has left unnamed.



Course of the French Antarctic Expedition.

The results of the hydrographic, pendulum, astronomical and seismographic observations are summarised by M. Bongrain. The preliminary conclusions from the determinations of gravity at five localities differ somewhat from the theoretical results from Helmert's formula. The seismographic observations made on Deception Island are said to promise interesting results; the instruments recorded seismic storms at the winter quarters in March and September, 1909.

M. R. Godfrey contributes a report on the tidal observations, coastal hydrography, and the chemistry of the air; careful determinations of the nitrates and ammonia in the air were prepared at winter quarters. A short account of the observations on meteorology, oceanography, and atmospheric electricity is given by M. M. Rouch. The meteorological instruments were read every four hours, or more often while the ship was at sea or when more detailed records seemed desirable. The work on terrestrial magnetism and actinometry was undertaken by M. Senouque, who determined the magnetic elements at four stations—Deception, Petermann, and Jenny Islands, and Matha Bay. Dr. Gourdon describes the geological observations; he found no sedimentary rocks or fossils, but widespread igneous rocks similar to those previously recorded from the lands to the north-east. M. Jacque Liouville gives a summary of the zoological log of the expedition, which shows that a most valuable collection was made. Especial attention seems to have been devoted to parasitic zoology. The results of the dredgings during the summer voyage are described as having been very fruitful. M. Gain, the botanist, had a very limited field of work open to him on land, where he found some lichens, mosses, and the grass *Aira antarctica*; the plankton promises a rich harvest from the sea, while on shore M. Gain worked at bacteriology, and has brought back sealed preparations of fæcal matter for culture in Europe. By tying coloured badges upon some of the birds he was able to show that they not only returned to the same rookery, but to the very same part of it.

The results of most general interest were gained in the voyage into the South Pacific. The first impression is one of regret that the expedition could not follow the land in that direction, but the thick ice kept the *Pourquoi-Pas?* too far to the north. The ice conditions suggest that there is land not far to the south behind the ice-packed sea. The work in south-western Graham Land is unquestionably of great importance. Adelaide Island is much larger than its discoverer, Bisco, thought, but Graham Land, instead of extending south-westward as a continuous land, breaks up into an archipelago, or makes a sharp bend to the south-east. The lands explored clearly belong to a volcanic Andean chain, of which the coast has been penetrated by a network of fiords; but owing to the inaccessibility of the land, its composition remains less known than its distribution.

The results of the Charcot expedition suggest that Graham Land either breaks up south-westward into an archipelago, or that in the neighbourhood of Adelaide Island it curves sharply southward, corresponding to the northward curve of South America on the opposite side of Drake's Strait. Dr. Charcot's expedition, therefore, adds fresh interest to the problem of Graham Land. All interested in Antarctic research will join in Prof. Joubin's hope that the necessary funds will be provided for the full publication of these important additions to Antarctic knowledge. J. W. G.

TUBERCULOSIS AND THE MILK SUPPLY.

ON the publication of the final report of the Royal Commission on Tuberculosis the view was frequently expressed that those in authority ought, long ago, to have taken precautions against the dangers arising out of the use of milk containing tubercle bacilli. To those who have followed the matter carefully this scarcely seems to be a very rational position to assume, as, up to the publication of this report, Koch's dictum, backed by the authority of his enormous prestige, held the field. It is now recognised that Koch's pronouncement on this question was the cause of the difficulties that arose immediately after he had spoken at the London Tuberculosis Congress, and there can be little doubt that these difficulties, then foreseen, led the executive of the congress to insist so strongly on the appointment of a Royal Commission. It was evident that inspection, the use of tuberculin, the destruction of tuberculous cattle, might all be ruled out as unnecessary, if Koch's thesis that there was no danger from the presence of the tubercle bacillus was to be accepted.

Now, however, that the commissioners have reported, and in no uncertain voice, that tuberculosis, especially in the child, may be the result of infection with tubercle bacilli conveyed in the cow's milk, it is essential that the question of regulations relating to milk and meat supply should be carefully reconsidered, and that, as the commissioners put it, "Government should cause to be enforced throughout the kingdom food regulations, planned to afford better security against the infection of human beings through the medium of articles of diet derived from tuberculous animals." Also that the supply of milk from a "recognisably tuberculous cow, irrespective of the site of the disease, whether in the udder or in the internal organs, should be prohibited," as the commission has demonstrated that infection of milk may take place, not through the udder merely, but by channels through which such infection has not hitherto been followed.

This report alters entirely the whole aspect of affairs. The President of the Local Government Board is now in a very strong position as regards the tuberculosis order issued in 1909, and his own Milk Bill already drafted. Indeed, the conditions are so far changed that it is absolutely necessary that some steps should be taken at as early a date as possible to ensure the passage of legislative measures dealing with the protection and improvement of the milk supply. Hurried or "panic" legislation would, however, be unwise; a careful consideration of the whole position is necessary. On one hand are the interests of the consumer, which, in this instance, must be looked upon as of paramount importance; whilst on the other the great financial interests of the cattle breeders and dairy owners (though of secondary importance) must be considered.

In the tuberculosis order issued in 1909, but not yet brought into force, it is enacted that every person having in his possession, or under his charge, (1) any cow which has, or appears to be suffering from, tuberculosis of the udder, indurated udder, or other chronic disease of the udder, or (2) any bovine animal which is, or appears to be, emaciated from tuberculosis, shall give notice to a constable of the police force. The local authority shall then cause to be made a veterinary examination of the suspected animal, and the milk from such animal shall be kept separate and shall be boiled or sterilised. If the animal is found to be tuberculous, the local authority shall notify the owner that it is to be slaughtered. Moreover, if the owner objects, special authority must be obtained from the Board of Agriculture to slaughter.

So much for the animals themselves; and, after all, this is the point at which the question should be attacked in the first instance. It is evident, however, that until considerable advances have been made along the above lines, milk containing tubercle bacilli will still find its way into our milkshops and dairies, and regulations at least as stringent or more searching than those already in force will have to be devised in order to protect customers against milk coming from tuberculous cattle. Inspection and biological examination will, for some time, be essential, and certainly should not be neglected, as in these, probably, we have the only effective means of safeguarding the milk supply against infection from tuberculosis. It may confidently be anticipated that those in authority have already under consideration these and other points, to be attended to and included in any new measure to be brought forward.

The question of compensation is one of considerable difficulty and delicacy. How is the honest trader to be protected without at the same time making it easy for those not quite so honest to benefit at his expense? It is suggested in the tuberculosis order of 1909 that if the animal after slaughtering does not show that it was suffering from tuberculosis, full compensation as agreed shall be paid, along with a further sum of twenty shillings. If the animal is found to be suffering from tuberculosis (not being advanced tuberculosis), three-fourths of the value as agreed shall be paid, one-half of the cost of valuation being deducted. If, however, the animal is suffering from advanced tuberculosis, one-fourth of the value shall be paid, or the sum of two pounds, whichever is the greater, one-half of the cost of valuation still being deducted. It is further ordered that all suspected animals shall be isolated at once and until seen by veterinary surgeons, whilst disinfecting and cleansing shall be carried out at the expense of the owner on all premises where tuberculous animals are found.

Then, of course, the question arises, From what source shall the compensation be made? Abroad, compensation has been paid out of an insurance fund to which various authorities and individuals make contributions. The seller of the animal, the buyer, the municipality, and even the State are, in various places, put under contribution, and in a case of this kind it certainly seems reasonable that there should be some such cooperation. The farmer who sells his cattle should be prepared to pay something towards a fund that shall indemnify him for any loss that may result from the presence of tuberculosis amongst his animals. The milk dealer or butcher who runs the risk of buying a tuberculous animal, and thus of having to pay more for the food of the animal during life and of receiving a less price for the carcase after death, should be equally prepared to pay towards an insurance scheme. (Butchers' insurance associations—voluntary—have already been founded in this country.) The ratepayer, through the municipality, owes something to any scheme that protects him and his children from the dangers associated with the consumption of tuberculous milk, and even of tuberculous meat, whilst the State may well be called upon to contribute its quota towards the protection of the child, the young adult, or, in some cases, even the adults of more mature years, against the ravages of tuberculosis, one of the great factors in bringing about the diminution in the wage-earning power of the worker in the State. The whole question is no doubt now under careful consideration, and whilst it is inadvisable to press for any measures that have not been carefully considered, it must be urged that there shall be no unnecessary delay in bringing forward a Bill and putting into force a measure for the improvement of our milk supply and the protection of the consumer against infection, the reality of which has been so amply demonstrated by the Royal Commission.

SCIENTIFIC WORK IN INDIA.[1]

IN any large organisation a certain amount of subdivision is necessary to ensure economy in working, even though this may conduce to a want of connection and cooperation between the departments so formed; and when their work lies in scientific and technical fields the inevitable specialisation is likely to accentuate the evil of any such lack of cooperation, and lessen the advantages derived from the work in each. In India the Board of Scientific Advice was formed a few years ago in order that by its aid the scientific resources of the Government of India might be organised to the best advantage and their efforts concentrated on the solution of the problems which were the most urgent.

The Board held its eighteenth and nineteenth meetings in 1910, and the report for the year 1909–10 has just been published, in which contributions from the different services and departments are restricted to the scientific work coming under the various headings of the report, and do not deal with matters of departmental administration or detail. We have in consequence, within a compass of two hundred pages, a valuable summary of scientific work in India for the period under review, so far as it is covered by the departments which contribute to this report. In industrial and agricultural chemistry the work done has resulted in much knowledge gained of indigenous products and their technical applications. Reference is made to the report of a committee, appointed by the Asiatic Society of Bengal, on the adoption of a temperature of reference suitable for India, in which the temperature of 30° C. is recommended. This matter has been referred to the Royal Society for submission to the International Association of Academies in order that other countries in tropical regions may express their opinions.

The water requirements of crops have been investigated in continuation of work which has been in hand for several years, and the results are about to be published. This work and field tests at Cawnpore and Pusa have shown how great the value would be of an accurate method of determining the quantity of water which can move through soils under the influence of surface tension. Cottonseed oil was investigated in order to ascertain whether the acridity of the Indian oil could not be economically removed, and a large number of natural products were studied with a view to improving the final product. A large amount of observational work in solar physics was carried out, and advantage was taken of Halley's comet being favourably situated in April and May, 1910, to photograph the comet and its spectrum. In meteorology Mr. Field's experimental work with recording balloons resulted in more than half of the seventeen sent up in the monsoon season being recovered, but only one of those liberated in December was regained. In the present year, following that of the report, it is proposed to liberate two recording balloons weekly at Jhang in the Punjab, and to continue the search for relationships between the seasonal variations of weather in different parts of the earth, which has already produced instructive results.

In terrestrial magnetism a survey of the Andaman and Nicobar Islands is proposed as the work of the following year. Some of the geological work referred to has already appeared in the publications of the department, and an exhaustive memoir on the Triassic rocks of the Himalaya by Dr. C. Diener is about to appear. The map of the Raniganj coalfield has been revised, and much additional information relating to the underground correlation of the coal seams has been gained. Reports of coal in Sikkim were proved to be baseless, the rock being but a black carbonaceous shale greatly crushed. Advice on such matters as the suitability of building sites, irrigation dam sites, sources of suitable road metal, and the prospect of increasing a subsoil water supply by deeper boring was widely given.

In geodetic work operations were carried out in northern Baluchistan, Kashmir, and in Upper Burma on the lines of former years, but an innovation is the employment of secondary triangulation with 8-inch micrometer theodolites to fill in between the principal series instead of the third order network, which has hitherto been used. This improved grade of work will furnish permanent stations for the control of the periodic re-surveys which become increasingly necessary, and which are often required to be on larger scales than in the past. Gravity work was directed to testing the suitability of Hayford's method to the results obtained in India, and so far as work has gone his correction serves to intensify the anomalies in regions like the Indo-Gangetic plain.

In botanical survey work on the catalogue of the non-herbaceous flowering plants cultivated in the Royal Botanic Garden has been continued, the numerical index of the first 4000 plants being completed, and another 4000 being in the press. From Burma and southern India large accessions of material have been received by the Calcutta herbarium. Economic botany records a large amount of work done on the improvement of the wheat crop, not only in the field, but investigation has been carried into the mill and the bakehouse. The questions involved are of the greatest importance, and the results already obtained are of great value. Mycological studies of various plant diseases of tea in Darjeeling, of palms in Madras, of sugar in the Godaveri delta, are all instances of the value of scientific research suitably directed and coordinated.

The whole report presents a valuable survey of the application of science to many problems related

[1] Annual Report of the Board of Scientific Advice for India for the Year 1909–10. Pp. iv+210. (Calcutta: Government Printing Office, 1911.) Price R. 1 or 1s. 6d.

directly or indirectly to the inhabitants of India, and shows how much is gained by effective organisation and cooperation. We could wish that similar co-operation of scientific and technical work existed in all regions, as it already does in some, since it not only favours efficiency and economy, but also provides a useful summary of results obtained, which are often hidden in the administrative detail and statistics of an annual progress report, though they may appear subsequently in a detailed publication.

EARTHQUAKE STUDIES.

THE last two bulletins of the Imperial Earthquake Investigation Committee (vol. iv., No. 2, and vol. v., No. 1) are each from the pen of Dr. F. Omori. The second memoir deals with the eruption of Mount Usu, in Yezo. This began at the end of July, 1910, and resulted, amongst other things, in the formation of about fifty craterlets parallel to a lake shore. The highest of these was about 700 feet. As these were formed, not only did the shore of the lake rise, but there was a rapid upheaval of ground to form a new mountain. This approximately reached to the same height as that of the craterlets, when its growth suddenly ceased. A curve of barometric pressure and another of earthquake frequency in the vicinity of the mountain, but prior to its eruption, shows that premonitory shocks began when atmospheric pressure was least, and that the first volcanic explosion occurred when it was at a maximum. The frequency of volcanic after-shocks does not appear to have followed that which is usually followed by the after-shocks of a large earthquake. Dr. Omori points out that there are many instances in Japan where volcanic eruptions have been preceded by numerous earthquake shocks and "jinaris" (earth-sounds). Whenever this is the case, tromometer and seismograph observations should give warning of an approaching outburst.

Fig. 1.—The Craterlets Group opposite the New Mountain, seen from the east. The cone at the extreme left end is the "Taka-Ana," and that at the right side is the "Fuji-Yama." To the right-hand side of the figure is shown the inside, or the dislocation plane, of the "New Mountain."

The first relates to the vibrations of railway-bridge piers and trusses. The period of transverse and longitudinal vibrations of piers 82 feet in height was found to be from 0·2 to 0·4 second. As this is much shorter than that of a destructive earthquake which is from 1 to 1·5 seconds, the inference is that in a great earthquake these piers would be expected to fracture at their base.

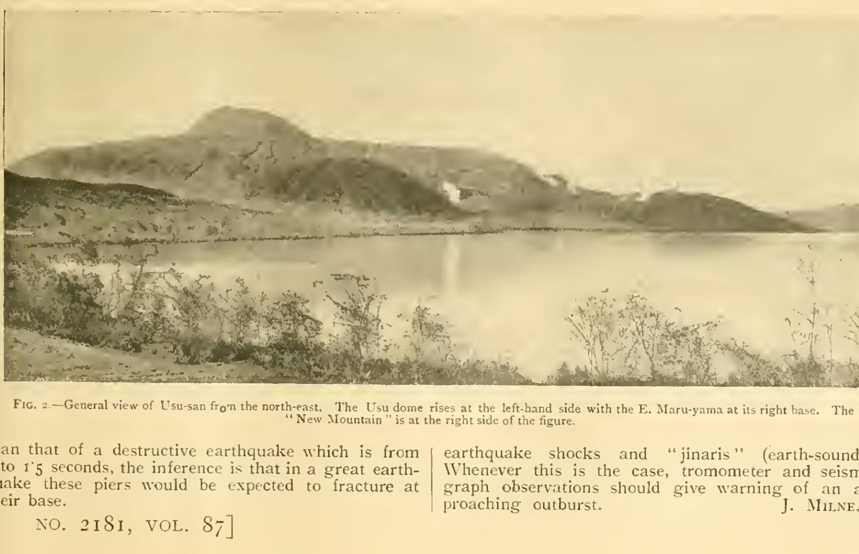


Fig. 2.—General view of Usu-san from the north-east. The Usu dome rises at the left-hand side with the E. Maru-yama at its right base. The "New Mountain" is at the right side of the figure.

J. Milne.

THE LIBRARY AND THE SPECIALIST.

THIS is the age of the specialist. There is scarcely any branch of science in a review of which it would be inappropriate to remark that "the literature of this important section of the subdivision to which we allude is already assuming enormous dimensions." The published mass of scientific research is accumulating in ever-increasing volume. The investigator, especially when the circumstances of his life are such that he lives remote from intellectual centres, is generally exposed to the danger of working either along lines inferior to those already followed by predecessors in the same field, or in a direction which has been shown to lead to barren results. During his hard-earned leisure he may have been spending his energies upon work of research, only to discover at a later stage that he has been anticipated. The philosopher will murmur, "Comme les beaux esprits se recontrent!" The man of modest temperament will say resignedly, with one of Hermite's correspondents, "Je suis prédestine, semble-t-il, à découvrir des théorèmes connus!" More ordinary mortals will exclaim, each with his own degree of vehemence: "Pereant illi qui ante nos nostra dixerunt!" In each case time has been wasted, and it may be that science has suffered.

De Morgan has somewhere said that the history of science is in the main the history of books and manuscripts. If this were true in the days of that accomplished bibliographer, to whose untiring efforts the student of the history of mathematics in the 'forties and 'fifties of last century was so profoundly indebted, it is even more so now if we consider the cosmopolitan character of the development in every department of intellectual activity. It is becoming more and more imperative that the work of investigators in any branch of science shall not be impeded by causes which, by a mere effort of cooperation, may be effectually and for all time removed. The organisation of scientific research has of late years been the text for many sermons from the leaders of opinion, and the problem of its most effective promotion is slowly and surely assuming that ultimate form which will secure the solution. We wish to direct attention to what some may consider a minor detail, but as it concerns the working specialist—and he is not always articulate—we make no apology for bringing once more to the front the relations between the libraries of the country and the investigator.

In NATURE (Feb. 15, 1906, p. 372) we referred to a paper published by Dr. Muir in the Proc. Roy. Soc. Edinburgh (Dec. 18, 1905), in which the historian of determinants indicated his reasons for the belief that "under existing circumstances mathematical research can only be pursued in Scotland with difficulty and uncertainty, and that research in mathematical *history* is practically an impossibility. . . . There can be little doubt that other subjects are in as bad a plight, and that the whole question of library aid is worth serious and prompt attention from all scentific men." In the current number of the *Quarterly Journal of Pure and Applied Mathematics*, on presenting his "Fifth List of Writings on Determinants," Dr. Muir returns to the charge, and laments that practically nothing has been done in the way of improvement, so far as London is concerned, for the last five years. He finds that the large *general* libraries—*e.g.* those of the British Museum, the Royal Society, South Kensington, University College, &c.—are "surprisingly well supplied with mathematical works and are reliably cared for." On the other hand, there is "no self-sufficient reference-library for mathematicians," and "the libraries that have a partial mathematical equipment are as far as ever from entering into cordial cooperation with one another for the purpose of providing a reasonable substitute." The library of the London Mathematical Society is "poorly housed, poorly cared for," and "has many of its serials imperfect." The library of the Mathematical Association is practically valueless, has no home of its own, and does not even possess a printed catalogue, though this blemish, we understand, is to be remedied. In all cases the main faults are redundancy and deficiency. One great failing is the imperfection and even the absence of series of mathematical periodicals. For instance, the only sets to be found in the country of recent volumes of the *Periodico di Matematico* with its supplements, of the *Journal de Mathématiques Spéciales et Elémentaires*, of the *American Mathematical Monthly, L'Intermédiaire des Mathématiciens*, and *Wiskundig Tydschrift* were after some search discovered in the hands of a private individual. As for the *Monatshefte, Rivista di Fis. Mat.*, &c., and *Math. is Phys. Lapok*, Dr. Muir had, we are inclined to think, to make a pilgrimage to the Continent to consult them for his purpose.

This is a state of affairs that is little to our credit. Surely the time has come to remove these impediments in the way of the working specialist! Until we possess a "self-sufficient" mathematical reference library it ought to be possible to do something to the point by proper cooperation between our libraries, general or otherwise. To diminish duplicates by exchange or gift, to complete imperfect sets of serials, to keep on hand an up-to-date list of serials in which they are deficient, with a list of the libraries where they may be found—this is the least that each library ought to do, and if the matter were properly organised it might be done in a few months, so far as mathematics is concerned. The longer it is delayed, the more difficult will it become to place within reach of the working specialist the mere tools of his trade. There is little doubt that in other branches of science than mathematics there will be many who will bless Dr. Muir for thus directing attention to this serious blot upon our *organisation* of scientific research. The matter appeals to all who are interested in the advancement of science. Miserably inadequate as are the funds at the disposal of the British Association for that object, we cannot help feeling that here at any rate a small grant in aid would be well spent, and would be productive of fruitful results.

FLIES AS CARRIERS OF INFECTION.[1]

THIS report contains further work on the importance of flies in the conveyance of disease parasites.

The first report, by Dr. Copeman, Mr. Howlett, and Mr. Merriman, deals with the range of flight of flies. In July last year Postwick, a small village five miles east of Norwich, experienced a plague of flies. No special conditions existed in the village for the breeding of the flies, and attention was directed to a refuse depôt about half a mile distant. The opportunity was taken to ascertain to what distance flies may travel and whether the flies in Postwick were derived from this refuse heap, and, if so, whether the flies were merely attracted to it from the surrounding country or whether they were distributed from it as a breeding centre. For this purpose flies were caught in various localities, marked by being shaken with coloured chalk powder, and liberated; subsequently some of the flies were recaptured. The experiments showed that the flies were distributed from the refuse

[1] Further Reports (No. 4) on Flies as Carriers of Infection. Reports to the Local Government Board on Public Health and Medical Subjects. (New Series, No. 53.)

heap as a breeding centre, and that they may travel as far as 1,408 yards from the place of liberation.

Mr. E. E. Austin contributes the second memorandum on the species of flies present at Postwick; the great majority consisted of the common house-fly. The part played by flies in the dispersal of the eggs of parasitic worms is the subject of the third report, by Dr. William Nicoll. Many experiments were performed, and it is shown that the ova of several worms may be conveyed by flies, the ova in some cases being ingested, in others merely sticking to the surface of the body. Those adhering to the body are generally got rid of within a short time, but when ingested they may remain for two days or more in the intestine. The habit of flies of feeding in turn on excrementitious material and on human foodstuffs obviously suggests that house-flies may play a part in the dissemination of infection of parasitic worms. Dr. Graham-Smith describes further observations on the distribution of bacterial infections by house-flies and blow-flies. It is definitely shown that both are capable of infecting fluids, such as milk and syrup, on which they feed and into which they fall. With house-flies gross infection may be produced for at least three days, and a smaller degree of infection for ten days or more. Blow-flies may carry the infection longer—up to three or four weeks.

The reports, in addition to the observations recorded, contain summaries of previous work on the subjects with which they deal, and form valuable contributions. R. T. H.

NOTES.

CONSIDERABLE progress has now been made with the arrangements in connection with the forthcoming meeting of the British Association at Portsmouth. Suitable meeting rooms have been found for nearly all the sections within about seven minutes' walk of the reception room. The programme of entertainments and excursions promises to be very attractive, and includes a naval display at Whale Island, steamer trips and coach drives in the Isle of Wight and in the South Downs, where visits will be made to Arundel Castle, Goodwood House, West Dean Park, and Parham Park. The following corresponding members and foreign representatives have announced their intention to attend the meeting:—Prof. Cleveland Abbe, U.S. Weather Bureau, Washington; Prof. Carl Barus, Brown University, Providence R.I., U.S.A.; M. A. Gobert, Brussels; Prof. A. A. Michelson, The University, Chicago, U.S.A.; Prof. W. Ostwald, Leipzig; Prof. Otto Pettersson, Stockholm; Prof. F. W. Clarke, U.S. Geological Survey, Washington; Prof. W. J. Humphreys, Mount Weather, Va.; Prof. H. Freundlich, Leipzig; Prof. Albin Haller, Paris; Prof. E. J. Cohen, Utrecht; Prof. R. Wegscheider, Vienna; Prof. Hans von Euler, Stockholm; Prof. P. Zeeman, Amsterdam; Prof. J. W. Spencer, Washington; Prof. Caullery, Paris; Dr. Johan Schmidt, Copenhagen; Dr. P. P. E. Hoek, Haarlem; Prof. H. Jungerson, Copenhagen; M. Chas. Lallemand, Paris; Dr. F. Graebner, Cologne; Prof. H. Webster, Nebraska; Dr. A. Goldenweiser, Columbia University, Missouri; M. A. van Gennep, Seine; Prof. N. Zuntz, Berlin; Prof. Behal, Paris; Prof. H. J. Hamburger, Gröningen; Prof. H. C. Cowles; and Prof. A. A. Noyes.

THE drought and excessive temperature of the present summer continues with great persistence, and if it had not been for the rains which fell generally over the country during the latter half of June, the season would have been practically rainless. The dry weather has embraced nearly the whole of England, although probably it has been most pronounced in the Midland and south-eastern districts, where the aggregate rainfall so far for the summer is only about 50 per cent. of the average. In Scotland and Ireland occasional rains have fallen, as shallow disturbances have skirted our northern and western coasts on their passage from the Atlantic. At Greenwich the aggregate rainfall since the commencement of July only amounts to 0·32 inch. The absence of cloud has resulted in an abnormal amount of sunshine, and the rays of the sun have been exceptionally fierce, and on at least three occasions this summer the black bulb thermometer at Greenwich has exceeded 161°. In the south-east of England the duration of bright sunshine for the first ten weeks of summer was 668 hours, which is 184 hours more than the average. The shade temperature has exceeded 80° at Greenwich on thirty days between July 1 and August 14, and 90° has been exceeded on five days. The shade temperature of 100° at Greenwich on August 9 is the highest authenticated reading in London since trustworthy records commenced in 1841, and is 3° higher than any previous reading at Greenwich, the previous record being 97·1° on July 15, 1881. There have in all only been three days since 1841 with the temperature above 95°; these were 96·6° on July 22, 1868; 97·1° on July 15, 1881; and 95·1° on August 18, 1893. The temperatures in other parts of London on August 9 were also a record, and the same occurred in many parts of England. A reading of 98° was recorded at Epsom and Canterbury, and at Raunds in the Midlands, 97° at Hillington, and 96° at Marlborough, Fulbeck, and Lincoln. In France and Germany the heat has also continued to be excessive. On Tuesday, August 15, there was a cooler air generally over England, and in London the highest temperature was 75°, which is the lowest day maximum for a month.

MR. C. E. ADAMS, of the Department of Lands, New Zealand, has been appointed astronomical observer at Wellington in succession to Mr. T. King, who has resigned.

MR. T. SOUTHWELL, scientific adviser to the Ceylon Company of Pearl Fishers, Ltd., and Inspector of Pearl Banks, Colombo, has been appointed (by the India Office) Deputy Director of Fisheries, Bengal.

THE council of the Royal Statistical Society of London has awarded a Guy medal in gold to Mr. G. Udny Yule "for his extraordinary services to statistical science, for his valuable contributions to the Transactions of the society, and for the special work done by him in the interests of the society."

THE geological and archæological collections made by the late Rev. E. Maule Cole, all the objects of which are connected with East Yorkshire, have been presented to the Hull Municipal Museum by Lady Philadelphia Cole.

THE appointment of Mr. F. W. Taylor, of Denver, Colorado, as Director of Agriculture in the Philippines, is expected to mark the beginning of the application of scientific methods to the cultivation of land in those islands. Mr. Taylor was professor of horticulture in the University of Nebraska from 1891 to 1893. He superintended the departments of agriculture and horticulture at the expositions at Omaha in 1898, Buffalo in 1901, and St. Louis in 1904. He has lately been occupied as an irrigation engineer.

THE council of the Institution of Civil Engineers has made the following awards in respect of students' papers read during the session 1910–11:—the "James Forrest" medal and a Miller prize to Mr. D. Hay (Birmingham), and Miller prizes to Messrs. D. A. Howell (Bristol), R. Bonner (Bristol), G. F. Walton (London), R. G. Parrott (Manchester), E. E. Farrant (London), A. C. Dean (Manchester), H. W. Coales (Birmingham), A. H. Meade (London), A. C. Swales (Leeds), and H. J. F. Gourley (Manchester).

In connection with the celebration of the tercentenary of the Authorised Version of the Bible (1611–1911), a special exhibition, illustrating the natural history of the Bible, has been arranged on the east side of the central hall in the Natural History Museum, Cromwell Road, London. Printed descriptive labels have been attached to the exhibits, which comprise all the animals, plants, minerals, and precious stones mentioned in the Bible. A guide book to the exhibition has been prepared, and is on sale, price 6*d.* (postage 2*d.*). The exhibition is open to the public free daily.

The Manchester Microscopical Society has arranged, as in previous winters, to provide through its Extension Section lectures and demonstrations of a popular character on scientific subjects. The lectures are arranged for delivery in and about Manchester. The cost, as a rule, is limited to lecturers' expenses, which in most cases do not exceed a few shillings. The work of lecturing and demonstrating is entirely voluntary and gratuitous on the part of the members of the society, but hire of slides, travelling, and out-of-pocket expenses are charged, and in some cases an additional small fee for the lecture is asked for. The list of lectures includes sixty-five subjects, most of which deal with the biological and geological sciences. Secretaries of societies desirous of including lectures on nature subjects in their syllabus may receive a copy of the lecture list on application to the honorary treasurer and secretary, Mr. R. Howarth, 90 George Street, Cheetham Hill, Manchester.

The Technical Museum in Vienna, which is nearing completion, was initiated by Austrian manufacturers, with the assistance of the State and of the city of Vienna, to commemorate the sixtieth anniversary of Emperor Francis Joseph's reign. The foundation-stone was laid on June 20, 1909, and the building, which is situated opposite the palace of Schönbrunn, covers an area of more than 20,000 square yards. The museum will demonstrate chronologically the development of industries and crafts, illustrate the technical achievements of the present day, and by periodical exhibitions stimulate and promote future progress. In other words, it is intended as an educational centre to spread a knowledge of science and technology from the point of view of national welfare. Considerable progress has been made in stocking the museum, and several large and valuable State collections have been secured already. The historical sequence in the development of pure and applied science is not yet completely shown in the exhibits available for the museum, and the authorities appeal to men of science, technologists, manufacturers, and craftsmen in all countries to assist them in procuring suitable objects for the museum. Everything pertaining to technical labour will be acceptable, principally tools, machines, apparatus, models, materials, methods of working, finished articles, as well as plans, designs, books, illustrations, and manuscripts. The names of donors will be recorded by inscription on the gifts and in a memorial book. Further particulars can be obtained from the office of the Technical Museum, Vienna, I. Ebendorferstrasse 6.

Mr. Noel Buxton, M.P., and Mr. J. H. Whitehouse, M.P., have issued a memorandum relating to the formation of an "Inshore Fisheries Parliamentary Committee," which has made certain proposals to the Board of Agriculture and Fisheries apparently with regard to the administration of the Development Fund. It is proposed that a sub-department of the Board, consisting of "Inshore Fishery Commissioners," should be established, and that this body should administer a grant of money for the purposes of local cooperative societies for purchasing boats and gear, and for insurance; credit banks; loans; the circulation of information, such as means of transport and distribution; the cultivation of shell-fish and the provision of foreshore allotments, and the policing of the territorial waters. The prosecution of scientific investigation is not suggested; and since the committee remarks that even the best of the fishery committees "are unable to prevent injury to the spawning beds," it is evident that it passes over the fishery research of the last twenty years. The objects of the memorandum are excellent, but it is quite certain that some of them cannot be carried out economically and efficiently without great familiarity with local conditions and a certain amount of scientific research; and this information, with the organisation for increasing it, already exists in the case of several of the better equipped fisheries committees. There are parts of the coasts of England and Wales where fishery research and regulation have never been adequately developed, and a good deal might be said in favour of applying the proposals of the Parliamentary Committee to these neglected inshore areas; but it is difficult to understand why all the organisation for local investigation and control, built up laboriously during the last twenty years by some of the district committees, should be ignored, and the problem of improvement of the inshore fisheries tackled again in apparently a *de novo* manner.

We learn from *The Japan Times* that the Imperial Academy of Japan has awarded a medal and testimonial to Dr. Kimura for his discovery of the term in the variation of latitude which is generally known by his name. This is the first award under a benefaction which the Academy owes to the Emperor. As at present understood, the complete expression for the variation of latitude at a station in longitude λ is

$$x \cos \lambda + y \sin \lambda + z,$$

where x and y are the rectangular components of the displacement of the pole on the earth's surface relative to its mean position. The third, or z term, which was discovered by Dr. Kimura and is the subject of the award, is annual in period and independent of the longitude of the station. Dr. Chandler therefore sought to explain it as a result of the mean parallax of the stars observed, but found on examination that not more than one quarter of its amount could be accounted for in this way. The nature of the term points to an apparent and unexplained oscillation of the centre of inertia of the earth with a semi-amplitude of 4 or 5 feet. The addition of two observing stations in the southern hemisphere, one in West Australia and the other in the Argentine, to the six international stations previously established in the northern hemisphere, has corroborated the objective reality of the phenomenon, which still presents, therefore, an extremely interesting problem in geophysics. On the occasion of the presentation to Dr. Kimura a lecture was delivered by Prof. Nagaoka, in which he recounted the circumstances in which the discovery was made. The observations made at Mizusawa, the latitude station in Japan under the charge of Dr. Kimura, were suspected of inaccuracy, but the most careful examination failed to reveal the source of error. Finally, Dr. Kimura was able to prove that the errors were not due to an instrumental or personal source, but arose from a cause affecting all the stations alike. He thus vindicated his accuracy as an observer, and discovered what appears to be a very remarkable phenomenon at the same time. The circumstances are of a piece with the whole history of our knowledge of the variation of latitude; and this is perhaps natural enough, since it is entirely a question of residual phenomena only revealed by observations of the highest order of accuracy.

In *The Athenaeum* of August 12 Prof. W. M. Ramsay reports a very interesting and important archæological discovery, which will hereafter throw much light on the religion of Asia Minor. This is the holy place of Men Askaenos at Pisidian Antioch. The site contained no temple, but only a great altar standing in an enclosure surrounded by a massive wall. The shrine has clearly remained in the state in which it was left by the Christians when they destroyed it in the fourth century. No other primæval sanctuary on a mountain top, dedicated to a known god and famous throughout Asia Minor, has ever been discovered. The sacred way with votive reliefs on the rocks, the wall of the precinct covered with votive dedications to Men Askaenos, the church built of materials collected from the shrine, the theatre of the Hellenistic or Roman period, present a combination of interesting archæological remains without parallel in this region; and the shallowness of the soil renders excavation particularly easy. It may be hoped that funds for the excavation of this unique sanctuary will soon be provided, and the work carried on by some of the scholars who have been trained by Prof. Ramsay in archæological research in Asia Minor.

The third season's investigations, conducted at Avebury by the British Association under the superintendence of Mr. H. St. George Gray, commenced in April last. The results of the work supply further corroboration of the conclusions already arrived at that the "temple" dates from the Neolithic stone period. This is shown by the discovery of two worked red-deer antlers, a finely chipped flint knife, and fragments of prehistoric pottery. This last is formed of a coarse, thick black paste containing grains of various substances introduced to bind and strengthen the ware, such as pieces of burnt bone and tiny bits of charcoal. Its chief interest lies in the fact that it is ornamented on both faces, the impressions of twisted grass, or cord, and finger-nails being clearly defined. This pottery was found about $5\frac{3}{4}$ feet below the surface. At a lower depth, but still below the Roman stratum, another form of vessel was discovered, ornamented in a herring-bone pattern, which was impressed by means of a notched implement of wood, bone, or antler, or by a shell with its natural ribbing. This pottery is identical with specimens found in the West Kennet long barrow, at Peterborough, on the Thames at Mortlake, and in General Pitt-Rivers's excavations at Handley, North Dorset. The date of the Avebury circle seems to be definitely fixed by these discoveries.

The Hittite Excavations Committee, the honorary treasurer of which is Mr. R. Mond, Coombe Bank, Sevenoaks, has issued an appeal for assistance in archæological research in certain parts of Asia Minor and northern Syria. Much information has already been collected regarding Hittite civilisation by the excavations at Boghaz Keui, the capital of the great Hittite kings in the fourteenth and thirteenth centuries B.C. Numerous clay tablets have been discovered here which will throw welcome light on the relations of the Hittite Empire with Assyria on the east and Palestine, the Ægean, and even Egypt on the west. It is now proposed that excavations shall start on the great mound at Sakje Geuzi, which lies four days' journey eastward from Adana, near Tarsus, and on an ancient route between the east and west by way of Carchemish and the Cilician Gate. Prof. J. Garstang, who will take charge of the operations, has already made some preliminary excavations on this site, and has discovered a palace with sculptured portico which promises to contain most interesting material, possibly that bilingual inscription which would solve the riddle of innumerable documents.

The Scientific American of July 22 contains an appreciative notice, accompanied by a full-page portrait, of Prof. Henry Fairfield Osborn, who, it appears, takes his second name from the Connecticut town in which he was born in 1857. In the course of the article reference is made to the strong support accorded by Mr. Osborn to the tritubercular theory of the evolution of mammalian molars, and likewise to his investigations into the phylogeny of the titanotheres of the American Tertiary.

The so-called British bird-fauna has just been augmented by another subspecies in the shape of the Alpine ring-ouzel (*Turdus torquatus alpestris*), of which, as recorded by Mr. M. J. Nicoll in *British Birds* for August, a specimen was shot at Guestling, Sussex, on May 23. This race, which ranges from central and southern Europe to the Balkans, differs from the typical form by having more white on the secondary quills, and the presence of large median patches of white on the feathers of the breast and chest, and of white streaks on the under tail-coverts. The more eastern *T. t. orientalis*, which ranges into Egypt, is intermediate in colouring between the typical and Alpine races.

No. 3 of the first volume of the Records of the Canterbury Museum, New Zealand, is devoted to a continuation of the account of the zoological results of the New Zealand Government trawling expedition of 1907, Mr. E. R. Waite dealing with the fishes, Mr. H. Suter with the molluscs, and Mr. C. Chilton with the crustaceans. In a summary of the results of the expedition Mr. Waite directs attention to their bearing on the supply of local food-fishes. One of the results is the marking out of areas suitable for trawling; and although there appears to be no evidence of commercial trawling having in consequence been undertaken on an extended scale, it seems that the favourable report as to the potentialities of the Chatham Islands for line-fishing has been effective in attracting capital to what it is hoped will prove a profitable venture.

We have received copies of six guides to the Grange Wood Museum at Croydon and its various sections, written by the hon. curator, Mr. E. A. Martin. Unfortunately, at least some of these lack that accuracy and "up-to-dateness" which are of such prime importance in publications of this nature. On the first page of the Guide to the Back-boned Animals we find, for instance, the statement that the Chordata (in its restricted sense) includes the sea-squirts and the lamprey, instead of the sea-squirts and the lancelet. In a reference on the same page to the notochord, the author assumes his readers to possess more knowledge than they are likely to have acquired. On p. 8 the statement that the constituent bones of the chelonian shell articulate by means of teeth is misleading, while on the next page readers are led to believe that chameleons are restricted to N. Africa. The classification of both birds and mammals is quite obsolete; it is stated that there are only two kinds of monotremes, Edentata is misprinted Endentata, and the *horns* of antelopes are referred to as *antlers*. In the Shell Guide Lamellibranchiata is spelt with two m's, and Spondylus is included among gastropods; and, to take one example from the Fossil

Guide, we are told that Dolichosaurus was still in existence in the Chalk, whereas it is only known from that formation.

In part ii. of the Proceedings of the Zoological Society of London, published in June, Dr. W. N. F. Woodland has published a thesis "On the Structure and Function of the Gas Glands and Retia Mirabilia associated with the Gas Bladder of some Teleostean Fishes." The structure of these bodies is well illustrated by eight coloured plates, and an ingenious hypothesis is advanced to explain the remarkable conformation of the well-known rete mirabile duplex constantly associated with the gas gland (oxygen gland). The general theory put forward to explain the actual mode of production of oxygen by the gland—a very interesting physiological problem—is, we notice, almost entirely based upon the study of stained microscopic preparations, and thus lacks the essential support only to be derived from physiological experiment. The author, however, has recently investigated the physiological aspect of the subject at Plymouth, and has supplied an account of the results obtained in a further paper to be read before Section I at the forthcoming meeting of the British Association at Portsmouth.

Prof. Hans Driesch's essay "Die Biologie als selbständige Grundwissenschaft und das System der Biologie," almost entirely rewritten, has appeared in a second edition (Leipzig: Wilhelm Engelmann, price 1.20 marks). The book is issued as "Ein Beitrag zur Logik der Naturwissenschaften," and is a clear statement of the value of the interaction of philosophy and biology.

The new volume (xliii., 1 and 2 Heft) of the *Morphologisches Jahrbuch* (Gegenbaur) contains, among other memoirs, a detailed account of the spinal cord of the dugong, by Drs. Dexler and Eger. The simple segmentation of the body of the animal and its adaptation to aquatic life are found to be reflected in the cord, which is almost uniformly segmented, and exhibits no trace of thickening in the lumbar region; there is, however, some shortening in the cervical portion. The form, size, stainability, position, pigment, tigroid substance, nuclei, and processes of the nerve cells do not present any special peculiarities. Dr. Hans Bluntschli describes an abnormal pelvis of a female Java ape (*Macacus cynomolgus*), which exhibits differences from the normal similar to those shown by a human "Naegele pelvis." Dr. K. Ogushi contributes the first instalment—the description of the skeleton—of his account of the anatomy of the Japanese three-clawed turtle (*Trionyx japanicus*).

Prof. Raymond Pearl deals in the current number of *Scientia* with biometrical ideas in biology, their significance and limitations. He points out that the real purpose of biometry is the general "quantification" of biology, that the biometrical constants (mean, standard deviation, coefficient of correlation, &c.) are constant characters of the "group" (for instance, a species) as such, and that the shape of the variation curve for the particular group of organisms is a definite character for the group. Biometry furnishes, in fact, a valuable and refined extension of the descriptive method; but it must not be applied loosely; it is necessary to use in its application as much general "biological intelligence" in regard to the significance of the problem attacked, the validity of the assumptions made, and the applicability of the methods to the particular problem as would be exercised in an investigation by any other method.

The second Heft of vol. xcviii. of the *Zeitschrift für wissenschaftliche Zoologie* comprises three memoirs. Herr Rungius gives a detailed account of the anatomy and histology of the alimentary canal, larval and adult, of the water beetle *Dytiscus marginalis*. Dr. Gustav Fritsch describes the histology of the eye of a fruit bat (Pteropus) from Sumatra. The remarkable point in the structure of the eye is the presence of finger-like processes extending from the choroid into the middle layer of the retina. The author regards these as comparable to the pecten of the eye of birds, and attributes to them a nutritive function and the *rôle* of regulating pressure in the eyeball. Herr Kapzov has investigated the intimate structure of the cuticle of insects, and finds that it has a honeycomb appearance, due partly to variations of pressure during its formation, and partly to varying activity of the hypodermis cells which secrete it.

Among the articles in the July issue of *The Popular Science Monthly* is one by Mr. A. H. Thayer on concealing coloration, the writing of which was prompted, in the first instance, by certain statements in Mr. Roosevelt's recent book on African animals. Mr. Thayer holds that it is the rule for animals to be coloured like the background which most concerns their feeding and escaping attack; but the human observer, in order to experience the concealing effect of such marking, must look at the animals from the same level as their normal enemies; in many cases he must look *up* to them from near the level of the ground. The reed and sky markings of zebra and oryx make it difficult to distinguish them, in their usual surroundings, by night as well as by day. Prof. Montgomery advocates the expansion of the usefulness of natural history museums. He holds that they should be centres for instruction in taxonomic work, which can be better undertaken there than in university laboratories. Under such an arrangement, taxonomic collections and courses may well be abolished from universities. He also enters a plea for increased opportunities for research by the staffs of museums.

The July number of *Tropical Life* is devoted to an account of the rubber exhibition recently held in London. An important feature was the excellent quality and appearance of certain samples of Castilloa, Funtumia, and Ceara rubber. Castilloa rubber from Mexico was shown in block, sheet, and crêpe forms; Funtumia and Ceara were sent from the Gold Coast as "biscuit," as well as in balls. Specimens of Castilloa from Tobago, comparing favourably with sheet Para, received general commendation.

Noteworthy among the numerous diagnoses of new plants, chiefly from tropical Africa and Asia, published in the *Kew Bulletin* (No. 6), are the descriptions of two species of Impatiens from Malaya, communicated by Sir Joseph Hooker; *Impatiens peltata* is distinguished by its peltate leaf, and *I. Vaughanii* bears characteristic sepals. Another important determination is supplied by Dr. O. Stapf of a lawn grass, locally termed blue couch, that has found favour in some coastal districts in New South Wales. The author refers it to *Digitaria didactyla*, specimens of which he has also discovered from Madagascar and Tonkin. It grows more strongly than *Cynodon dactylon*, which is generally employed for lawns in the colony, and is said to possess other advantages.

Prominence is accorded to a contribution by the eminent zoologist Prof. E. Giglio-Tos in the *Botanisches Centralblatt* (July 15), in which it is claimed that the recent experiments with reciprocal hybrids recorded by Prof. de Vries, and briefly noted in these columns (Nature, April 13), provide striking confirmation of certain laws in hybridism advanced by the author. According to one of these laws, crosses from reciprocal hybrids show a return to the characters of one of the original species, and these are the only crosses in which hybrid characters are not maintained. Another law states that when crosses are raised from a hybrid and one of the original parents, if a hybrid carrying the male character is crossed with the female parent, or *vice versa*, the hybrid characters are maintained; in the other alternatives there is a return to the characters of the parent.

It seems reasonable to affirm that primitive or natural woodlands still exist in parts of Scotland, although the question does not admit of definite proof. Interesting evidence, based upon an examination of selected observational areas, is submitted by Mr. C. P. Gordon in the Transactions of the Royal Scottish Arboricultural Society (vol. xxiv., part ii.). He discusses three types of "Urwald," *i.e.* birch, Scots pine, and oak. On the ground of inaccessibility and condition of the trees, the birch woodlands on the shores of Loch Ossian and Loch Laggan, ranging to an elevation of 2000 feet, are considered to be primitive. Antiquity is claimed for the Scots pine forming Locheil Old Forest in Inverness-shire; although the trees have flattened crowns, the quality of the wood is excellent, and surpasses that of any imported Scots pine timber. Again, the shape and development of the oaks on Lochwood Moss in Dumfriesshire suggest that this forest is primitive; epiphytic growth of the common polypody and Usnea is here a striking feature. The article also contains notes on the ground floras observed.

The example set by the United States in retaining a large tract of country as a sanctuary for wild life has been followed by several other countries, including Canada and Switzerland. Mr. J. S. M. Ward appeals in *The Builder* for August 4 that something similar should be done in England. The growth of towns and of small holdings, and the gradual conversion of England into a "Black Country," are causing the disappearance of the real wild country. Efforts should be made to save sanctuaries near our different towns, a matter which might be taken in hand as an extension of the town-planning movement. Forestry should be encouraged wherever possible; much land in private hands might become sanctuary to all practical purposes. Two or three sanctuaries already exist; Epping, though an accidental one, has been a great success in this direction, and so has the Brent Valley Bird Sanctuary of the Selborne Society. Mention should also be made of the work done by the National Trust and by the Commons and Footpaths Preservation Society. Many of the most beautiful spots in England have been saved by their joint efforts, and there are signs that these bodies intend to extend their work in the direction of the provision of sanctuaries.

The number of new seedling sugar-canes available for planters is greater at the present time than ever before, and experiments are undertaken by the West Indian Department of Agriculture to serve as a guide to planters in selecting the most promising sorts for cultivation. In order to render the investigations applicable to a wide range of conditions, the location of the different experiment stations is chosen with the view of making each station, so far as possible, representative of the cane-growing district round about it, so that, as a whole, the stations supply a complete survey of the conditions under which sugar-cane is grown in the particular island. The report of the experiments conducted in the Leeward Islands for 1909–10 is now issued as Pamphlet 67 of the West Indian Department.

The Agricultural Journal of the Union of South Africa contains each month papers of scientific and of technical interest by officers of the Department. A report is published in No. 3 of the new volume showing that cotton can be successfully raised in the Cape Province. The cultivation is attracting a good deal of local attention, and the crop is satisfactory in quality; there seems the promise that cotton-growing may become a profitable industry. In No. 4 Dr. Theiler gives an interesting and complete summary of recent work on ticks and the part they play in the propagation of diseases in cattle; the particular diseases dealt with are biliary fever in horses, caused by *Piroplasma equi*; redwater in cattle, caused by *P. bigeminum*; gall sickness, or anaplasmosis, due to *Anaplasma marginale*; fevers, caused by *Piroplasma mutans*, by Spirochætes, and the East Coast fever caused by *P. theileria*; and heartwater.

The annual report for 1909–10 of the Department of Agriculture, British East Africa, shows an encouraging growth of production and a steady influx of settlers with capital. The climate is very varied, and ranges from temperate to tropical within somewhat narrow distances; in consequence, a considerable variety of crops can be produced. Beans, coffee, maize, and millet have increased enormously in area, and in spite of the growing local demand there is a large balance for export. Rubber has likewise increased in amount, and a still further increase is foreshadowed in the future, as the plantations have not yet reached the tappable stage. Sem Sem is also a valuable and increasing crop. On the other hand, copra and wax have fallen off in value; but the decline in copra is not regarded seriously, because the cocoanut is now put to more economical uses. There is a large and growing export of hides, chiefly ox and goat, while ostrich farming, which has recently been introduced, promises to become an important industry.

MM. Claude, Ferrié, and Driencourt give in the *Revue générale des Sciences* for July 30 an account of the experiments made for the determination of longitudes by means of wireless telegraphy between Paris and Brest, a distance of about 600 kilometres, and afterwards between Paris and Bizerta, which are separated by about 1550 kilometres. Diagrams of the instruments and connections are given. In the experiments between Paris and Brest in July, 1910, comparisons by radio-telegraphic and telephonic signals gave the same degree of precision, the mean error being less than 0·01s. In the experiments with Bizerta at the end of 1910 suitable radio-telegraphic signals actuated by a clock at the Paris Observatory were received, so that coincidences could be accurately observed, and the differences between the mean comparisons of the same series were of the order of 0·01s.

In the *Revue générale des Sciences* for July 30 M. Lallemand, the director of the Levelling Service of France, discusses the most suitable form for an international air-map, and proposes a system of marks to enable the aviator to determine his position. The Permanent Committee for Aërial Navigation of the Ministry of Public Works has adopted 1 : 200,000 as the most suitable scale, each sheet containing 1° of latitude by 1° of longitude; longitudes are to be reckoned from 0° to 360° in an easterly direction from the antimeridian of Greenwich; for the ordinary numbering of the parallels of latitude a continuous numbering from the South to the North Pole is proposed with the view of avoiding the change of sign on passing the equator. For local marks a rectangle containing a dot indicating the position of the place in the map sheet, and the number of the map sheet would be painted on a house-roof or other suitable surface, and this is considered more practical than giving the name of the place. The projection employed is the same as that of the international 1 : 1,000,000 map.

ACCORDING to the *résumé* of communications made to the Société française de physique on July 7, M. M. Kernbaum has succeeded in showing that the "oxygenation" of water, which two years ago he proved could be obtained by allowing the ultra-violet rays from a mercury lamp to act on the water, can be obtained from sunlight. Since it is the ultra-violet rays which are effective, the action is most marked at high altitudes, but it is large enough to be easily detected at sea-level if the water is in presence of air.

IN a thesis submitted for doctor's degree in mathematical science at Geneva, M. Hermann Streele, of Neuchatel, dealing with the theory of mercurial compensation for pendulums, suggests a new form of pendulum in which the free surface of the mercury is near the middle of the column, the upper part resembling a barometer tube. This form, he claims, enables him to compensate theoretically both the actual changes of temperature and the error due to the want of uniformity of temperature in different parts of the pendulum chamber. He follows Herr Wanach (remembered as one of Prof. Albrecht's longitude observers) in condemning the old approximate formulæ of Lord Grimthorpe and others, but apparently fails to realise the great dependence of makers on "trial and error." He has not completed the theoretical study, as he ignores, for instance, any molecular temperature effect, and from the practical point of view he has omitted any mention of devices for keeping the atmospheric pressure nearly constant. No hint is given of any possible application of "invar" to mercurial pendulums, though its striking success in bimetallic compensation would seem to recommend a trial of this alloy for some part of the pendulum, if not for the actual stalk.

EXTENSIVE schemes of improvement of the docks of the Port of London, forming part of a more extended scheme resolved on some time ago, are now about to be carried out at a cost of four millions of pounds. It is anticipated that when these works are completed, they will be sufficient to meet the needs of the port for several years. The remainder of the proposed improvements will be deferred until the increase of trade renders them necessary. The works now to be put in hand include the construction of a new deep-water dock of sixty-five acres. It is anticipated that this will occupy five years, and the estimated cost is 2,150,000*l.* This dock will be constructed to take vessels of considerably larger size than those which now can find accommodation in the Thames, the depth being 38 feet and length of the lock 800 feet, or 250 feet longer than that of the present Albert lock. The East and West India docks are to have their approach widened to 80 feet, and depth increased to 31 feet, allowing the entrance of vessels up to 9000 tons. The South-west India dock and the London docks are to have new entrances constructed, and to be otherwise made to meet modern requirements. The water in the latter is to be increased so as to make it 4½ feet above Trinity high-water mark by means of a pumping installation.

A CLASSIFIED list of new books and new editions added to Lewis's medical and scientific circulating library, 136 Gower Street, W.C., during April, May, and June, just received from Mr. Lewis, is a useful catalogue of important works published during that period.

OUR ASTRONOMICAL COLUMN.

COMET 1911*b* (KIESS).—Observations of Kiess's comet, made by Mr. Stratton with the Newall telescope on July 22, 25, and 26, showed a head some 3′ in breadth, but without any sharply defined nucleus. Mr. Newall, in No. 4517 of the *Astronomische Nachrichten*, does not give the times of the observations, but states that the comet was visible to the naked eye.

Spectroscopic observations revealed a bright band at λ 516 in which the head was seen to be 5′ or 6′ broad, and the band could also be traced along the tail to a distance of at least 5′; bands were also seen at λλ 474, 516, and 564, and the continuous spectrum was recorded as very faint.

A note appended to the ephemeris given in No. 438 of *The Observatory* directs attention to the fact that on September 3 the earth will pass through the point traversed by the comet on August 7; a careful watch should be kept for cometic débris in the form of meteors.

BROOKS'S COMET, 1911*c*.—New elements and ephemeris for comet 1911*c* are published in No. 4517 of the *Astronomische Nachrichten* by Dr. Ebell. As the new positions, especially for the later dates, show considerable departures from those we reproduced in these columns on August 3, we give the following abstract from the ephemeris :—

Ephemeris (12h. M.T. Berlin).

1911	α (true) h. m.	δ (true) ° ′	log *r*	log Δ	mag.
Aug. 16	21 22·0	+39 33·5	0·1932	9·8632	8·5
,, 20	21 4·3	+43 6·8	0·1747	9·8324	8·3
,, 24	20 41·9	+46 43·8	0·1552	9·8033	8·0

This comet was observed by Mr. Stratton on July 25 and 26, and was found to have a bright nucleus which gave a continuous spectrum; the band at λ 516 in the spectrum could be traced faintly for about 2′ from the nucleus both towards the sun and in the opposite direction. The comet could be seen with a pair of opera glasses.

A large number of observations of position and brightness are recorded in the *Astronomische Nachrichten* (No. 4517) from Greenwich, Utrecht, Algiers, and many other observatories. At Algiers Dr. Gonnessiat found, on July 22, a 4′ or 5′ nebulosity having an eleventh-magnitude nucleus which was not central. Herr G. van Biesbroeck found that the magnitude of the comet seen with opera glasses on July 26, 27, and 29 was about 8·0.

ENCKE'S COMET, 1911*d*.—Dr. Gonnessiat's report of the rediscovery of Encke's comet appears in No. 4517 of the *Astronomische Nachrichten*, and states that the comet was a difficult object in the dawn. Perihelion passage takes place on August 19, and an ephemeris giving positions from August 24 to September 21 appears in No. 438 of *The Observatory*; for August 24 and 28 the positions are 10h. 44·5m., 5° 46′ N., and 11h. 16·1m., 1° 2′ N., respectively.

THE OBSERVATION OF METEORS.—Amateur astronomers not possessing efficient instrumental equipment cannot do better than devote their attention to the observation of meteors, about which students of cosmogony still require to learn many things.

For such observers the publication (*Observatory*, No. 438) of a letter written by the late Prof. Alex. Herschel to Mr. Denning in August, 1876, is full of interest and practical information. Those who had the pleasure of corresponding with Prof. Herschel will understand that it is impossible to describe a letter of his in detail in a confined space, but the amateur will find especially interesting the discussion of "trains." These phenomena are seldom properly described, and Prof. Herschel takes some pains to impress upon his correspondent the great importance and the almost infinite variety of the luminous phenomena attending a meteor flight.

BETA AND GAMMA RAYS IN SOLAR PHENOMENA.—From Dr. A. Brester, Jz., we have received an interesting monograph dealing with the theory that solar phenomena are produced by the solar emission of β and γ rays. Dr. Brester starts with the terrestrial aurora produced by electrical radiations, and shows that the solar phenomena may be similarly explained. The presence of helium as a prominent solar element is taken as evidence of the presence in the sun of the radio-active elements from which the β and γ rays may emanate. The monograph is published by W. P. van Stockum et Fils, The Hague.

PAPERS ON INVERTEBRATES.

IN the Records of the Indian Museum for May (vol. vi., part 2), Dr. N. Annandale describes certain curious masses dredged in the Bay of Bengal, which on examination proved to be sponges associated with gregarious molluscs of the family Vermetidæ, the latter being embedded in the former. The masses, which were in a bad state of preservation, are of two types, one consisting of shells with serrated ridges embedded in moderately hard black sponges, and the other of smoother shells associated with stony sponges, ranging in colour from red to yellow. The ridged shell is *Siliquaria muricata*, and the associated sponge *Spongorocites topsenti*. The second type comprises two molluscs, *Spiroglyphus cummingi* and *Siliquaria cochlearis*, the associated sponges being two forms of *Racodiscula sceptrellifera*, which differ from one another in colour. When fresh, the masses of the second type must have had a brilliant appearance, the sponge being red or orange, the shells pink, and the soft parts of the molluscs yellow. Both the two sponges associated with the three Vermetidæ are found elsewhere growing alone.

In two issues of the Proc. U.S. Nat. Mus. (Nos. 1823 and 1826), Mr. Paul Bartsch catalogues the recent and fossil representatives of the molluscan genera Cerithiopsis and Bittium from the west coast of America; and in No. 1820 of the same serial Messrs. Dall and Bartsch describe several new shells from Bermuda, including some of the aforesaid Cerithiopsis.

Variation in certain Jamaican species of land-snails of the genus Pleurodonte (or Pleurodonta) forms the subject of a paper by Mr. A. P. Brown in the Proceedings of the Philadelphia Academy for February, 1911. Variation in the height of the spire indicates two waves of migration into the district from the north, the first being probably represented by an extinct race from near Somerset. In analogous cases the variation in the height of the spire has been attributed to difference of atmospheric pressure according to altitude, tall-crowned forms being found high up, and *vice versâ*. But, as Mr. Brown points out, this cannot be a *vera causa*, the diurnal oscillations in pressure at a given point being in some parts of the island more than equal to variation due to altitude. Moreover, in one at least of the mountain forms, increase in spire-height is accompanied by a diminution in the size of the shell. In the author's opinion, such variations are mainly controlled by local differences in humidity.

In the same serial for March, Messrs. Pilsbry and Ferriss continue their review of the land-shells of the south-western United States, dealing in this instance with those of the Grand Canyon and northern Arizona. The molluscan fauna of the Grand Canyon consists, with one exception, of northern Arizona types; but the canyon forms an impassable barrier to Oreohelix, of which distinct species are found on its two sides.

Certain features in regard to the vertical distribution in the San Diego area of the minute translucent crustacean *Eucalanus elongatus* (a relative of the better-known *Calanus finmarchicus*) are discussed by Mr. C. O. Esterly in vol. viii., No. 1, of the Zoological Publications of the University of California. Despite considerable hourly variation in the numbers taken in plankton, it does not seem that the species performs diurnal vertical migrations; and the reason for the numerical variation is therefore still unknown. The author is led to suggest that diurnal vertical migrations may have in part a protective object in many species, seeing that Eucalanus is adapted in other ways to life in the plankton.

How much remains to be done in connection with South African earwigs is made evident by the fact, as recorded by Dr. M. Burr in vol. x., part i., of the Annals of the South African Museum, that out of nineteen species from the districts south of Rhodesia, no fewer than seven proved to be new. One of these is assigned to Apterygida, a genus, as now restricted, previously known only by *A. alpipennis* of Central Europe.

The lug-worms (Arenicolidæ) of South Africa are discussed by Dr. J. H. Ashworth in vol. xi., part i., of the same serial. The special interest of this article is the record of the rediscovery of *Arenicola loveni*, a species hitherto known solely by a specimen from Natal preserved in the Riksmuseum at Stockholm, and described by Kinberg in 1866. An examination of the internal organs of this specimen, supplemented by others recently obtained by Dr. Gilchrist at Saldanha Bay, Cape Colony, shows that the reference of the species to the typical genus is correct.

The one article in vol. iv., No. 7, of Records of the Indian Museum is devoted to the description, by Mr. E. Brunetti, of nearly fifty new Oriental flies of the group Nemocera.

To *Biologisches Centralblatt* for July 1 the Rev. Father Wasmann contributes the first part of a critical review of Escherich's "Termitenleben auf Ceylon."

In vol. xxxiii., No. 4, of Notes from the Leyden Museum Dr. R. Horst revises the characters of the genus Notopygos, typified by an amphinomid worm from St. Helena described by Grube in 1855. The special feature of the genus is the dorsal position of the vent, some distance in advance of the terminal segment. Shortly afterwards Grube referred to the same genus a Costa Rican annelid, mentioning the presence of two dorsal cirri. In 1857 Kinberg, who was apparently unacquainted with the account of this second species, diagnosed the genus as having a single cirrus, making no mention of the dorsal position of the anus. He also referred two annelids, respectively from Tahiti and Panama, to the new genus Lirione, on account of the presence of a pair of dorsal cirri. Apparently the single cirrus specimens, which were from St. Helena, did not belong to Notopygos, of which Lirione is now shown to be a synonym. The genus is now known from St. Helena, Costa Rica, Florida, Bermuda, Malaya, the Amirante Isles, and Australia.

In No. 1846 of the Proceedings of the U.S. National Museum Mr. E. Kirk discusses the relationships, classification, and genealogy of certain "Eleutherozoic Pelmatozoa," in other words, of free-living echinoderms of the cystid and crinoid groups. "With the possible exception of the Holothuroidea, we may hold," writes the author, "that such eleutherozoic echinoderms as are known to us have been derived from statozoic ancestors. . . . In the case of the eleutherozoic forms we have one newly acquired set of tendencies superimposed upon another set. These secondary tendencies, induced as they are by a form of life widely at variance with that under which the first set operated, tend to vitiate the force of many of the primary tendencies, if not indeed to nullify some of them. . . . Such being the case, one's efforts to establish relationships among these aberrant forms are apt to be unsatisfactory at best. In many cases, however, the eleutherozoic Pelmatozoa stand so near the point of inception of their several lines that the problem is not greatly complicated by the presence of altered or superimposed structures." Nevertheless, the classification and grouping adopted in the paper are admittedly artificial and arbitrary.

THE FOSSIL ELEPHANTS OF RUSSIA.[1]

ALTHOUGH a fine series of elephant remains from Tiraspol, Government of Kherson, preserved in the Geological Museum of Moscow University, forms the basis of Madam Pavlow's monograph, the author has examined several other collections, such as one from Kouialnik, near Odessa, and a second at Kief. The Tiraspol elephant has been identified with that form of the mammoth distinguished, on account of the thicker plates of its molars, as *Elephas trogontherii*, and characteristic of the horizon of the Cromer Forest-bed. Madam Pavlow finds, however, that in the Tiraspol molars the plates are still thicker, and accordingly regards them as representing a new species—*E. wüsti*, or *wuesti* as it

[1] "Les Éléphants Fossiles de la Russie." By Marie Pavlow. Pp. iii+60+3 plates. Nouveaux Mémoires de la Société Impériale des Naturalistes de Moscou, tome xvii, livraison 2. (Moscow, 1910.)

should be spelt—which is considered to connect the typical mammoth by means of *E. trogontherii* with the broad-plated *E. meridionalis* of the Val d'Arno and Forest-bed. Two molars from Tiraspol are stated to approximate respectively to those of *E. armeniacus* and *E. antiquus*, but it is scarcely likely that three more or less closely allied forms occur in one deposit. *E. trogontherii* is recorded from Nijni-Novgorod, *E. meridionalis* from Kowialnik, and the typical *primigenius* from a prehistoric station at Kievo-Kirillovskaïa. Finally, a molar from Tiraspol and a second from Bessarabia are respectively compared with those of the Siwalik *E. hysudricus* and *E. planifrons*.

The important part of Madam Pavlow's paper is, however, contained in the discussion as to the mutual relationships of the various species and races. After noting the resemblances between *hysudricus* and *meridionalis* on one hand and *antiquus* and *namadicus* (which some naturalists regard as inseparable) on the other, the author suggests that *meridionalis*, by an increase in the number and degree of compression of its molar plates, passed by means of *wüsti* and *trogontherii* into the mammoth, which died out without descendants. On the other hand, a thin-plated phase of the *meridionalis-hysudricus* group appears to have given rise to *antiquus* and *namadicus*, while the latter in turn produced the modern Indian elephant. The idea that *antiquus* was the ancestor of the living African elephant is considered improbable.

The main objection to these views appears to be the phylogenetic separation of the Indian elephant from the mammoth, the two being closely connected by the so-called *E. armeniacus*, which was probably the animal hunted by Thothmes III. in Mesopotamia. Moreover, the suggestion that *E. namadicus* (= *antiquus*) was the parent of the Indian species is unlikely on account of the peculiar form of the forehead in the extinct species. That the *meridionalis-hysudricus* line gave origin to the Indian elephant, and that the mammoth branched off from the same stock, perhaps, as Dr. Andrews has suggested, by way of *armeniacus*, is a far more probable supposition, and one that fits in with all the facts. In regard to the African elephant, there is a general tendency to connect it with *antiquus*, Dr. Andrews even going so far as to suggest ("Guide to Elephants in Brit. Mus.," p. 42) that the narrow-toothed form of the latter may have been the actual ancestor, or at all events nearly related to the ancestor, of the existing species, although in a previous passage (p. 39) he states that *antiquus* is unlikely to have given rise to descendants.

While venturing to dissent in some degree from her theoretical views, I may conclude by expressing appreciation of the value of the work of Madam Pavlow, as it is only by means of such investigations that we can hope to solve the riddle of the elephants. R. L.

WORK OF THE PHYSIKALISCH-TECHNISCHE REICHSANSTALT IN 1910.

THE subjoined notes, based upon the annual report of the above institution for last year, indicate a few of the more important researches, &c., undertaken.

One of the chief researches was the joint work carried out at the Bureau of Standards, Washington, in conjunction with representatives of the English, French, and American standardising laboratories, the most important portion of this work being the determination of the value of the E.M.F. of the Weston normal cell. This was found to be 1·0183 international volts at 20° C. within limits of 1/10,000, agreement being secured in this respect among the countries mentioned. The value given has therefore been accepted in Germany as from January 1 last.

A research on the specific heat of gases at low temperatures by the continuous-flow method has been made. In using this method, a measured quantity of energy C^2R is conducted electrically to a gas passing through a tube at a constant rate of flow. If the temperature-difference dt between inflowing and outflowing gas is known when the stationary state has been attained, as also the quantity of gas Q flowing through the calorimeter in a certain interval of time, then $\frac{1}{J}\cdot\frac{C^2R}{Qdt}$ is the specific heat of the gas provided no thermal loss takes place, J being the mechanical equivalent of heat.

In the course of the ordinary conductivity tests on copper carried out during the last few years, it has been found that with great approximation proportionality exists between temperature coefficient and electrical conductivity, *i.e.* that a very approximate formula was $\alpha_{15}.c_{15}$ = const. (α_{15} temperature coefficient, c_{15} specific resistance in ohms m/mm^2 at 15° C.). The mean value for all types of copper tested at the Reichsanstalt since 1905, for the constant, is $6{\cdot}7_6{\cdot}10^{-5}$. The same relation seems to hold —of course, with other values for the constants—for aluminium and iron. A similar relation has been found by Dellinger at the American Bureau of Standards.

The investigation into the variation of wire resistances with atmospheric humidity has been continued, and further experiments made on coils hermetically sealed in accordance with the suggestion of the Bureau of Standards. Two coils were filled with petroleum and two with paraffin oil, and sealed up, measurements being made before and after sealing. The coils filled with paraffin oil have shown good constancy, while the petroleum-filled ones have not been so constant.

A comparison has been carried out between the German standard petroleum testers and four English testers, the result being that the flash-point as given by the English instruments is, on the average, 2° C. lower than with the German instruments, the same oil being used for both.

Some comparative tests have been made on Seger cones in the electric and the ceramic furnace, the results showing that the cones collapse in the ceramic furnace at much lower temperatures than in the electric furnace of the Reichsanstalt. A definite opinion as to the reason for this difference is not pronounced.

Investigations have been instituted into the change in length of hardened steel. The twenty sets of end rods, of 10, 25, 50, and 100 mm. length, forming the basis of the experiments, were again measured in November, 1910. The lengths of the great majority of test-pieces have become constant, four years after manufacture; the changes observed in the remainder are within small limits (fractions of a micron). The results are to be published shortly.

A series of tests have been made on the energy-loss in dielectrics. An experimental condenser was built up of ten plates of solid insulating material interleaved with copper-foil sheets, the capacity being from 0·004 to 0·01 mfd. A description of the method of testing is given, and the results up to now show that over a range of frequency 0 to 2000 periods the phase-variation in the case of some substances is only to a slight extent dependent on the frequency, while in the case of others the variation is considerable. Sometimes it was also noticed that the phase-difference depended on the voltage applied.

Numerous other researches more or less important in character were undertaken during the year, but space will not permit of describing them here. Those interested will find the report of the Reichsanstalt published in the *Zeitschrift für Instrumentenkunde* for April, May, and June.

E. S. HODGSON.

RECENT PUBLICATIONS OF ECONOMIC ENTOMOLOGY.

INSECT pests of trees and crops demand constant attention on the part of the expert, and a very voluminous literature is growing up round the subject. Few laboratories are more prolific in published papers than those of the Bureau of Entomology of the United States Department of Agriculture. Among recent papers, we note one by F. M. Webster on the alfalfa weevil (*Phytonomus murinus*, Fab.), a pest introduced from Europe or North Africa some six years ago, and now spreading somewhat widely in Utah, and another paper by the same author on the lesser clover-leaf weevil (*P. nigrirostris*, Fab.), an insect introduced probably fifty years ago, but not very common even yet; it suffers from at least two parasites, a small Tachinida and a fungus, *Empusa sphaerosperma*. The broad-nosed grain weevil (*Caulophilus latinasus*, Say) is described by F. H. Chittenden, and also the long-headed flour beetle (*Latheticus oryzae*, Waterh.); both are found in stored cereal products, and may become serious pests if they succeed in establishing themselves. Two other pests infesting stored cereal products are also described, the lesser grain-borer (*Rhizopertha dominica*, Fab.), which is fairly common, and is cosmopolitan in its distribution, and the larger grain-borer (*Dinoderus truncatus*, Horn), which is more confined to tropical countries. The ravages of the codling moth (*Carpocapsa pomonella*, L.) in California are dealt with by S. W. Foster; two full broods of larvæ could be traced during the season, the first, however, being relatively small, and often overlooked. Treatment with a lead arsenate spray is recommended. The grape leaf-hopper (*Typhlocyba comes,* Say) an insect causing damage to vines in the Lake Erie Valley, is shown by F. Johnson to yield to a nicotine spray. Three pests on crops are dealt with: the timothy stem-borer (*Mordellistena ustulata*, Lec.), a pest which has recently been observed by W. J. Phillips; the sorghum midge (*Contarinia sorghicola*, Coq.), described by W. H. Dean; and the maize billbug (*Sphenophorus maidis*, Chittn.), by E. O. G. Kelly. The alfalfa caterpillar (*Eurymus eurytheme*, Boisd.) is dealt with by V. L. Wildermuth; it is very common, and does a good deal of damage in various localities. A very useful bulletin by L. O. Howard sets out various remedies against mosquitoes. The best mixture for keeping them off was found to be 1 part of oil of citronella, 1 of spirit of camphor, and ½ of oil of cedar; a few drops sprinkled on a towel and hung over the bed will keep mosquitoes away during the night. For the actual bite the most satisfactory remedy is said to be moist soap. Traps are described, and methods for the destruction of the insects over both large and small areas are set out.

Hydrocyanic acid has long been recognised as one of the most potent fumigating agents, but great practical difficulties are met with in its use, which so far have not been entirely overcome. If the concentration of the acid is too high the tree is killed, if too low some of the insects escape; further, the optimum concentration depends somewhat on the conditions. Thus there is almost an indefinite field of work for entomologists, and a stream of bulletins is issued on this subject. Among recent issues from the United States Bureau of Entomology are two by R. S. Woglum and one by C. C. McDonnell.

The work of the West Indian Department of Agriculture is published in the West Indian Bulletin, but summaries are also given in *The Agricultural News*, the fortnightly organ of the Department. In vol. xi., No. 2, of the bulletin H. A. Ballou gives a list of the insect pests prevalent during 1909–10, a corresponding list of the fungoid pests being prepared by F. W. South. This is the first occasion on which information of this nature has been collected, and it is proposed to repeat the reports each year in order to obtain some records of the increase or decrease of any given pests, and thus to determine the effectiveness of the preventive measures used for control. The value of such a plan is obvious, and it might with advantage be adopted in our own country.

Considerable interest attaches to the control of insect pests by natural parasites, and we note that in Barbados the hymenopterous parasite *Zalophothrix mirum*, Craw., was able to keep in check the black scale insect (*Saissetia nigra*, Nietn.), whilst in St. Vincent it was not so effective. Simple instructions are given in issues of *The Agricultural News* showing how planters may introduce the parasite among the insects, and thus increase its action; in No. 232, in particular, a summary of the whole subject is given. Active search for parasites of other pests is in progress by other departments; investigators were, for instance, recently sent from the United States to Panama to search for parasites of the citrus white-fly (*Aleyrodes citri*), of the cotton boll-weevil, and allied species.

A well-illustrated bulletin has recently been issued by P. L. Guppy on the life-history and control of the cacao beetle (*Steinastoma depressum*, L.), which for some years past has been a serious pest and a source of trouble to planters in Trinidad. Hitherto nothing definite seems to have been worked out in regard to its life-history, and its habits have only been superficially observed. Mr. Guppy's publication supplies much useful information on the insect.

WATER SUPPLY.[1]

THE question of water supply is in one aspect a scientific one, and in another aspect a political one. The source of all water supply is evaporation, which raises and purifies water which is taken up from the land and the sea, which after condensation is returned to us as rain, dew, snow and hoar frost, and these waters are to be found ready to our hand in springs, streams, lakes, and in the envelope of earth which is tapped by means of wells. In early days the water supply was a matter of hand to mouth. In the matter of water, at any rate, men drank water when they were thirsty—unlike the characters in Maeterlinck's "Palace of Happiness," who had, you will remember, the Luxury of Drinking when they were not Thirsty and of Eating when they were not Hungry. In the old days people, in relation to these ordinary articles of diet, acted upon the advice given in that old-world book "Sandford and Merton," and "only drank when they were dry." Yet even in the old days men in this country used water occasionally for washing, although the modern passion for baths had not developed in the dark ages. We find, however, that even in these early days there was a political aspect in water supply. The existence of springs in many cases determined the sites of cities. Many towns have been built on rivers partly because they were sources of water supply, but mostly when the rivers were navigable and afforded a highway for ships. Now, however, it is found that populations have increased to such an extent in certain localities, owing to the gregariousness of men and other political considerations, that the immediate sources have proved inadequate, and great towns in this country—like Rome in ancient days—have had to go a distance for their water supplies, and have had to construct great engineering works for the conveyance of water to the area of distribution. Water is at present collected and sold in England to a value of nearly 8,000,000*l.* annually, and when it is delivered at the house of the consumer it costs him about 2*d.* a ton.

Aqueducts, or channels by which water is conveyed along an inclined plane, were known to the Greeks, but there are no remains of those they constructed. The Roman aqueducts were amongst the most important of their great works, and the present supply of Rome is still carried by these artificial rivers, sometimes through passages cut in the hills, sometimes on arches bridging the valleys and carrying the water across the plains. One of these aqueducts is 62 miles in length. We in this country have had to go even further afield for our water sources. A large portion (56 per cent.) of the supply of Liverpool is brought from the River Vyrnwy, in North Wales, a distance of 68 miles. Leicester is 60 miles from the sources of the Derwent Valley Water Board supply; Birmingham gets its water from Radnorshire, a distance of 74 miles; and Manchester from Thirlmere, by means of pipes and aqueducts, a distance of 96 miles. Paris derives some of its water from the Champagne district through pipes and aqueducts 80 miles in length, and some from Vanne, a distance of 104 miles. There has, too, been a suggestion that London should draw its public water supplies from Wales, which would involve carrying the water about 200 miles. This scheme was first suggested by Mr. Bateman in 1867. He proposed to collect the rainfall on 204 square miles, and, by means of an aqueduct 173 miles in length, to bring 230 million gallons of water a day to London, and he estimated the cost at 11,400,023*l.* About the same time, too, there was a suggestion to carry the water of Ullswater and Hawswater, which it was said could supply 550 million gallons a day from an area of 100 square miles to the metropolis, supplying Liverpool, Leeds, Bolton, Bury, Blackburn, Huddersfield, &c., on the way. These great ideas were, of course, too large to be realised in these small times, and many of these towns have, since the suggestion was made, supplied themselves with water by means of comparatively small scale works instead of becoming parties in a national undertaking.

The difficulty of meeting the demands of such large towns is obvious, from the fact that it involves such great works and such heavy expense to secure an adequate supply.

[1] From a discourse delivered at the Royal Institution on Friday, March 17, by J. H. Balfour Browne, K.C.

To-day, the ratepayers of Birmingham are paying not only water rates, but contributing out of the ordinary rates 64,000*l.* a year to meet the heavy annual charges in connection with their Welsh scheme. Such a fact indicates that for places far from the sources of supply, and with wealth comparatively small to that of the great Midland towns, the difficulty of securing any supply for their future wants has become increasingly difficult, and may soon become impossible; and in this aspect the question of the future water supply of our populations becomes a significant political question, and because it is a matter of real importance to the health and trade of our great town populations, it has received no attention at all at the busy hands of our platform politicians. And yet, in my view, no matter is more worthy of serious consideration and attention, and none is more urgently practical, than the question of the future water supply of England. At one time England was able with its rich fields to feed its own populations, but, as trade prospered and populations increased, it was found impossible to produce food-stuffs sufficient for our people, and at present probably five-sixths of the total food of the people is imported from abroad. It is in this connection that current politics has taken in hand the problem how we are to continue to obtain these supplies from abroad; and while one school of politics thinks that the future is assured to us so long as the price of the loaf is not increased, another recognises the necessity of earning sufficient here to enable us to buy our food in other markets. But in relation to water supply we are in a worse predicament. We must depend for that on the rainfall of our own lands, and the improvident way in which our sources have been squandered in the past, the way in which the long arm of wealth has been allowed to appropriate sources which may not naturally or geographically belong to the community in question, the exhaustion of local sources, and the waste of underground water which takes place in connection with the mining operations of England, has much complicated the great question, and has made the future of Britain as to water supply both precarious and serious.

I have pointed out that the sources of supply are from springs, streams, and wells which tap the underground sources. There are in some quarters objections to rivers—full-grown rivers—as a source of supply, largely due to the fact that communities with insanitary rashness and short-sightedness have thrown their refuse and filth into streams, and made them the carriers of sewage. This matter was fully discussed recently in Parliament when the Great Yarmouth Water Company endeavoured to secure an additional supply of water to the town beyond that which it then drew from Ormesby Broad. We know, of course, that the rainfall in the Eastern counties is much less than in the west of England and Wales, and the company had been advised by most competent engineers that the most suitable source of supply was from the River Bure. The population above the proposed intake was very small, only one person to four acres, but still it could not be said that no sewage did find its way into the river. But even this insanitary indiscretion is condoned by nature, and rivers, especially rapid and turbulent streams, have a way of burning off effete matter which is put into its liquid charge. Whether this process of purification is absolutely effective or not is still a moot point, and chemists and bacteriologists are divided as to the safety in any case of drinking water which has been subject to sewage pollution. The great experiment of London has failed to convince some of these experts.

London derives the bulk of its water from the Thames. In the Thames watershed, above the Water Board's intake, there are at least 1,000,000 people and about 800,000 other animals. The London water is supplied to nearly 7,000,000 people. This is obviously a large experiment, for there are about as many people in Water London as in the two kingdoms of Norway and Sweden, about the same population as there is in widespread Canada. The water mains of London, according to the chairman of the Board, would reach from London to New York and back; and yet, notwithstanding the supply of river water, the health of London is exceptionally good. Indeed, there are some persons who seem to think that river water is really more wholesome than any other, and there is an interesting statistic produced in proof of this assertion. The death-rate of Great Yarmouth, which, as I have said, now takes its water from the Bure, is 15 per 1000; Chester, which is supplied from the Dee, 15·4 per 1000; and Greater London, which drinks water from the Lea and the Thames, has a death-rate of 13·3. But against this the death-rate of the great towns which have pure hill waters for their supplies are, in the case of Birmingham, 15·9; Manchester, 18·2; and Liverpool, 19·2. If statistics were absolutely convincing, the case for river water as against hill water would seem to be made out. But we must weigh statistics, and not allow them merely to count. It might almost as reasonably be suggested by anyone who was an opponent of municipal trading that the results were due to the fact that in the first three cases the water was supplied by companies and in the last three by corporations.

But, apart from any such questions, it is obvious that Thames and Lea water as supplied to London is far from being an unsatisfactory drinking water. But it is only fair to remember that just as in economics there is no such thing as "raw material," so in the case of our raw waters the water as delivered is in most cases a manufactured article.

It was always understood that mere sedimentation carried down a certain number of the germs which were contained in water, but the experiments of Dr. Houston and others show that millions of these germs in water artificially infected with cholera vibrios are dead at the end of a week's storage.[1]

It is in these circumstances that the Metropolitan Water Board has abandoned the idea of going to Wales for its supplementary water supply, and proposes, by a Bill in the present Parliament, to obtain power to construct a chain of reservoirs for the purpose of decanting the raw river water at Staines, and to spend 6,000,000*l.* on this great scheme which is to supply the wants of Greater London for the next thirty years—until, indeed, the population of the metropolis may be twelve millions.

But I was referring to the immense difficulty that any comparatively small town has in our days of securing a pure supply of hill water. So great is the difficulty that as I have said, the Metropolitan Water Board has properly hesitated to go to Wales, having spent 47,000,000*l.* in the acquisition of the London water companies—the enormous difficulties of a Welsh scheme seem to have been too great even for the gigantic financial resources of London. It is not, therefore, a matter for wonder that a town like Great Yarmouth has to look to some near source of supply for the further wants of the town, and, as I have said, they were advised to have recourse to the Bure. There were the usual objections to river water, and in this case it was urged that the river which drains the Broads is in summer the home of a large floating population in house-boats and other craft. It was, on the other hand, said that the same objection might be made against the Thames, for the Thames above the intakes has, in a momentary lapse into poetic diction, been called "the water park of London." But here again the health of London was in evidence, and in the case of Yarmouth power was taken to prevent any house-boat anchoring within a considerable distance of the intake.

There was another objection urged to the taking of water from the Bure for town supply. When the wind was in the north-west the waters of the German Ocean were heaped up by the spade-work of the gusts, and when that happened at the same time as a spring-tide the waters of the Bure were held or backed-up, and it was said that, owing to the mixing action which takes place between sea and river water, the waters of the river at the point of intake would be salt or brackish. It was argued that it was ridiculous to supply a river water impregnated with chloride of sodium to two towns like Yarmouth and Lowestoft. But here science came to the help of the water company. The occasions when the north-west winds and the high spring-tide synchronised were of course very rare, and it was proposed by the Bill that whenever such an event took place and when there were more than 20 grains of common salt to the gallon (that is, in 70,000 parts) in the Bure water, the company should cease to pump from

[1] Dr. Houston has found, too, that even a week's storage of raw river water is an enormous protection against the "cultured" and "uncultured" bacilli of typhoid fever, and "that less than a month's storage is an absolute protection against typhoid fever."

the river, and supply the town only from the stored water of the Ormesby Broad. Sir William Ramsay, too, invented for the occasion a little instrument. It was a small glass cell, containing two copper plates. This was to be sunk in the river, and so long as the plates were in contact with the fresh river water no electric current passed between the plates. But when salt water was substituted for fresh, and it was sufficiently salt to have 20 grains of chlorine to the gallon, an electric current passed and rang a bell. If this little apparatus was placed in the river two or three miles below the intake, there would be timely warning of the uprush of the sea water, and it was explained that it could be made not only to ring a bell but to stop the pumping-engine. This apparatus was exhibited to the Lords' Committee, and, upon salt being added to the water, the bell rang.

It may be of some use if I say something about the sources and methods of supply. There is nothing very new about water supply. Even in deep wells we have been anticipated: Joseph's Well at Cairo is 297 feet deep, and some of the wells in China have gone to a depth of 1500 feet. In modern times we have in some cases been abandoning our well supplies. At one time almost the whole supply of Liverpool was drawn from wells in the New Red Sandstone. To-day she only draws 7·36 per cent. from wells—36·42 per cent. from Rivington and 56·22 per cent. from Vyrnwy. There is a well at Passy, near Paris, 1923 feet deep, and it delivers $5\frac{1}{2}$ million gallons of water a day. In South Dakota there is a well which penetrates the earth's crust 725 feet and raises $11\frac{1}{2}$ million gallons a day. In relation to the purity of such underground supplies, many of them in this country are derived from the chalk, and it is interesting to note the precautions which nature has taken to purify such supplies. It is found that such soils as chalk breathe air and expel gases just as the human lungs do. The breathing is long-drawn and irregular, and depends mainly on the barometric pressure of the atmosphere. But that such breathing takes place can be shown by the simple experiment of closing the folding doors over a chalk well and holding a lighted candle to the bucket rope-hole, and the sensitive flare will show the indraft or outdraft as the case may be; which varies, of course in intensity according to the extent of recent barometric changes. When water has to be got from underground sources, then a well has to be sunk, adits driven, a pump established, and the water raised to the clear water-tank. In some cases, however, nature not only does the purification of our water by its chalk lungs, but does our pumping for us, as in the case of an artesian well.

But not only have we been anticipated in the matter of wells; in aqueducts we are mere imitators of our predecessors, who even understood, it is obvious, the principle of the inverted syphon, as it is called, by means of which water is carried in pipes across valleys running down hill on the one side and up hill on the other; for Lyons, in France, was supplied long ago by means of lead pipes from 12 to 18 inches in diameter, 9 miles in length, and worked under a head of 200 feet. It is true that the favourite method of engineers before the nineteenth century, when cast-iron pipes came into use, was to cross valleys by bridge aqueducts, and this, apparently on the ground that the materials of their pipes (either trunks of elm-trees hollowed out, from which our word "trunk main" has survived to us, or lead) did not lend themselves to the conveyance of large volumes of water as the ordinary aqueduct did. The favourite system of supply in this country to-day is undoubtedly by means of a gravitation system, either from natural lakes like Loch Katrine or Thirlmere, or from artificial lakes—or, as they are called, "impounding reservoirs." These reservoirs, by means of a dam formerly formed of earth, with a core of impervious puddled clay, but now more frequently of masonry, catch and impound the water which falls upon the gathering ground. Of course, it is desirable to avoid a gathering ground which consists of cultivated land or upon which there is any considerable population. The best gathering ground is one composed of impervious rocks—for porous strata steal too much water—and covered only with mountain pasture or moorland. In many cases no objection is made to the existence of sheep upon the gathering ground; but Liverpool, in the case of its Rivington works, has purchased the whole of the gathering ground, and, after destroying and pulling down many of the farms and buildings, has kept a great part of the gathering ground free from sheep and let it to a sporting tenant. The largest gathering ground in this country dealt with by water works is the Birmingham gathering ground, which will collect the water from 44,000 acres, while the Thirlmere scheme of the Manchester Corporation has only a contributory area of 11,000 acres, and the Vyrnwy works of Liverpool Corporation only 22,000 acres.

Hundreds of dams have been built in this country to collect the waters from gathering grounds in connection with water supply to towns, or water supply to canals and waterways. The wall which impounds the water at Vyrnwy is 85 feet high. The Manchester Corporation, which had to deal with a natural reservoir, constructed a dam only 50 feet in height, but the masonry embankment at Caban Coch, the reservoir of the Birmingham Corporation, is 122 feet high above the bed of the river; and some of the other dams of that great scheme, when complete, will be 128, 120, 101, and 98. These walls, of course, have behind them immense quantities of water varying from 8000 million gallons, in the case of Birmingham, down to the very small number of gallons which run down a mill goit. The tensile strain or tear of such a mass of water as that at Caban Coch is enormous, and in that case the work is strong enough to bear such a strain up to 12 tons per square foot. The Bouzay dam, near Epinal, in France, which was bad in design and faulty in construction, gave way with the pressure of $1\frac{1}{4}$ tons to the square foot.

On January 13 of this year a dam of a reservoir containing 250,000 cubic metres of water, which belonged to the Huelva Copper and Sulphur Company, Spain, owing, it is said, to a hidden spring under the masonry, gave way, and eleven people were drowned. That is near to-day, and affects us like a new wound. But even if none of us have memories which go back to 1840, tradition has told us of the bursting of the Bradfield Reservoir, which drowned the town of Sheffield, and put the country round for a distance of 12 or 14 miles under water. In that catastrophe 250 lives were lost, and property was destroyed to the extent of 327,000*l.* in value. The Holmfirth Reservoir, which had an embankment 90 feet high and 150 yards long, after heavy rains burst in 1854, and 100 people were drowned in that night, and property valued at 600,000*l.* was destroyed. In most of these cases, however, the calamity can be traced to the defective engineering skill which went to the construction, or subsequent carelessness in the maintenance. But many engineers would tell you that they have sleepless nights when one of these great cauldrons are filling with water for the first time—and people in the valleys below may well hold their breath until the stability of these great walls has been proved. In the case of the Bradfield Reservoir, the burst reservoir filled the Don Valley with a mad flood. In the town of Sheffield the water rose to the height of the roofs of low buildings. Dead cattle were carried down by the waters, and in some cases deposited on house-tops, and as in the days of Horace "fishes roosted in elms."

In the case of spring waters, these are collected where they issue from the earth from their underground recesses in protected tanks, and from these the water, which in many cases has been sufficiently filtered by nature, is conveyed to the clear-water tank, as in the case of surface water. But when, as in the case of surface water, nature does not produce a ready-made article, and the water is liable to surface pollution, then filtration is a necessity, and, as in many other cases, in this connection our ancestors were wiser than they knew. Indeed, experience is often more valuable than science, and is universally the foundation upon which all safe science is built. Sand filters have been used in Britain since about 1829. These filters are tanks from 6 to 8 feet deep. Over the floor drain pipes or channels lead to the outlet pipe, and over these we lay a layer of broken stones and gravel. These stones are laid to a depth of 2 or 3 feet, the larger stones being at the bottom of the tanks, and the smaller bearing the 2 feet of sand, which was supposed to be the filtering and purifying medium. The water is allowed to percolate downwards at a certain slow rate, and the effect is to remove mechanically certain matters in suspension. For many years our chemical experts saw little or no value in sand filtration, because in chemical analyses they found little or no difference between the filtered water and the unfiltered raw water. But it was left to bacteriologists to find the real significance of sand filtration. We know now that after use a jelly-like deposit is formed on the top of the sand, and that that film has prevented the water from getting through the filters at the ordinary vertical rate of 4 to 6 inches an hour, or about 2½ million gallons a day per acre of sand. One ingenious engineer had the jelly scraped off the surface of his filter, and the water flowed more freely certainly, but there were within a few hours urgent telephonic messages from the bacteriological department announcing the arrival of thousands of bacillus coli, and that the water supplied by that company was not fit to drink. The fact is that it is the organic slime which is formed on the top of the sand, and which the sand is only useful in supporting, that is the effective agent in filtering the water, for the organic slime destroys the micro-organisms which are in impure water. It is in this respect that our ancestors, in using their sand filters, were wiser than they knew.

While the micro-organisms which cause cholera, typhoid, and tubercle are so rapidly conveyed to us by means of water, and then exercise their fateful activities, which bring us disease and death, there are beneficent bacteria which "come to succour us who succour want," and these are applied as a bastion or a defence against our enemies by means of the at one time despised sand filter. I think it was Napoleon who said that a wise general should not fight too often with the same enemy, for the enemy was apt to learn too much from his implacable foe. We have fought often with the bacillus of cholera and typhoid, and have learned of our battles. Nothing could be more tragic in the way of instruction than what took place at Hamburg and Altona in 1892. Both Hamburg and Altona are dependent for their water supply on the Elbe, but the intake for the Hamburg supply is above the town; the intake for the Altona supply is below Hamburg, at a place below the point where the sewage of that town, with its 800,000 inhabitants, is discharged into the river. The Hamburg supply had, therefore, a great initial advantage over that of its neighbouring town. But the cholera epidemic scourged Hamburg, and the Angel of Death passed very lightly over Altona. At Hamburg the deaths from cholera amounted to 1250 in 100,000, and at Altona to only 221 per 100,000 of the population. Where the division between the two towns was only the imaginary line down the centre of a street, and the houses on one side of the street, being in Hamburg, were supplied with the above-town water, and the houses on the other side were supplied by the below-town water, the cholera visited with fatal results the houses on the Hamburg side, while those on the Altona side were free from the disease in this new Passover.

These haggard statistics are to be accounted for only by the fact that the foul sewage-polluted water of the Elbe which was supplied to Altona was carefully filtered, while the comparatively pure water taken above Hamburg for the supply of that town was not. Altona had the protection of the micro-organisms in its sand filters. Hamburg had no such protection, and suffered accordingly.

A similar experience in relation to another water-borne disease—typhoid—has been put on record by the Massachusetts Board of Health. There in twenty years, from 1856 to 1876, the death-rate from typhoid in that State was 8·6 per 10,000 of population; in the years between 1876 and 1895, when private wells had been given up and a public supply of filtered water substituted, the death-rate was only 4·1 per 10,000, and between 1896 and 1899 the death-rate went down to 2·6 per 10,000. The State Board report says:—"The death-rate from typhoid fever has generally fallen as the percentage of the population supplied with public water has risen, for the reason that the majority of the deaths from this disease have occurred among communities and portions of communities not supplied with public water."

But an examination of our own Thames water at Hampton showed there were 1644 micro-organisms in twenty drops of water, and the water, after passing through the sand filters, was found to contain only thirteen such organisms in the same number of drops. The discovery of the 1644 germs was at the time so startling that the shares of one of the water companies dropped in value; and I think these 1600 did valiant duty in the arbitration which had to determine the value of the company's undertakings when they were being transferred to the Water Board.

But notwithstanding these startling vindications of sand filters, the great town of Chicago takes its water from Lake Michigan, which receives the untreated sewage of various towns having in the aggregate a population of more than two million people, and has not thought it necessary to subject its water to any preliminary purification before distribution. That town has, however, with curious inconsistency, diverted its own sewage from the lake, but it has undertaken that sanitary improvement only in connection with the commercial undertaking of the drainage and ship canal.

We know that one of the riddles of the politico-economic platform is, "What is raw material, and what is a manufactured article?" But we have seen sufficient to see that "raw water" is quite a rare commodity, and that most of our waters are manufactured articles. Even eastern countries like China and India have long "doctored" water with alum to get rid of clay by coagulation. But in this country not only do we get rid of the turpidity of water by sedimentation, but we purge the waters of micro-organisms, including pathogenic germs, by storing in large reservoirs, as well as by filtration. Very hard waters, waters containing lime and magnesia, are treated and softened by what is called Clarke's process. Everyone knows that chalk waters fur boilers and kettles, and that the bicarbonate of lime is precipitated by boiling; but Clarke's process consists of a chemical method which expels chalk by chalk, and is an ingenious application of science to the practical purpose of softening water which lengthens the life of boilers and saves soap. But, again, water may be too soft. Hill waters are sometimes too soft to be palatable. Water at Keswick is under half a degree of hardness; Loch Katrine water, 1 degree; Thames and New River water is about 14 degrees.

But it is found that distilled water, or soft lake or river water, acts with extreme rapidity upon lead, and many cases of lead poisoning have occurred in consequence of persons drinking waters which have been in contact with the lead of which distributing pipes are, for the most part, constructed. It has been said that sand filters remove the lead; but at present it is the rule to treat, or "doctor," these very soft waters, as is done at Sheffield, where, to overcome this difficulty, from half to (rarely) three grains of powdered chalk is added to each gallon of water with excellent results. It has been found, too, that loam or clay remove by merely carrying down organic or inorganic impurities from water; and it is certain that the precipitation of lime which takes place in Clarke's process has some effect in the same direction, although, from experiments made by Dr. Percy Frankland in connection with the Cambridge Water Bill of 1910, it does not seem to be a thoroughly effective method of purification. In connection with that Bill, a suggestion was made that suspicious waters—waters drawn from wells in the chalk in close proximity to certain villages—could be made perfectly safe by the chlorination of water; and it was stated that the ozone process which has been adopted in relation to certain waters forming part of the supply to Paris is also a useful and protective process in cases where waters are liable to organic pollution, and in which the danger-signal of bacillus coli is found. These instances are sufficient to show that water, to be potable, must pass through the hands, not only of the engineer with his filter and storage, but also through the hands of the chemist and bacteriologist; in fact, water, unlike the poet, is made, not born.

There is at the present time a good deal of sporadic information as to the water supplies and resources in various localities, and mining engineers have, from their experience, some knowledge of the subsoil or underground waters, for these, of course, are the enemy with which they have to contend in their operations; but there is no general survey to determine what are the supplies and what are the water resources of this country; there is no general knowledge as to the underground water supplies. We know that in many districts these are being pumped for supply; in many where mining is going on they are, with reckless economy, being pumped to waste. But what is required is a comprehensive knowledge both of the overground and underground reserve forces for water supply, and until that is prepared any legislation with regard to water supply must be merely hand to mouth, unscientific, and futile; and this seems to have been the wise opinion of Mr. Lithiby, of the Board of Trade, who gave evidence before the Joint Select Committee on the Water Supplies Protection Bill, which sat and reported during the last session of Parliament.

The necessity for the acquisition of such knowledge is emphasised by the proceedings and report of the Royal Commission which has been inquiring and reporting upon canals and waterways since the year 1906. No one can say that the investigations of that commission have not been exhaustive, although many may think that the reservations of Lord Farrer and three other commissioners seem to show that their labours will prove absolutely futile. But the commission has gone further, and proposes to improve the waterways of England, and great new or improved canals are to connect the Midlands and South Staffordshire with the estuaries of the Thames, the Humber, the Mersey, and the Severn. These four routes, which are, after all, only to be large barge canals, suited for barges of, in one scheme, 100 tons burden, and in another of 300 tons burden, are, in the report, referred to as the "cross," and if this gigantic scheme is carried out at an expense, according to Sir John Wolfe Barry's estimate, of, for the small scheme, 13,393,483*l*., or for the large scheme of 24,513,823*l*., certainly England would be financially crucified. But criticism of that imaginative proposal forms no part of my present purpose. It is only interesting to me to note that after the commission had adumbrated this idea, and ascertained approximately the cost of constructing the "cross," which, as I have said, would be a cross greater than England could bear, they bethought themselves how they were to get water for their canals—in the deplorable absence of the Alps—and they instructed an engineer to survey and inquire and to give them an estimate of the cost of getting the water. I have no doubt he did his work as well as he could. He found ready to his hand the admirable statistics as to rainfall which are collected by Dr. Mills, but complains, rightly enough, that "other questions connected with the national water supplies appear to receive less attention." Of course, it is quite an exception to find anywhere river gaugings, and the engineer in question says:—"This inquiry has shown the necessity, if such problems as those which the following reports attempt to solve are to be thoroughly investigated in future, of some public authority being charged with the duty of recording the flow of rivers, and of the proportion of the rainfall available or run-off in catchment basins overlying different geological strata in various parts of the country."

But this claim to water for canals, which, according to the reporter, would involve an expenditure of 1,194,000*l*., without including the cost of obtaining the power or the cost of water compensation, and is, of course, in addition to the sums estimated for construction by Sir John Wolfe Barry, raises again in an acute form the whole question of our national supplies, and points to the absolute necessity now of some systematic dealing with this great question. The nation is being forestalled by municipalities, and here is a suggestion that a Canal Board should lay a gigantic hand upon some of our sources of supply. The time for dealing with the matter is *now*; but, as in other cases, it is quite likely that the matter will be postponed until it is "too late."

SELF-LUMINOUS NIGHT HAZE.[1]

THERE is one phase of the night skies which does not seem to have received much or any attention. It is the occasional presence of self-luminous haze. This matter does not seem to be similar to the luminous night clouds, "die leuchtenden Nachtwolken," which were observed by O. Jesse and others some twenty-five or thirty years ago, and were found to be clouds at such great altitudes above the earth's surface (upwards of 50 miles high) that they received the sunlight long after or before the ordinary clouds. The observations of O. Jesse were printed in the *Astronomische Nachrichten*, Bd. 121, pp. 73, 111; Bd. 130, p. 425; Bd. 133, p. 131; Bd. 140, p. 161. In *Astronomische Nachrichten*, Bd. 140 (No. 3347), he gives a long list of altitudes, determined by photography, which range from 81 km. to 87 km. The mean value given by the observations from 1885 to 1891 was 82 km. (52 miles). These clouds were seen in the northern hemisphere only near the time of the summer solstice. In the southern hemisphere they were seen at the opposite season. From his papers it is clear that these sunlit clouds were in no way related to the present subject, and I only mention them to forestall any suggestion that they were similar to the ones seen by me.

The objects to be described here were apparently at the altitude of the ordinary higher clouds. They have been seen in all parts of the sky and at all hours of the night. In a paper on the aurora[2] I have previously directed attention to the frequent luminous condition of the sky at night. This feature long ago impressed itself upon me. Indeed, anyone who has spent much time under the open sky hunting comets, &c., will have been forcibly impressed with this peculiarity. In most cases this illumination has been due, evidently, to a diffusion of the general star light, perhaps by moisture in the air. This latter condition is present as a whitening of the sky, which gives it a "milky" appearance. At other times the sky is more or less feebly luminous; but the luminosity is different from the other condition, and is evidently not due to a diffusion of star light. In reality, the sky seems to be self-luminous. Sometimes the whole sky has this appearance, and at other times a large portion only. At times the illumination is so great that the face of an ordinary watch can be read with no other light than that of the sky. It is indeed seldom that the sky is rich and dark. In any determination of the total amount of the light of the sky the results must be uncertain, because of the great changes that so often take place in the amount of the illumination. The self-luminous condition frequently occurs when no ordinary indications of an aurora are present. It is, nevertheless, doubtless of an auroral nature, for Prof. Campbell has shown that the spectrum of the aurora is essentially always present on a clear dark night (*Astrophysical Journal*, 2, August, 1895, p. 162).

I have given an account[3] of the remarkable pulsating clouds of light that are seen here occasionally, which usually, but not always, have an easterly motion—generally south-east. They are mostly confined to the northern half of the heavens. There is another phenomenon that has been visible on a number of nights of last year, and also in the present year, of which I have seen no record. This consists, usually, of long strips of diffused luminous haze. I believe that this is really ordinary haze which for some reason becomes self-luminous. It is not confined to any particular region of the sky nor to any hour of the night. It always has a slow drifting motion among the stars. This motion is comparable with that of the ordinary hazy, streaky clouds that are often seen in the daytime. They are usually straight and diffused, and as much as 50° or more in length and 3° or 4° or more in width. In some cases they are as bright, or nearly as bright, as the average portions of the Milky Way—that is, they are decidedly noticeable when one's attention is directed to them. They apparently are about as transparent as ordinary haze. Sometimes, when seen near the horizon,

[1] From a paper read before the American Philosophical Society on April 21, by Prof. E. E. Barnard.

[2] *Astrophysical Journal*, 31, April, 1910.

[3] *Astrophysical Journal*, 31, April, 1910, p. 210, &c.

where they may be quite broad, they have strongly suggested the "dawn" or glow that precedes a bright moonrise. Their luminosity is uniformly steady.

The reason I refer to this matter as haze, and the reason I think it is only ordinary haze made self-luminous, is because on one occasion I watched a mass of it in the north-western sky which was slowly drifting northerly in the region of the great "dipper" of Ursa Major as daylight came on. These hazy luminous strips had been visible all the latter part of the night—new strips coming and going slowly, sometimes several being seen at once. As daylight killed them out I noticed, when the light had increased sufficiently, that there were strips of ordinary haze exactly the same in form and motion, and occupying the same region of the sky. I am sure they were the same masses that had appeared luminous on the night sky. My impression, therefore, is that these hazy luminous strips were only the ordinary haze which had for some reason become self-luminous. I am specially certain that these masses are not luminous as a result of any great altitude which might bring them within reach of the sun's light, for they were frequently seen in such positions that the sun's rays could never reach them. The sun or moon, therefore, had nothing to do with their illumination. It is also needless to say that they are not related to the pulsating auroral clouds which I have previously mentioned.

I have not noticed this luminous haze in former years, though it may have been present; and did it not seem unreasonable, one might suspect some relation between this condition of the atmosphere and the possible passage of the earth through a portion of the tail of Halley's comet on May 19, 1910.

It seems to me that these objects should be observed and a record made of the times of their visibility and their motion, &c. It would be valuable to have records of them from different stations to see if their luminosity is due to some general condition of the earth's atmosphere at the time. It is not probable that this luminosity is in any way due to local conditions. In the records here given, it is possible that on one or two occasions an aurora was also present, but I have tried to confine the accounts to what I have called, and believe to be, self-luminous haze. They were not seen previous to June 7, 1910.

[Prof. Barnard then gave details of observations made on various dates from June 7, 1910, to March 2, 1911.]

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

An advanced course of instruction on "The Systematic Design and Manufacture of Dynamo-electric Machinery" will be given at the City and Guilds (Engineering) College, South Kensington, during the forthcoming session, under the general supervision of Prof. T. Mather, F.R.S., professor of electrical engineering at the college. The course is to prepare men to take up positions as designers in electrical works. It will deal with present-day problems in design, construction, and testing, in a thoroughly practical manner. An experienced designer and draughtsman, specially engaged for the purpose, will devote his whole time to the drawing-office work in connection with the course. The course is intended for post-graduate and other duly qualified students, the number of which will be strictly limited. Application for admission to the whole course, or parts thereof, should be made by letter to the Dean, City and Guilds (Engineering) College, Exhibition Road, London, S.W.

The President of the Board of Education has appointed a departmental committee to inquire and report—(*a*) Whether it would be inconsistent with due regard to educational and hygienic considerations that the *minimum* standard of playground accommodation for new public elementary schools prescribed in the Building Regulations of the Board of Education—viz. 30 feet per head of accommodation should be modified or adjusted according to the size, design, or situation of schools, the proximity of recreation grounds or open spaces, the density of population, the cost of land, or otherwise. (*b*) How far it is possible or desirable to define more precisely the standard of playground accommodation which the Board of Education will require under the Code of Regulations for Public Elementary Schools in the case of existing schools or to regulate the practice of the Board of Education in dealing with cases in which the playground accommodation is considered to be insufficient. The committee will consist of Mr. L. A. Selby-Bigge, C.B., principal assistant-secretary of the Elementary Education Branch of the Board of Education (chairman); Sir George Newman, chief medical officer of the Board of Education; Mr. J. C. Iles, H.M.I., divisional inspector for the North-western Division; Mr. F. H. B. Dale, H.M.I., divisional inspector for the Metropolitan Division; Mr. A. B. McLachlan, of the Local Government Board; with Mr. L. J. Morison as secretary.

The latest report of the U.S. Commissioner of Education gives some interesting statistics of the so-called land-grant colleges, established under the provisions of the Act of Congress of July 2, 1862, and receiving aid from the Federal Government from funds provided by Acts of Congress of 1890 and 1907. Each State received from the U.S. Treasury during the year ended June 30, 1910, the sum of 8000*l.* for the benefit of these land-grant colleges—commonly called agricultural and mechanical colleges—making a total of 400,000*l.*, exclusive of the sums paid for experiment-station purposes, expended by the Federal Government in aid of these colleges. There are sixty-eight of these institutions, sixteen of which are separate institutions for the coloured race. These colleges are in a period of rapid growth, shown by a marked increase in the number of instructors and students and the value of their property and income. The total number of instructors during the year in all departments of the sixty-eight colleges was 6665, of which 742 were women. The total number of students enrolled for the year was 80,646, an increase of 9·6 per cent. over the preceding year. The total value of the property held for the benefit of these colleges amounts to 23,568,600*l.*, an increase for the year of 910,000*l.* The total income from all sources, excluding the grants for experiment stations, was for the year about 4,180,000*l.*, an increase of some 459,000*l.* during the year.

The "Directory for Higher Education, 1911–12," issued by the Education Committee of the Staffordshire County Council, contains the regulations of the committee and details of schemes in operation throughout the county. Very complete provision is made for technological instruction, and among the subjects catered for the following may be mentioned:—Instruction in mining is provided by means of lecturers, whose whole time is devoted to the work, and their assistants. For this purpose the county is divided into two portions, comprising the North Staffordshire coalfields and the South Staffordshire coalfields respectively. Theoretical and practical classes in metallurgy and iron and steel manufacture are conducted in accordance with the regulations of the Board of Education and the City and Guilds of London Institute. Instruction is also provided in pottery and porcelain manufacture, boot and shoe manufacture, silk manufacture, and in wrought-iron work. In order to enable teachers in elementary and secondary schools to impart instruction in various branches of technical and manual training, the committee provides special classes at convenient centres. In localities where suitable instruction is provided already, classes in approved subjects are recognised by the committee, and with the object of encouraging the attendance of teachers at such classes, grants towards their railway fares are made. The work of the committee in rural districts falls under three heads: instruction directly supplied in special subjects, viz. agriculture, horticulture, hygiene, domestic subjects, and wood-carving and drawing; evening schools taught by local teachers, and earning a grant from the Board of Education; and experimental and demonstration plots.

The Charity Commission has given notice that it proposes to make an order establishing a scheme for the future regulation of the People's Palace in East London. The scheme sets forth that with reference to the administration of the East London College, in connection with the Palace, by the Council, the charity and its endowments shall be administered by a body of governors fifteen in number. Of these the master and clerk of the Drapers' Company shall be two, the Drapers' Company shall nominate six, the Central Governing Body two, the County Council one, and four shall be coopted members. So long as university education is carried on by the Council in the present college premises, the governing body shall grant the use of them at a rent of 1*l.* per year. The scheme goes on to state that the Drapers' Company shall pay to the governing body the sum of 7000*l.* per annum. The company may, however, discontinue such payment on giving notice and, at the expiration of five years, paying for the purpose of the scheme the sum of 30,000*l.* If at the date whereon the payment of 30,000*l.* becomes due university education is being carried on in the present college premises, the money shall be applicable for the future maintenance of the East London College as may be directed by the Board of Education. So long as university education is carried on and the annual payment from the Drapers' Company is received, the amount is to be paid for the purposes of the East London College, and the scheme determines that the part of the endowment of the charity which is held for educational purposes consists of the present college premises, so long as university education is carried on there, the sum of 7000*l.* per annum so long as it is paid by the Drapers' Company or the 30,000*l.* to be paid by the company in the event of the discontinuance of the annual payment. The educational endowment is to be administered under the title of the East London College as a separate educational foundation for the promotion of university education.

WE learn from *The Pioneer Mail* that new buildings of the Poona Agricultural College were opened by Sir George Clarke, the Governor of Bombay, on July 18. The college at present consists of two large buildings, and another is in course of construction. In the main building all work except that relating to chemistry and physics will be done, the smaller one adjoining being devoted solely to these latter subjects. The complete course at the college lasts three years and includes practical farming, general chemistry, botany, agricultural engineering, veterinary science, agricultural climatology, entomology, and so on. During the course of his address Sir George Clarke said there is only one fault in the Bombay Agricultural Department: it is far too small, in comparison with the needs of cultivators and the vast magnitude of the task which it has undertaken. "If I were an Indian politician," he continued, "I should worry Government, in season and out of season, to spend more money upon the improvement of agriculture and the acquisition and spread of knowledge. We require much more research work because the problems of India are her own, and careful investigations carried on in other countries may be valueless in our special conditions. We want more demonstration farms where cultivators can receive an object-lesson by which the advantages of improved methods can be brought home to their minds. I should like to see many more lecturers employed in going about among villages to instil new ideas and to awaken interest. I think we should also establish rural schools where the elements of practical agriculture could be taught in the vernacular. The demands upon the Government are now so many and so insistent that we cannot do all we wish. If the nature and vast importance of agricultural work were more widely known, I am certain that our many wealthy and generous philanthropists would come forward to help. There can be no better proof of patriotism and no better way of promoting prosperity than the increase and development of the production of the land, which lies within our power if adequate means were available."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society.—Prof. J. H. **Poynting**: Small longitudinal material waves accompanying light waves. (Received July 26.)

All experiments on the pressure of light agree in showing that there is a flow of momentum along the beam. This flow is manifested as a force on matter wherever there is a change of medium. When the light is absorbed, the momentum is absorbed by matter. When the beam is shifted parallel to itself there is a torque on the matter effecting the shift. The momentum would therefore appear to be carried by the matter, and not merely by the æther. Though there is an obvious difficulty in accepting this view when the density of the matter is so small as it is in interplanetary space, it appears to be worth while to follow out the consequences of the supposition that the force equivalent to the rate of flow of momentum across a plane perpendicular to a beam of light acts upon the matter bounded by the plane. This rate of flow per square centimetre is equal to the energy density or energy per cubic centimetre in the beam. Of course, in experiments, only the average of the rate of flow during many seconds and the average energy per cubic centimetre in a length of beam of millions of miles is actually measured. But on the electromagnetic theory of light, which suggested the experiments and gives the right value for the pressure, this pressure is equal to the energy density at every point of a single wave.

Let us suppose that we have a train of plane polarised electromagnetic waves of sine form, the magnetic intensity being given by

$$H = H_1 \sin \frac{2\pi}{\lambda}(x - vt),$$

where H_1 is the amplitude of H. The electromagnetic energy per unit volume is $\mu H_1^2/8\pi$, and

$$\frac{\text{Energy in longitudinal waves}}{\text{Electromagnetic energy}} = \frac{\mu H_1^2}{32\pi\rho v^2} = \frac{1}{S}\frac{\mu H_1^2}{S\pi} \Big/ \frac{\rho v^2}{2}$$

which is one-eighth of the electromagnetic energy divided by the energy which the matter would have if it were moving with the velocity of light in that matter.

This shows how infinitesimal is the fraction of the energy of the beam which is located in these waves of compression of the material.

The fraction is proportional to the intensity of the beam.

As an example, take a beam of the intensity of full sunlight just outside the earth's atmosphere, in which the energy flow is about $1{\cdot}4 \times 10^6$ ergs/sec. The energy density $\mu H_1^2/S\pi$ is therefore $1{\cdot}4 \times 10^6 \div v$. Put $v = 3 \times 10^{10}/n$, where n is the refractive index. The fraction is

$$\frac{1}{4} \cdot \frac{1{\cdot}4 \times 10^6}{27 \times 10^{30}} \frac{n^3}{\rho}, \text{ or about } 1{\cdot}25 \times 10^{-26} n^3/\rho.$$

At the surface of the sun it would be about 40,000 times as much; say $5 \times 10^{-22} n^3/\rho$.

It is interesting to note that if a beam of light is incident on any reflecting or absorbing surface, and if the pressure of light is periodic with the waves, it must give rise to ordinary elastic waves in the material of frequency double that of the light waves.

EDINBURGH.

Royal Society, July 14.—Sir William Turner, K.C.B., president, in the chair.—Prof. F. A. **Forel**: Refractions at the surface of a lake, mirages, and *fata morgana*. In discussing mirages and refraction effects over the surface of a lake, one must distinguish between refractions in air over warm water and refractions in air over cold. In the former, with the warm layers below, the curve of refraction is concave upward; in the latter it is convex; and the horizon is, respectively, elevated above and depressed below its normal position. On a summer day, as the temperature of the air changes from being lower to being higher than the temperature of the water, there appears a phenomenon called by the Italian men of science the *fata morgana*. It has the appearance of a series of rectangles, as if some great cliff or the quays of an enormous city extended along the opposite side of the lake. The higher line of this striated zone coincides with the horizon of the refraction over cold water, and the lower line is continuous with the horizon of the refraction over warm water. The *fata morgana* is the fusion of the two types of refractions as the one succeeds the other.—J. Y. **Buchanan**: Experimental researches on the specific gravity and displacement of some saline solutions.

Paris.

Academy of Sciences, July 31.—M. le Général Bassot in the chair.—R. **Radau**: The tables of the moon, based on Delaunay's theory. The solar perturbations of Delaunay, with some additional corrections suggested by Andoyer, may be considered as sufficiently exact from the point of view of practical astronomy, but there is still a lack of agreement with the observed figures as tabulated by Hansen. Means are suggested for further reducing the differences between the observation and calculation.—P. **Villard**: A self-recording electrometer with carbon filaments. A U-shaped carbon lamp filament, carrying a small cylindrical mirror made of a short piece of glass capillary tube silvered inside, forms the moving part of the electrometer. The sensibility of the instrument can be readily modified so as to be suitable either for use in an observatory or in a balloon.—Lecoq **de Boisbaudran** and A. **de Gramont**: The spectrum of gluanum and its bands in different sources of light. The wave lengths of the principal components of three bands (green, blue, and indigo) are given. The general similarity with the corresponding aluminium bands is pointed out.—Édouard **Heckel**: The genus Spermolepis of New Caledonia and its relations with the genus Schizocalyx.—M. **Javelle**: The Wolf comet (1911*a*). Observations made at Nice with the 76 cm. equatorial. Data are given for July 15, 20, 21, 22, 26, 27, 28, and 29. The comet appeared as a feeble nebulosity, about 10 inches in extent, and with a nucleus below the 14th magnitude.—M. **Esmiol**: Observation of the Brooks comet (1911*c*) made at the observatory of Marseilles with the Eichens equatorial of 26 cm. aperture. Data given for July 22. The comet appeared as a round nebulosity, 0·2′ in diameter, with a nucleus of about the 12th magnitude.—M. **Borrelly**: Observations of the Brooks comet (1911*c*) made at the observatory at Marseilles with the comet-finder. Data given for July 22 and 23.—A. **Korn**: An important class of asymmetrical nuclei in the theory of integral equations.—May Sybil **Leslie**: The molecular weight of the thorium emanation. An application of the apparatus used by Debierne (effusion through a small orifice) for the determination of the molecular weight of the radium emanation to the thorium emanation. The results show that the molecular weight of the thorium emanation is in the neighbourhood of 200.—Edm. **van Aubel**: Hall's phenomenon and the transversal thermomagnetic effect in graphite. Graphite shows Hall's phenomenon in the opposite sense to antimony, or in the same sense as pure bismuth, like the other varieties of carbon.—L. **Dunoyer**: Researches on the fluorescence of the vapours of the alkaline metals.—William **Duane**: The mass of the gaseous ions. Under the experimental conditions described in the paper, all the results obtained were opposed to the hypothesis of the existence of positive ions.—J. **Danysz**: The β rays of the radium group. The β rays from the radium emanation have yielded a magnetic spectrum of seven homogeneous bundles, the velocities of which have been exactly determined.—Eugène **Cornec**: The cryoscopic study of some mineral acids and some phenols. The method used consists in neutralising the acid or phenol gradually by a strong base and determining the freezing point for each mixture; the neutral point is indicated by an angular point on the curve.—H. **Pelabon**: The metallography of the selenium-antimony systems. The results obtained confirm the conclusions drawn in an earlier paper from a study of the fusibility curves.—M. **Jouguet**: Indifferent points.—F. **Bodroux** and F. **Taboury**: The action of bromine in presence of aluminium-bromide on cyclohexanol and cyclohexanone.—F. **Bodroux**: The action of anisaldehyde and piperonylaldehyde upon the sodium derivative of benzyl cyanide.—A. **Barillé**: The action of soda water upon lead, tin, and antimony. The causes of poisoning by chemical alteration. More lead and tin are dissolved by soda water from an alloy of tin and lead than from either of the pure metals, and this is true even for an alloy containing only 0·5 per cent. of lead. The author concludes that all the metallic parts of a soda-water siphon ought to be protected by enamel or similar means from contact with the liquid.—Marcel **Badouin**: Study of the action on the brain of the annular deformation of the skull of the Gallo-Roman period.—Maurice **Arthus** and **Bolesława-Stawska**: Poisons and antipoisons. A criticism of the results of experiments by C. J. Martin and T. Cherry, on the interaction of a toxin and antitoxin *in vitro*. The authors' experiments with mixtures of cobra-venom and its antiserum lead to the conclusion that the neutralisation of the venom by the antivenom is practically instantaneous, and rather resembles the neutralisation of an acid by a base than a diastatic action. The same conclusion was arrived at when working with the venom of *Lachesis lanceolatus* and of *Crotalus terrificus* and their corresponding antivenoms.—M. **Mazé**: Researches on the formation of nitrous acid in the plant and animal cell.—Gabriel **Bertrand** and Arthur **Compton**: The influence of the reaction of the medium on the activity of cellase. A new distinction from emulsine.—E. **Voisenet**: A ferment causing bitterness in wine, a dehydrating agent for glycerol. An account of the isolation of a bacillus, capable of transforming glycerol into acrolein.—C. **Levaditi** and S. **Muttermilch**: The diagnosis of sleeping sickness by the examination of the attaching properties of the serum.—Jules **Welsch**: A depression of the Lower Eocene north of Blaye in Cosnac (Charente-Inférieure).

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THURSDAY, AUGUST 24, 1911.

TWO WORKS ON WIRELESS TELEGRAPHY.

(1) *Précis de Télégraphie sans Fil. Complément de l'Ouvrage: les Oscillations Electromagnétiques et la Télégraphie sans Fil.* By Prof. J. Zenneck, Translated from the German by P. Blanchin, G. Guérard and E. Picot. Pp. x + 385. (Paris: Gauthier-Villars, 1911.) Price 12 francs.

(2) *A Handbook of Wireless Telegraphy: its Theory and Practice. For the Use of Electrical Engineers, Students, and Operators.* By Dr. J. Erskine-Murray. Third edition, revised and enlarged. Pp. xvi + 386. (London: Crosby, Lockwood and Son, 1911.) Price 10*s.* 6*d.* net.

(1) THE literature of wireless telegraphy grows apace, both in new books and new editions. This at least is a proof that the art is in a progressive condition. The book by Dr. J. Zenneck before us is a French translation, under the title "Précis de Télégraphie sans Fil," of a work by him which appeared in Germany two years ago, called "Leitfaden der Drahtlosen Telegraphie."

It is, as the author tells us, intended as a condensation and supplement of his larger treatise on "Electrical Oscillations and Wireless Telegraphy," published in 1905. In the present work mathematical discussions have been almost completely avoided, and the reader is referred to other sources for the systematic proofs of the few formulæ given. The book appeals therefore to the general reader or practical worker who wishes for a non-mathematical but scientific discussion of phenomena. The numerous excellent diagrams, curves, arrangements of circuits, and illustrations of apparatus are sufficient to convey to the careful reader a large amount of solid information on the subject. One good feature is that there is no attempt to describe various "systems" of wireless telegraphy by different inventors; but the separate elements which make up the arrangements generally used are scientifically discussed. Beginning with the analysis of the phenomena of oscillations in a condenser circuit and the measurement of the quantities concerned, we have successive chapters on the transformation of oscillations, resonance curves, antennæ, radiators, detectors, receiver circuits, and directive telegraphy.

The treatment for the most part follows orthodox lines as adopted in other standard treatises on the subject, and is characterised by a German thoroughness of treatment, though marked by an occasional tendency to claim for Germany rather more than is historically warrantable. Thus, for instance, the electric hot-wire thermometer figured on p. 66 is attributed to Riess, whereas Sir William Snow Harris first described it in the Philosophical Transactions of the Royal Society in England in 1827, long before Riess. In the same manner, Prof. F. Braun is given credit on p. 161 for the modern coupled transmitter, whether single coil or double coil, which is called "l'émitteur couplé ou émitteur de Braun," although the recent judgment of Mr. Justice Parker in the British High Court of Justice has declared that the modern tuned coupled transmitter first described by Marconi, whether used with a two coil or with an autotransformer, was not anticipated by the inventions of Braun. The double transformation transmitter, the arrangement of which is figured on p. 173, is the invention of this reviewer, whose name, however, is not mentioned in connection with it. The chapters on resonance curves and on antennæ are very good, but that on transmitters might have been improved by a little more attention to the description and theory of impact dischargers, which are of considerable importance.

In discussing the action of directive antennæ, Dr. Zenneck advances a theory—which is not, however, supported in this book by mathematical proof—that the explanation of the greater range of a bent antenna in the direction opposite to that in which the free end points is to be explained by the different shape of the wave surface on the two sides, so that the wave obtains a greater reach one way than the other, just as a rifle when fired carries further if elevated than if depressed. Another explanation has been given by the writer, based on an opinion expressed by Sir J. Larmor, that the bent antenna can be regarded as a combination of closed and open antennæ. This theory receives experimental support from the work of Bellini and Tosi on directive antennæ. One of the most interesting as well as practical questions in connection with long-distance wireless telegraphy is that of the atmospheric absorption and the influence of daylight in reducing the range of transmission for certain wave lengths. This is generally attributed to ionisation of the atmosphere produced by ultra-violet solar light. This solar radiation is, however, so rapidly absorbed by the atmosphere that the chief effect can only be produced at high altitudes. The theory that it is due to the direct action of ultra-violet light on the sending antenna is not supported by any experimental evidence. The hypothesis that it is due to ionisation of the air receives some confirmation from a certain variation of radiotelegraphic range with variations in atmospheric electricity. It is well known to radiotelegraphists that occasionally atmospheric conditions exist in which quite extraordinary and unusual distances are covered by day as well as by night, and that curious differences exist in the facility with which electric waves of large wave length are propagated in different directions.

We cannot say yet that the phenomenon has received adequate explanation, but materials are being slowly gathered which may in time point to an explanation. The same may be said of the abnormal manner in which electromagnetic waves of long wave length travel round the curvature of the earth. Marconi has succeeded in sending and detecting radiotelegraphic waves at a distance of 6000 miles, or a quarter of the way round the earth. The subject of this abnormal diffraction has been discussed mathematically by Poincaré and by Nicholson, but the complexity introduced by the purely atmospheric and surface absorption of the wave makes it almost impossible to check the mathematical theory which has been given.

(2) The second book before us for review is a third edition of Dr. Erskine-Murray's well-known "Handbook of Wireless Telegraphy." The present edition contains a considerable amount of new matter, but the explanations given of fundamental effects, such as the creation of Hertzian waves, are somewhat too brief to be very useful. The student is not much assisted merely by reproducing on a double page Hertz's well-known diagrams of the electric radiation of a dumbbell oscillator accompanied only by an extract from Hertz's own book, and without further elucidation of the difficulties involved. Rather too much space is occupied in some parts by extracts from original papers, whereas the essentially new information could be concentrated and difficulties removed by a more independent authorship.

After the usual introductory chapters dealing with early history, three chapters follow on detectors for electric waves, considerable space being given to the theory of magnetic detectors and descriptions of forms which have not been much used for radiotelegraphy, whilst the contact or rectifying detectors are very briefly treated. With regard to Fleming's glow-lamp detector, the erroneous remark is made that Dr. de Forest "improved this detector." As a matter of fact, his improvements did not enable it to operate better than in its original form. Chapters viii., ix., x., xi., and xiii. are devoted to descriptions of the Marconi, Lodge-Muirhead, Fessenden, Hozier-Brown, de Forest, and Telefunken "systems" of wireless telegraphy. All of them, however, involve essentially the same system, viz. the spark method, and differ only in the details of the apparatus used. A chapter, which is, however, interesting, is given to methods and apparatus which have never reached the practically efficient stage, such as the "world wave telegraphy" described in chapter xviii., in which Tesla's somewhat tentative experiments are discussed. There is no evidence that any useful telegraphic work has been carried out by these methods.

In the chapter on theories of transmission, a large amount of information is collected on the influence of atmospheric states on radiotelegraphic transmission. Facts are being accumulated which seem to connect variations in received signals over long distances with changes in atmospheric electricity. Much work has yet to be done before a satisfactory theory can be evolved, and it is therefore perhaps premature to attempt to construct such theories in text-books issued now. For one thing, we need much more information than we now possess as to the variation in atmospheric conductivity at high elevations, which may some day perhaps be provided by the use of dirigibles or aëroplanes.

Dr. Murray's book concludes with a useful chapter on high-frequency electric measurements and appendices containing many valuable practical tables, curves, and memoranda. The book is well printed and fully illustrated, and certainly one to be included in any radiotelegraphic library. J. A. F.

THE SCIENCE OF SHIPBUILDING.

The Design and Construction of Ships. By Prof. J. H. Biles. Vol. ii., Stability, Resistance, Propulsion, and Oscillations of Ships. Pp. x+428. (London: C. Griffin and Co., Ltd., 1911.) Price 25*s*. net.

THIS second volume was originally intended to complete the work, but the author found his materials growing rapidly and wisely decided to develop more fully in a third volume his treatment of ship-designing. Like the first volume—reviewed in NATURE, February 18, 1909—the second is complete in itself. It will be of much value as a text-book for advanced students of naval architecture, and as a book of reference for men engaged on the practical details of ship-design. The contents are arranged in four sections; in which the stability, resistance, propulsion, and oscillations of ships are discussed. Under each head is presented an excellent *résumé* of the accepted theory of the subjects treated; in association with valuable data, drawn from recent practice, illustrating the characteristics of various types of ships. A mass of information which was previously widely scattered in various publications has thus been concentrated, including published results of the latest experimental research work.

In dealing with the geometric theory of stability the author has naturally followed the lines laid down by M. Charles Dupin in his memoir entitled "Stabilité des Corps Flottants" (published in 1814), one of the series of "Applications de Géometrie" presented to the Institute of France. Dupin for all practical purposes exhausted the subject, although certain corrections and extensions of his generalisations have since been made by other investigators, more especially as the result of determinations by calculation and experiment of the stability of actual ships made during the last forty years. Prof. Biles describes the methods of calculation, as well as the ingenious integrating instruments (devised by Amsler and others) by means of which arithmetic labour has been greatly reduced. Typical examples are given of curves of stability constructed for many classes of ships, and for different conditions of lading; and the whole section has been arranged in a manner which will enable advanced students to master present knowledge of the subject, while draughtsmen and others who are engaged in the work of calculations of stability will find help and guidance.

From the middle of the eighteenth century mathematicians and experimentalists have been attempting general solutions of the problems of water-resistance to the motion of ships, but with moderate success, and with small practical influence on ship-design, until the late William Froude, little more than forty years ago, introduced the system of experiments on models. Froude demonstrated the law of comparison between ships and models moving at "corresponding speeds," and showed how to make the necessary correction for frictional resistance when passing from models to ships. Model experiments are now universally regarded as necessary to successful steamship design, when precedents have to be surpassed or greater speeds obtained. They can be applied both to the determination of the ship-forms most suitable under the conditions of a given problem, and to the selection of the most efficient propellers.

The first experimental tank, designed and built by Froude, was placed at Torquay, near his residence. It was comparatively modest in size and equipment, and was not intended to be permanent; but it continued at work for many years, first under the direction of the founder, and then under that of his son (Mr. R. E. Froude, F.R.S.), and yielded remarkable results, greatly to the benefit of the designs of ships of the Royal Navy. About twenty-seven years ago the Admiralty decided to construct at Haslar (near Portsmouth) a larger and better equipped experimental tank, to the designs of Mr. R. E. Froude, who has happily continued ever since in charge of its operations, and has greatly developed the system. This Admiralty tank has been the pattern adopted for tanks subsequently established in this country by a few leading firms of shipbuilders, and for many tanks established abroad. France, Germany, Russia, Italy, the United States, and Japan have followed the lead; and the latest, largest, and best equipped of the series is that which has been added to the National Physical Laboratory by the generosity of Mr. Yarrow. The primary purpose of that tank is the conduct of systematic experimental research, and great results may confidently be anticipated from its operations. Previous tanks have necessarily been chiefly devoted to experiments on models representing ships which are to be built, and pure research work has had to yield to more pressing requirements. At the same time, it is but fair to recognise the fact that many very valuable results of a general character, influencing the selection of the most suitable ship forms and propellers, have been published already. Mr. R. E. Froude (with the sanction of the Admiralty) has been the principal contributor; but Mr. Taylor, the superintendent of the United States tank, Colonel Rota of the Italian Navy, Prof. Sadler of Michigan University, and others have added to available information. Prof. Biles has summarised and analysed the results of tank experiments in the present volume, and has undertaken the labour of presenting the facts in a condensed and practical form; he has thus rendered a service to all who are interested in the subject.

Closely connected with the resistance experienced by ships in motion is the subject of propulsion, which is treated in the third section of this book in an adequate and practical fashion. Model experiments on propellers have been, and are of great value, but they require to be supplemented by trials on full scale. The author has brought together available data and indicated the need for further information. He states the conditions which chiefly govern the efficiency of screw propellers, and gives details of the methods of designing them. Progressive speed trials of actual ships are described and recommended, and there is universal agreement that such trials are essential to success in the practical application of model experiments. Numerous examples are given of the results obtained from experiments both on ships and models.

The subject of the oscillations of ships in still water and among waves furnished the opportunity for a second great contribution by the elder Froude to the science of naval architecture. His work in this direction really constituted a new departure in ship-design. Much has been learned from experiments both with ships and models since Froude indicated the way, and a great deal has been done towards endowing ships with greater steadiness and limiting their oscillations. This result has been due in part to a better understanding of the problem and partly to the use of bilge keels, moving weights, internal water tanks, and other special arrangements the action of which tends to limit the range of oscillation of ships in a sea way. These arrangements are discussed by Prof. Biles, and the effects produced by their use are illustrated by results observed on board ships when in actual service at sea.

Although this book is primarily intended for the use of students of naval architecture, it will be seen from the foregoing summary of its contents that it deserves a wider circulation. It should, in fact, have an interest not merely for students and naval architects, but be welcomed by mathematicians and others, to whom the subjects treated and the experimental results recorded should offer many attractions. W. H. W.

JURASSIC AND CRETACEOUS STRATIGRAPHY.

Traité de Géologie. By Prof. Emile Haug. Vol. ii., Les Périodes géologiques, fasc. 2. Pp. 929–1396. (Paris: A. Colin, n.d.) Price 10 francs.

THE Jurassic and Cretaceous systems were for long the most popular among British geologists, and the former will always be of special interest as the principles of historical geology were established by William Smith from work on the Jurassic rocks of the south-west of England. The second part of the second volume of Prof. Haug's "Traité de Géologie" is devoted to these two systems, and we are glad to note that he retains the Rhætic in the Jurassic. The work is of great value as a summary of a wide range of recent research, and its excellent photographs illustrating many well-known Continental localities are of unusual artistic merit. The book is a useful complement to the great treatise of de Lapparent, with its invaluable tabular correlations. Prof. Haug gives short, readable summaries of the stratigraphical classification and geographical distribution of the formations, and deals especially fully with the bathymetric conditions of their disposition. Lists of characteristic fossils are given, and he wisely gives only generic names. Exception may be taken to some of his palæontological conclusions, such as the affinity of Tetracidaris to Archæocidaris.

The amount of space devoted to different areas is very uneven. In spite of the historic importance of the English Mesozoic rocks, they receive very scant attention. Thus the list of literature on the Jurassic contains 361 titles, of which only eighteen, including eight by Mr. Buckman and two by Prof. Pavlov, deal with the British Jurassic. He apparently considers that British Jurassic geology has not been kept up to date, and remarks that it is difficult to determine the precise equivalents of the Dorsetshire Kimeridge and Portland beds; he is disposed to adopt the view that the division between Kimeridgian and Portlandian should be drawn through the middle of the Kimeridge clay. The brief reference to the English rocks leaves more space for the account of their Continental representatives, of which a summary of recent work is of most value to British geologists.

The classification of the Cretaceous system adopted by Prof. Haug shows that there is no prospect of agreement as to the nomenclature. He subdivides this system into three groups, the Eocretaceous, all of which he regards as Neocomian; the Mesocretaceous, for the period of the great Cretaceous transgression during the Albian, Cenomanian, and Turonian; and the Neocretaceous, for the upper divisions, all of which he calls Senonian.

Prof. Haug, on the authority of Prof. Cayeux, accepts (p. 1161) the depth of the chalk sea as not more than 150 fathoms. Mr. Jukes-Browne, on the other hand, has recently reasserted the view that parts of the chalk are truly deep-sea deposits. M. Cayeux's low estimate is inadmissible for some zones of the English chalk.

One of the most instructive features of this treatise is its indications as to the progress of opinion on the principles and problems of stratigraphy, which are especially well illustrated by the Mesozoic rocks. Prof. Haug decides in favour of the existence in Jurassic times of well-defined climatic zones. The influence of climate on the distribution of the Jurassic fauna was recognised by Marcou in 1860, and Neumayr in 1883 defined five climatic zones approximately parallel to those of the present day. Several authorities have, however, denied their existence, and Prof. Haug shows that some of the arguments upon which Neumayr based his zones, can no longer be maintained. It would have been very surprising if thirty years' further palæontological research had not modified the known range of some of the fossils. Thus the genera Phylloceras and Lytoceras are less characteristic of the equatorial zone than Neumayr thought, and the distribution of those genera proves to be controlled rather by depth than by climate. There has also been a greater interchange between the faunas of the boreal zone and the north temperate zone in western Europe than was known to Neumayr. Nevertheless, Prof. Haug concludes that the existing evidence confirms the existence of the Jurassic climatic zones, though he retains only the boreal and equatorial zones of Neumayr. The fuller evidence now available enables him to recognise in Upper Jurassic times several well-defined zoological provinces.

The nature of earth movements is a problem of which Prof. Haug's solution greatly affects his views. He adopts a law that subsidence in one locality is compensated by simultaneous elevation in another. Hence transgressions of the sea upon the land are not universal, for while the sea is advancing in some places it is retreating elsewhere. This law is in direct conflict with the principles of Prof. Suess, and though there is no general discussion of the question in the present volume, attention is prominently directed to various instances where the evidence is consistent with Prof. Haug's law. Prof. Haug has prepared a series of maps of the distribution of land and water at various geological dates; their most novel and useful feature is the importance attached to the bathymetric conditions under which the beds were deposited. They, however, show an extreme acceptance of the view so characteristic of much French geology that beds were laid down in existing geosynclinals, and their occurrence in long, narrow bands is due to original distribution and not subsequent denudation. The maps of the world constructed on this principle do not look convincing. Thus Prof. Haug's map of the Jurassic world (p. 1113) represents by far the larger part as land with the seas in the Lower Jurassic limited, except in Europe, to narrow bands. Hence, according to Prof. Haug, instead of the oceans having been permanent throughout geologic time, there were periods with no oceans at all. The same map, moreover, considerably exaggerates the area in western Australia submerged by the middle Jurassic transgressions. Where the ocean waters were stored during the dry intervals is not explained, and the evidence available as to the Jurassic climates renders any such vast excess of land most improbable. Prof. Haug is to be congratulated on the value of this work, of which perhaps the chief drawback is the omission of economic geology.

J. W. G.

PRACTICAL DIETETICS.

Food and Feeding in Health and Disease: a Manual of Practical Dietetics. By Dr. C. Watson. Pp. xvi+638. (Edinburgh and London: Oliver and Boyd, 1910.) Price 10s. 6d. net.

THE subject of food and diets has rightly attracted considerable attention of late. When dealing with a community of individuals—soldiers and sailors, jails, Poor-Law institutions, &c.—fed by the State or by a local authority, it is obvious that a knowledge of the food values, nutritive and calorific, of the articles of diet, may conduce to considerable economy. On the other hand, a mere knowledge of the chemical composition of the food materials is by no means all the information required, for although the requisite chemical elements may be present in the right quantity the material may not be properly assimilated. Thus gelatin is nearly related to protein in elementary chemical composition, but it can only partially replace the latter. The manner in which the material is prepared and served, *i.e.* the art of cookery, also plays a part in nutrition, for a "tasty" dish acts secondarily by increasing appetite and the flow of saliva and gastric juice.

In disease and convalescence it is essential for the well-being of the patient that both the kind and the quantity of his diet should be regulated.

In the present work the whole subject of food and feeding is exhaustively dealt with, both in health and in disease. Starting with the classification of foods, their absorption and digestion, the important question of the daily amount of food required in health is dealt with. The opinion is expressed that Chittenden's dietary, in which the protein content is only one-half to one-third that contained in the ordinary standard dietary, will maintain the body in a satisfactory state of health, and that an ordinary dietary does give some excess which is injurious to health. At the same time, it is recognised that further observations are required before we can accept Chittenden's results as giving a standard for universal application.

Milk and milk products and eggs are next considered, and then animal foods and their composition. The information given is both varied and voluminous; for example, the influence of different breeds of cows on milk production is considered, and the usual Scotch method of cutting up an ox is illustrated. Full tables are given of the composition, constituents, and nutritive values of all foods—flesh, farinaceous, fruit, vegetable, and mineral. The condiments and alcohol are also considered. As regards that vexed question, the use of alcohol, the author expresses the opinion, with which we fully concur, that

"while the use of alcohol in the treatment of disease is now very restricted, there is no question as to its undoubted value in the treatment of certain diseases, more especially in their critical stages. . . . We must recognise that alcohol is a very valuable therapeutic agent in the treatment of some diseased conditions."

The dietetic treatment of disease is treated very fully and completely. Alternative views are stated with fairness and in a broad-minded manner. Not the least valuable parts of the book are the complete cookery recipes which are included; in this respect the work becomes one of very real practical worth and supplies a decided want. For them the author expresses much indebtedness to his wife.

We have read the book with great interest, and can recommend it as a complete and practical epitome for the student of dietetics, and one which should be of much value to every practising physician.

R. T. H.

FOREST MANAGEMENT.

Schlich's Manual of Forestry. By Sir Wm. Schlich, K.C.I.E., F.R.S. Vol. iii., Forest Management. Fourth edition, revised. Pp. x+403. (London: Bradbury, Agnew and Co., Ltd., 1911.) Price 9*s*. net.

THE fourth edition of the third volume of the above "Manual of Forestry" contains somewhat more matter than its predecessor. The volume is divided into four parts, in which the various departments of forest management are dealt with. A strong feature of the new and revised edition is the number of practical examples given to illustrate the use and application of the various formulæ.

Part i. deals with forest mensuration. A concise description of the various measuring instruments is given and also the procedure generally followed and the formulæ used in calculating the volume of single trees and whole woods. Determination of age and increment are also dealt with. This subject is treated of first, as it naturally forms the foundation of forest management and leads up to what follows in the succeeding parts.

Part ii.—forest valuation—is devoted to the consideration of forest capital and the returns yielded therefrom. The author has been very successful in his method of presenting and explaining this difficult and intricate subject to the reader. He starts by analysing the forest value into its several components, such as the forest soil, the growing stock, the forest as a whole, and the rental derivable from the soil or the forest as a whole. In order to deal with this subject fundamentally the author gives a preliminary chapter divided into four sections. Section 1 shows how the value of property is determined; section 2 shows how the rate of interest applicable to the forest industry may be fixed; section 3 contains the formulæ necessary for calculating with compound interest; and section 4 contains an explanation of the methods of estimating receipts and expenses. With these preliminary matters made plain, he proceeds in the next four chapters (occupying twenty-six pages) to deal with valuation of forest soil, growing stock, whole woods or forests, and the determination of the rental of forests. Chapter vi., which concludes this part, treats of the methods of calculating the financial results of forestry. This subject is usually dealt with separately under the heading "Forest Statistics," but it has been here condensed in a perfectly efficient manner into about sixteen pages as a logical appendage to forest valuation.

Part iii.—the foundations of forest management—likewise contains six chapters. A very interesting introduction is prefixed which sets forth the aims and objects of systematic forest management and forest working plans. The succeeding five chapters deal respectively with increment, rotation, normal age, classes, normal growing stock, and normal yield, while in the final chapter the relation between increment, growing stock, and yield is discussed.

Part iv. explains the preparation of forest working plans. This is the direct sequel and outcome of the previous part. In preparing his working plans the forester aims at bringing every part of his woods and forests into a state as near theoretical perfection as possible. His endeavour is to regulate and bring into a normal condition the increment, rotation, age-classes, growing stock, yield, &c. This necessitates an experienced survey and a very critical knowledge of the forest and its environment. The references in this part to pages and chapters of the previous volumes of the manual indicate in themselves that the forester must be thoroughly acquainted with the fundamentals of sylviculture before he can attempt to construct a rational working plan which is possibly the most important, and at the same time difficult, thing to do in the whole art of forestry, but, as has been indicated, the author has so clearly and thoroughly explained the fundamentals that the intricacies of the working plan may be easily understood. At the end of the book are given appendices containing many useful tables, such as tables for measurement, compound interest, and yield, working-plan schedules, and an index.

The author is to be congratulated upon the production of this volume, which can be warmly recommended to all students of forestry, foresters, and forest owners. Its value at present is great, and it will become greater in direct proportion to the spread of scientific forestry training and the extended afforestation of suitable lands in this country.

A. W. B.

THE MECHANICS OF THE SOCIAL BODY.

Mécanique Sociale. By Prof. Sp. C. Haret. Pp. iv+256. (Paris: Gauthier-Villars; Bucarest: Ch. Göbl, 1910.) Price 5 francs.

THIS volume represents an attempt by Prof. Haret to apply the laws and methods of mechanics to the study of sociology. The condition of an individual at any point of time, he argues, may be conceived as indicated (at least, in its principal aspects) by the magnitudes of three different factors—his economic possessions, his intellectual state, and his moral state. Supposing these three quantities to be measurable, the condition of the given individual at the given time can be represented by the coordinates of a point P, with reference to three rectangular axes OX, OY, OZ, which define his position in the "social space." If these coordinates do not change, the individual is in a state of "social rest"; when they vary, he is in a state of "social movement." Any cause which may produce or vary a social movement is termed a "social force," and any such force may be represented by a vector in the social space. Two individuals are said to possess the same "social mass" when the same social force, applied for the same time, produces the same movement. With such definitions, it is argued, all the ordinary laws of statics and dynamics apply.

That the idea is a novel one, possessing some attractiveness, we are willing to concede. The scheme of coordinates chosen also emphasises the fact, occasionally forgotten in some statistical investigations, that economic, moral, and intellectual changes are not (to use the common phrase) on the same plane, and index-numbers which measure changes in such diverse quantities should not be averaged together. But that the laws of mechanics apply to a system of material points representing, in the way described, the condition of a given population, does not seem to be proved.

The very difficulty that would surely occur to almost any reader at the commencement is ignored, and this, it seems to the reviewer, is the source of all subsequent difficulties. The three axes chosen do not represent quantities of the same kind or dimensions, but quantities quite different in kind. The mere representation of movement in the "social space," the magnitudes and directions of velocities and accelerations, will all depend on the three arbitrary scales chosen. Forces parallel to the three axes do not differ merely in direction but in kind: we cannot speak of forces which are equal in magnitude but different in direction until the three scales are defined. That the ratio of the masses of two individuals is not the same for all forces is admitted: for a given force in one direction the acceleration produced in A may be greater than that produced in B; for a force in another direction the contrary may be the case. The "economic," "moral," and "intellectual masses" of the individual are, in fact, like "economic," "moral," and "intellectual forces," totally different things. Prof. Haret proposes to evade the difficulty by regarding the forces as varying instead of the masses, but this is surely inadmissible. If A and B move, say, with the same accelerations when subjected to the same economic force, but with different accelerations when subjected to the same moral force, it is impossible to say that one and the same force is, in the latter case, different for the two individuals merely in order to avoid admitting that their "masses" are different.

It is with regret that the reviewer finds himself unable to accept the author's thesis, for undeniably it possesses a certain picturesque suggestiveness. Economic forces, for example, are often of a more or less periodic character, and seem to be accompanied by moral forces which are also periodic. If these got a quarter of a period out of phase with each other, the social body would start revolving round its intellectual axis . . . What would happen? G. U. Y.

THE GUM-TREES OF AUSTRALIA.

A Critical Revision of the Genus Eucalyptus. By J. H. Maiden. Vol ii., part i.–part xi., of the complete work. Pp. iv+59+iv plates. Vol. ii., part ii–part xii of the complete work. Pp. iii+61–100+iv plates. Published by authority of the Government of the State of New South Wales. (Sydney: W. A. Gullick, Government Printer, 1910.) Price 2s. 6d. each part.

THE first part of this comprehensive work was issued in 1903, and it is wholly devoted to the description and illustration of *Eucalyptus pilularis*. Parts two and three appeared in the same year, each dealing with only one species, *E. obliqua* and *E. calycogona* respectively. When reviewing those early parts, each of which contains four plates of figures, we ventured to suggest that Mr. Maiden had commenced with a fullness of detail that might imperil the completion of the work, considering that the genus comprises many more than a hundred species. Two species, *E. incrassata* and *E. foecunda*, are described in the fourth part (1904), and illustrated by no fewer than twelve plates. At this rate the probabilities of completion seemed to be exceedingly remote, and the author apparently realised the fact, for succeeding parts have included successively a greater number of species; parts one and two of the second volume containing ten species each, illustrated by four plates.

It is almost superfluous to mention that the genus Eucalyptus is the most important commercially in the vegetation of Australia, and its elucidation is correspondingly desirable. Some of the species are very abundant and widely dispersed, whilst others are very rare and local, and consequently liable to extinction.

At least two other botanists—Bentham and Mueller—have dealt with the whole genus before Maiden took up the work, and Mueller also possessed field knowledge. But one generation of botanists by no means mastered all the details of classification of this difficult genus. Mr. Maiden has the advantage of the results of the investigations of his predecessors, and he has fully availed himself of it, even to the extent of visiting Europe to study the types of the species described by the earlier botanists. The value of his classification can only be estimated after the practical use of it in the determination of new material. The figures in the parts under review are mostly of leaves attached to a small piece of the axis, detached inflorescences, and mature seed-vessels, the originals of all the figures being carefully recorded.

It may be mentioned, however, that the same author's "Forest Flora of New South Wales," so far as issued, contains figures of thirty-eight species of Eucalyptus, figures of larger branches, in flower and fruit, thus supplementing those of the "Revision." Of the latter, fifty-six plates have been published, illustrating fifty-nine species. Details of the economic value and the popular names are fully given only in the forest flora. The usefulness of Mr. Maiden's important work must remain comparatively limited until its completion; therefore any acceleration in its publication would be welcome. But it is to be feared that the author's arduous duties as director of the Sydney Botanic Garden and State botanist leave him little time for original research. Since the foregoing was written we have heard from the author that he had been laid up for two months and was only slowly recovering from a severe surgical operation.

W. Botting Hemsley.

AIRMEN AND AVIATION.

The Aeroplane, Past, Present, and Future. By C. Grahame-White and Harry Harper. Pp. xv+319. (London: T. Werner Laurie, 1911.) Price 15*s.* net.

THIS is one of those books which may be classed as ephemeral—that is to say, it is written for to-day and only for to-day; to-morrow it will be obsolete. The title is misleading, for throughout the book there is no general description of the machine or explanation of the principles of its actions. It is a curious circumstance that, although purporting to be written by a well-known aviator and a journalist who has specialised in the subject, yet out of the fourteen chapters which the book contains no fewer than ten of them are put down to the authorship of other writers.

The three anonymous chapters on "Flights and Records," "The World's Airmen," and "Aeroplane Fatalities" are but amplified lists such as may have been culled from the daily papers, and are already becoming somewhat out-of-date. A short chapter on "The Fascination of Flying" is presumably by Mr. Grahame-White, and gives a pleasant sketch of reminiscences.

Of the other chapters, that by Colonel Capper on "The Aeroplane in Warfare" is probably quite the most important; but this, of course, cannot be more than a series of suggestions. Although not new, it may be of interest to note that Colonel Capper firmly believes that the systematic use of aeroplanes "may revolutionise the tactics of the battlefield," but he wisely adds that in order to obtain such important results "no haphazard aggregation of individual machines and pilots, on the outbreak of war, can be relied on."

Mr. Howard T. Wright's chapter on "The Power Unit of Aeroplanes" records in simple language many interesting facts concerning engines and propellers. Mr. Henry Farman writes on "The Constructional Future of Aeroplanes," in which he says: "Personally, judging from what I know of the possibilities of the situation, I estimate that the maximum speed which will be reached during the year 1911 will be 150 kilometres an hour." We have not arrived at this yet, but there is time. Mr. Roger Wallace summarises some points on "Aerial Law." The chapter on "Sporting and Commercial Possibilities of the Aeroplane," by Louis Blériot, is somewhat disappointing, as is the "Future of Flying," by Louis Paulhan.

While the book is readable and interesting, it tells us little that is new or really instructive. Throughout it gives one the idea of having been rapidly put together and hurriedly produced, without careful planning or proper supervision. There is a profusion of excellent illustrations from photographs; in fact, there seem almost too many, since some of them, such as that of "Captain Dickson describing an aerial reconnoitring trip," might well have been omitted.

OUR BOOK SHELF.

La Haute-Loire et le Haut-Vivarais. Guide du Touriste, du Naturaliste, et de l'Archéologue. By Marcellin Boule. Pp. viii+366. (Paris: Masson et Cie., 1911.) Price 4.50 francs.

In our own islands we have few guide-books precisely of the type of those edited by M. Boule. Praeger's guide to County Down comes first to mind, a book in which scientific considerations associate themselves with the choice of summer quarters and hotels. M. Boule has had the help of specialists in the description of the flora, commerce, archæology, and inhabitants of the picturesque region of which he treats; but the routes by road or footpath are known to him as a geologist, and he rightly loves the contrasts of "les froides et tristes planèzes vellaves" and the "chaudes et riantes vallées vivaraises." He points out the perfectly preserved craters of the chain of the Velay, piled above a fissure sixty kilometres in length, which broke through an upland of old granite, and the fantastic relics of earlier eruptions, like those on which St. Michel d'Aiguilhe and the high castle of Polignac stand. The country is certainly one for lovers of the unusual and the remote. Roman traditions remained in the municipal government of Le Puy down into the fourteenth century (p. 115), and the struggle of the commonwealth against the prince-bishops, who were supported by the kings of France, was as stubborn as the basaltic theatre in which the tragedy was played.

Le Puy, one of the most romantic towns in Europe, forms the natural centre for the district; but M. Boule guides us into the gorges of the Allier, where the railway forms in places the only foothold, and eastward across the broad volcanic upland, set with columnar "orgues," until we reach at Le Cheylard the rivers running to the Rhone. The upland itself has something fascinating, something not quite realised among the *burrons* of Auvergne. Fay-le-frnid, in the grey light of a summer dawn, seems remote enough from the pulse of France all round it. The author, aided by well-chosen views, shows us how the volcanic masses have controlled the higher features of the landscapes, and how the Loire stream-system has cut through the lava-flows, while, on the side of the Allier, lavas of the same age have descended into a pre-existing waterway (p. 326). Full justice is done to the phonolitic mass of the Mézenc, explored by Faujas de Saint-Fond in the middle of the eighteenth century (p. 294). We miss the name of this great investigator from the bibliography on p. 14, although Scrope's work in 1827 is mentioned. The users of this guide will become such good geologists that they will surely like to turn the pages of Saint-Fond's admirable folio. It may be hoped that M. Boule will send many lovers of unspoiled country to the strange and broken slopes of the Cevennes. "J'ai composé ce guide," he writes, "avec un rare plaisir." He has transferred this pleasure to the reader.

G. A. J. C.

The Pronunciation of English by Foreigners: a Course of Lectures to the Students of Norham Hall on the Physiology of Speech. By Dr. Geo. J. Burch, F.R.S. Pp. x+110. (Oxford: Alden and Co., Ltd.; London: Simpkin, Marshall and Co., Ltd., 1911.) Price 3*s*. net.

THIS is a delightful book. Works on phonetics are usually dry and uninteresting except to those who are willing to face the technical difficulties of the subject. But Dr. Burch, who is well known in other departments of science, invests the discussion with both wit and humour, while, here and there, he gives an amusing anecdote which is always appropriate and telling. He deals with the difficulties experienced by foreigners in catching the correct pronunciation of some of the sounds of the English language. The book is founded on lectures delivered at Norham Hall, Oxford, to foreign women students, and during the past ten years or so Dr. Burch has kept records of the chief difficulties in the pronunciation of 1305 persons of many different nationalities. He gives an excellent, although a short, account of the general mechanism of speech, and minutely describes the movements necessary for the articulation of the speech sounds of consonants, diphthongs, and vowels. There are also excellent remarks on the breathing apparatus.

It would seem that individuals of different nationalities have different methods of using their nervous and muscular mechanisms for articulate speech, so that if one wishes to reproduce the sound in any given language, one must learn how to train the articulating mechanism so as to obtain the required result. Dr. Burch gives minute directions, and it would seem that his system of teaching the correct tones of English to foreigners has had conspicuous success.

"During these ten years I have been greatly struck by the excellent pronunciation of the majority of those attending these courses. If I could speak those languages with which I am familiar with as good an accent as mine is spoken by them, I should have every reason to be proud. But this excellence has made a severer critic of me." (P. 59.)

Excellent, however, as the description of the movements of the tongue and other organs may be to guide the student in reproducing a given sound, an appeal to the ear is all-important, and those are fortunate who have had the instruction communicated by Dr. Burch's own living voice. We feel sure that if anyone takes up this little book he will not find it dry and wearisome, as its title might indicate. It is full of interesting information supplied by one who is an experienced and versatile teacher.

JOHN G. MCKENDRICK.

Praxis der Linsenoptik in einfachen Versuchen zur Erläuterung und Prüfung optischer Instrumente. By Dr. W. Volkmann. Pp. vii+176. (Berlin: Gebrüder Borntraeger, 1910.) Price 3.50 marks.

THIS little book is one of a series composing a "Bibliothek für naturwissenschaftliche Praxis," in which the object of each volume is to provide an introduction to some branch of practical science by means of simple experiments which can be carried out with inexpensive and easily constructed apparatus. The optical equipment here described consists of some half-dozen lenses of different focal lengths, a number of simple wooden stands, some clips and lens-carriers, diaphragms, and screen, with a spirit lamp and strip of gas-mantle to serve as light source. Even with these simple means it is, of course, easy to arrange an interesting and instructive series of experiments to illustrate the properties of lenses and the formation and defects of optical images. With a pinhole and some fine gauze, one can go further, and study effects due to the fact that light is a wave motion. With but little increased expenditure the range of such experiments could readily be extended; but the apparatus described is sufficient to enable practical acquaintance to be made with nearly all the main defects of optical instruments: spherical aberration, astigmatism, coma, distortion, and chromatic aberration can all be examined, and even the theory of resolving power can be studied. The book concludes with chapters on the photographic lens, the magnifying glass, the microscope, and the telescope, in which application is made of the experimental knowledge acquired to the examination of the characteristics of a well-designed optical instrument.

To follow out the course of experiments here suggested would no doubt be for an intelligent lad an excellent introduction to the study of optics, and, though the book is not designed for school use, the German schoolmaster might find in it useful hints in experimental science teaching. For the English reader, however, it has no special interest; it shows no exceptional ingenuity in the devising of experiments, and, from its aim, novelty is not to be expected, nor, perhaps, desired.

Rhododendrons and Azaleas. By Wm. Watson. Pp. xi+116. "Present-day Gardening" Series, edited by R. Hooper Pearson. (London and Edinburgh: T. C. and E. C. Jack, n.d.) Price 1*s*. 6*d*. net.

THERE are certain prevailing ideas with regard to the constitution and requirements of rhododendrons which are only partially correct that have tended to restrict their cultivation. Thus the necessity for peat in the soil is an exploded assumption, although the presence of lime must be recognised as an effectual bar to success. Then again the tenderness of many attractive species is only too obvious, but it is fortunately possible to obtain hybrids of a more hardy character. Further, it may be mentioned that no good popular book on rhododendrons is extant; therefore the present work is eminently desirable, and the publishers are fortunate in securing the services of an author who is an ardent enthusiast, and is also thoroughly conversant with the different classes of rhododendrons and their special features. The classification in itself is tolerably complex. Botanists recognise a single genus which includes the true evergreen rhododendrons, a small group of Indian azaleas, also evergreen—comprising *R. indicum* and its allies—and deciduous azaleas or swamp honeysuckles of North America. The true rhododendron species are best developed in China, while Himalayan species, owing their prominence to Sir Joseph Hooker, are a favourite but tender group, and the North American contingent are valuable on account of their more hardy nature. The explanation of the various hybrids is difficult, and calls for the special knowledge possessed by the author. Famous collections, cultural directions, and a list of species make up the contents of a volume which every gardener—save perhaps the dweller on limestone—should purchase and study.

The Practical Flower Garden. By Helena R. Ely. Pp. xiii+304. (New York: The Macmillan Co., London; Macmillan and Co., Ltd., 1911.) Price 8*s.* 6*d.* net.

IF the descriptions of experience and garden stock presented by Mrs. H. R. Ely may be accepted as a trustworthy exposition of garden practice in the eastern States of North America, we are justified in assuming that there is very little difference between the methods pursued and the plants cultivated on the two sides of the Atlantic. We had anticipated that there would be at any rate very marked differences in the trees and shrubs; also that certain herbaceous plants would be better suited to the more extreme conditions prevailing in the States, whereas with few exceptions, such as Boltonia and Baptisia, all the border perennials mentioned in the author's lists are offered in any British horticulturist's catalogue; of the climbers or vines, *Dolichos japonicus* and *Vitis labrusca* are rarely grown in English gardens.

The reader who is searching for useful hints is likely to be rewarded by a perusal of the advice regarding fertilisers and plant remedies, although the pronounced commendation of a fertiliser of unknown composition passing under the name of Bon Arbor is tantalising if not savouring of quackery. It should also be noted that the author, like every good horticulturist, has a favourite specific, which in her case is bone-meal, especially for Delphiniums. Advice is offered on the subjects of colour-schemes and the making of lawns, but a more original note is struck in the account of a garden prepared for the growth—not cultivation—of indigenous plants. It may be conjectured that Mrs. Ely does not claim to be a botanist, as certain inexactitudes are apparent, although the only flagrant mistake is in the misuse of the term "annual."

A Short History of Ethics: Greek and Modern. By R. A. P. Rogers. Pp. xxii+303. (London: Macmillan and Co., Ltd., 1911.) Price 3*s.* 6*d.* net.

A USEFUL historical survey, chiefly descriptive but partly critical. The author's primary object is to give a short and accurate description of the leading Greek ethical systems and of those systems which represent the best type of modern philosophic ethics, from Hobbes to the end of the nineteenth century; secondarily, to show, by criticism and comparison, the connecting links between systems and the movements of thought by which new systems arise. Some familiar names are omitted, where the type of thought has already been illustrated by other thinkers; *e.g.* Reid is represented by Butler, and the French empiricists by Hume. Such recent systems as those of Wundt, Paulsen, Nietzsche, and the pragmatists are also omitted. The systems most lengthily considered are those of Plato, Aristotle, Epicurus, the Stoics, Hobbes, Butler, Hume, Kant, the German idealists culminating in Hegel, and the English utilitarians through Bentham, Mill, Spencer, and Sidgwick to T. H. Green, whose doctrine specially commands the author's admiration.

The book is well written, in commendably judicial tone throughout. It makes a modest claim—calling itself short and elementary—but those students who thoroughly master it will have obtained an excellent and more than elementary introduction to the subject.

LETTERS TO THE EDITOR.

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

The Forest of Auchnacarry.

THE letter in NATURE of June 1 would come as a shock to foresters throughout the world. It states that the Scotch pines at Auchnacarry are perhaps the largest and finest fragment that is left to us of the primæval Caledonian forest. In area about 1500 acres, the forest contains trees 200 to 300 years old of huge size, up to 6 feet in diameter. The scenery of the forest is of great beauty, and, save for a few isolated clumps, is all that we know to remain of the great forest of Scotch pine that once spread over all suitable ground in central Scotland. The writer also remarks that nothing is left so noble, so extensive, so worthy of preservation as this doomed forest of Lochiel's at Auchnacarry.

The photograph is striking. It is difficult to believe that forest such as this was once in the place of desolate and dreary bogland such as the Moor of Rannoch. But it was no farther back than Napoleon's time that the great forest of Rannoch was cut down and turned into the dreary waste of to-day!

Surely there is here a strong case—the strongest possible case—for the Development Commissioners! We read that they have 500,000*l.* yearly for five years, and this year an extra vote of 400,000*l.* in addition; and that a portion of their funds is to be devoted to forestry "by the purchase and planting of land."

The distant view is sometimes the clearest. To the man at a distance it is as clear as daylight that, whatever may be done for minor objects, this forest of Auchnacarry, this unique national monument, should be acquired for the country at any cost.

Italy has done much since it became a nation, but it has, perhaps unavoidably, neglected much. The most patriotic Italian will at once admit that Italy has neglected its forestry. Japan does more forestry in a week than Italy in many years! Yet Italy has nationalised the remains of its Apennine forests at Camaldole and Vallombrosa. Here are giant silver-firs not to be surpassed by any on this globe. And these most beautiful forests remain as national monuments ever pointing the way towards national regeneration, the restoration of the dreary and ruined Apennines to the beauty, the fertility, and the value of past days.

Spain is preserving the remnants of its ancient forests; Portugal is guarding them jealously. Is British forestry to sink to the level of Chinese? Surely, cost what it may, this remnant of the primæval Caledonian forest should be nationalised and preserved.

There is one important point to remember. The Italians, the Spaniards, and the Portuguese can replant and restore their national forests whenever they are strong enough as nations to do it. But these northern forests in Scotland and Sweden, near the limits of tree growth, can be restored only with extreme difficulty, if at all, when once they are destroyed. They seem to be the product of conditions that have passed away, or perhaps of geological time. Witness the Moor of Rannoch and many forests in northern Sweden. When once they have passed into bog and the great draining action of the trees has been removed, their restoration to forests seems nearly impossible at any practical expenditure. With forest near its climatic limits, this is the case in other lands and other climes.

D. E. HUTCHINS.
(Late Chief Cons. Forests B.E. Africa.)
Kenilworth, near Cape Town, July 20.

The Drought and the Birds.

As a rule, water has been left in my garden for the wild birds, and they have taken full advantage of the opportunity for bathing and drinking.

On Monday, however, a hen blackbird rather surprised me. The hose was working in a shady spot. Her ladyship came near, with great caution, to drink some of the drops from the grass. Having quenched her thirst, she got under the sprinkler for a shower bath. Being disturbed she flew away, but came back for a second bath, and later for a third.

This morning she returned, apparently for another bath, waited a considerable time, but as no water was forthcoming flew away.

To me this is quite a novelty; possibly other readers have had similar experience. CHARLIE WOODS.

"Vectis," 2 Wellmeadow Road, Lewisham, S.E., August 16.

A HANDBOOK OF BURMA.[1]

WITH the conspicuous exception of Japan, scarcely a country has been more written about, in proportion to the extent to which it has been visited, than Burma; yet we are in agreement with the publishers of this book, that there is room for one of the character prepared by Sir George Scott. The etherealised visions of Fielding are fascinating reading, but give a very inadequate impression of the reality, and the ordinary book of travel is unsatisfying and inaccurate; yet between these and ponderous tomes, of which the weight and bulk make them unportable and repellent to all but the serious student, we have had no book which would give the visitor to Burma an idea of the history, administration, and sociology of the Burmese and other races, or of the aspect and productions of the country itself.

In his preface, Sir George Scott disarms criticism. After stating that the sections of Mr. Oates on the fauna, of Captain Gage on the flora, of Mr. Bruce on the forests, of Mr. Richard on means of transport, and of Mr. Mariano on music could only be excelled by those who might have larger space allowed them, he goes on to say that it is certain that the book can be greatly improved, and expresses a hope that his critics and the public will write to show how this can be done, rather than indulge in mere carping and fault-finding. Yet it is hardly possible to suggest improvements without indicating faults, and in reading through the book there seems to us to be three conspicuous faults or possible improvements, according to the point of view.

First, we must regret that the course adopted for the flora, fauna, and other special subjects was not followed in the case of the geology; secondly, we suggest the provision of a more satisfactory map of Burma than the very poor little effort which the publishers have provided; and, thirdly, the omission of the word commercial on the cover of the book. The title-page describes the work merely as a "handbook of practical information"; on the cover this becomes "practical commercial and political information," but there can be little commercial value in statements based on statistics of no later year than 1905, and the deficiency in the case of Burma is especially striking, for the petroleum industry has been so revolutionised in the last three or four years that the description on p. 240 represents a condition of things which has passed away, and in the section devoted to agriculture no mention is made of the ground-nut, which, within the last few years, has risen to importance as a crop in upper Burma and an article of export from Rangoon.

A Sawbwa paying Call. From "Burma: a Handbook of Practical Information."

For the rest we must perforce agree with the author that the book can be improved, for nothing human is perfect, but with this reservation we confess that the margin for improvement seems very small. It is not merely the best book in existence on Burma, but as nearly an ideal book as is conceivable for the purpose it is intended to fulfil. For the traveller or the intending resident, who wishes to have an intelligent appreciation of what he will see and come in contact with,

[1] "Burma: a Handbook of Practical Information." By Sir J. George Scott, K.C.I.E. New and Revised Edition. Pp. x+520. (London: Alexander Moring, Ltd., 1911.) Price 10s. 6d. net.

it will be an admirable companion, and even the resident of many years' standing cannot fail to find explanation of much that he has not understood before, and have his attention directed to many things which he had previously failed to notice.

PLAGUE IN ENGLAND.[1]

THE recent appearance of plague in East Suffolk forms the subject of some valuable reports and papers recently issued by the medical department of the Local Government Board. The reports are divided into three sections, each of which deals with the plague from different aspects. The first section contains the late Dr. Bulstrode's "report upon the occurrence, in the autumn of 1910, of four deaths at Freston, near Ipswich, from a rapidly fatal and infectious malady diagnosed as pneumonic plague, and upon the prevalence of plague in rodents in Suffolk and Essex." It also includes his report upon two localised outbreaks of disease in East Suffolk in 1909–10 and 1906–7, which may have been instances of bubonic and pneumonic plague respectively." The second section records the results of an inquiry by Drs. Martin and Roland, in the months of November and December, 1910, into rat plague in East Anglia, with special reference to the fleas infesting rodents; and the third section gives a report by Drs. Petrie and Macalister "upon the examination of rats collected in Suffolk and Essex for plague-infection between January 16 and February 14, 1911."

The information in the volume, though not sufficient to fix the exact origin of the Freston outbreak, cr the avenues by which the other two outbreaks spread, is nevertheless very complete so far as the facts could be traced. The great loss which the medical department of the Local Government Board has sustained by the death of Dr. Bulstrode is impressed upon one when perusing his able report on the investigations which he made on the plague. Like all his former work, it is characterised by care, thoroughness, and good judgment.

It appears that between September 16 and September 29 there occurred in a four-roomed cottage in Freston three deaths. Daughter, mother, and father in a family of six succumbed to an obscure lung affection after a few days' illness. In a cottage a quarter of a mile away there also died on September 29 a woman with the same symptoms. She had nursed the mother, and had evidently caught the infection from her. The main features of the illness were the obscurity of the lung symptoms, the dark-stained expectoration, the high temperature, the great prostration, and the rapidly fatal issue in about three days without any corresponding serious physical signs to account for it. In three out of the four cases vomiting and purging were present. The anomalous character of the symptoms, the nature of which puzzled the medical men attending the cases, led to a bacteriological examination being made by Dr. Heath, the honorary bacteriologist to the Ipswich and East Suffolk Hospital, who found in the specimens and cultures a bacillus corresponding in its reaction and appearance with those of the plague bacillus. The illness was then recognised as pneumonic plague, which is well known for its infectivity and fatality.

No direct evidence could be obtained as to the manner in which the daughter, a child of seven years of age, who was first attacked, had become infected, but the inquiry as to the source of infection led to the important discovery that an epizootic affecting rats and hares was prevailing in the district. Bacteriological examination of a number of rats, hares, a cat, and a ferret showed them to be plague-infected, and accordingly afforded opportunities for human infection. There was evidence also that the epizootic among rats extended so far back as 1906. In that year a large number of dead rats had been observed at Shottley and its neighbourhood, about four miles distant from Freston. It was here that a sudden and fatal illness had occurred in December, 1906, in a poor family, and had extended to those who nursed the sick. Eight persons were attacked with what appeared at the time to be a virulent form of influenza, and six of these died after three to four days' illness.

Another outbreak of a puzzling character occurred in December, 1909, and January, 1910, at Frimley, on the north bank of the Orwell, and almost opposite Shottley. It was in a two-roomed cottage occupied by a family of seven in poor circumstances. The whole of the family was successively attacked by an illness unfamiliar to the medical men, and in some cases associated with glandular enlargements. Four of the family died and three recovered. One of the family went to stay with a friend for a few days, and subsequently the child of the friend was fatally attacked with similar symptoms. Dr. Bulstrode concludes from his investigation of the Frimley outbreak that, "although there are, from lack of full information, many lacunæ in the story, the balance of evidence certainly seems in favour of a view that the malady was bubonic and septicæmic plague."

It is an instructive story, and shows that in England as in other countries plague can be overlooked both in human beings and in the lower animals. It is evident that the infection of plague has existed in this part of the country for the past four years, introduced probably by infected rats in grain ships arriving from infected ports.

Drs. Petrie and Macalister's work is valuable in demonstrating that out of 6071 rats examined from the districts immediately surrounding those proved to be infected, all were of the *Mus decumanus* variety, and none were found to be infected with plague. It is to be hoped that the Government will continue this good work in the autumn and in the coming years, for it by no means follows that the rat plague-infections which, as has been shown by Drs. Martin and Roland, occur in pockets, have been all discovered, even with this large number of examinations.

The investigations of Drs. Martin and Roland have demonstrated some interesting facts relative to the rat-flea population. It appears that the rat-flea of India, *Xenopsylla cheopis,* could not be found on any of the rats examined; that more than 50 per cent. of the rat-fleas in East Suffolk consisted of the *Ctenophthalmus agyrtes*, which evidently does not bite men, and that the remainder of the rat-flea population is composed of *Ceratophyllus fasciatus*, which bites man, but not so readily as does *Xenopsylla cheopis.* These facts are cheering so far as they go, as it is estimated that on an average there is less than half a man-biting flea for a rat. It would be reassuring if it were proved that the flea was the only method by which human plague spreads, and if the history of the three outbreaks pointed in that direction. Unfortunately, two of them appear to have been of the pneumonic variety, and the third septicæmic and bubonic in character. The evidence so far scarcely lends itself to the view that the comparative freedom of the rat from man-biting fleas will secure safety from plague in England. Dr. Newsholme recognises the dangers from this aspect of the question, and the warning given by him and the late Dr. Bulstrode as to the necessity for vigilance is timely and none too strong. The

[1] Reports and Papers on Suspected Cases of Human Plague in East Suffolk and on an Epizootic of Plague in Rodents. Reports to the Local Government Board on Public Health and Medical Subjects. New Series, No. 52. (1911.)

optimism which leads to the relaxation of sustained effort in dealing with a plague epizootic is most dangerous.

The one important fact is that the plague-infection has gained a lodgment in this country after an absence of nearly 250 years, and the only safe course to be pursued is to prevent the rat-infection from becoming endemic. Nothing is to be gathered from the fact that only a few human cases have occurred in four years in a sparsely populated locality. This is the ordinary behaviour of plague in new localities in this pandemic. Because no human epidemic happens quickly the impression is produced that the country is immune. In London in the seventeenth century there were in seventy years only four severe epidemics, and for fifteen years before the great plague of London in 1665 there was only on an average fourteen plague deaths per year in the metropolis. It is well not to place too much reliance on the different conditions existing in the seventeenth century and now. In the former period the general sanitary conditions were undoubtedly much worse than they are at present, but we have the very poor, and more of them, still with us in our slums, and they still live in an overcrowded state, with none too much light or sanitation in their houses.

W. J. SIMPSON.

THE NUTRITIVE VALUE OF BREAD.[1]

DR. HAMILL has presented an admirable report, free in every way from prejudice, which will long serve as an authoritative statement on the somewhat vexed question of the nutritive value of bread. The account summarises the scientific and technical information at present available, and clearly indicates the complexity of the problem. Previous writers on this subject, when not biassed by commercial considerations, have as a rule dealt with the question from a restricted point of view, but this report in no way suffers in this respect.

The first section deals with the classes of wheat flour, and Dr. Hamill is careful to define the technical terms used, which are usually grossly misused by popular writers on the subject. The contention that nutritive flour cannot be made in roller mills is once for all disposed of, and the advocates of the stone mill are reminded that the hard foreign wheats with brittle skins, such as form the great bulk of the wheat grown in western America, cannot be satisfactorily milled between stones. A very much greater degree of separation can be obtained in the more complicated process of roller milling, and there is no reason for a return to stone mills even if this were possible economically. With regard to colour, patent grade flours, which are the whitest, have better baking qualities than households, and therefore command a higher price—the report, however, overlooks the fact that the colour of bread depends more on the "strength" of the flour used than on its colour in the dry state.

The second section, which is supplemented by much valuable tabular matter, summarises all that is known as to the nutritive value deduced from chemical analysis of various milling products and bread made from them. Much of the experimental work quoted has been done by the United States Department of Agriculture. It is to be hoped that now that this question has received so much notice in this country, the Local Government Board will itself initiate experimental work on some of the lines indicated by Dr. Hamill; indeed, the report contains analyses of various milling products made by Dr. Monier-Williams in the Local Government Board laboratories. Valuable as these are, it is now necessary to go somewhat deeper into the matter than the simple determination of elemental composition.

In a valuable section headed physiological considerations, it is shown that many of the opinions so confidently expressed in public by such bodies as the Bread Reform League are certainly untenable, whilst upon other points our knowledge is still too uncertain to enable a definite statement to be made. Highly erroneous is the notion that high-grade white patent flour is practically devoid of nitrogenous constituents—actually the very opposite is the case, and, other things being equal, a diet which consists wholly of bread would possess greater advantages in this respect when made from strong wheats. The degree to which bread is acted upon by the digestive juices, and the extent to which the products of digestion are absorbed and assimilated, are problems requiring further investigation, and although much has already been done this only serves to indicate the complexity of the subject and to show how many factors must be taken into account. The evidence available is given in full in the report.

Much has been written about the digestibility of bran. Results are quoted which indicate that the presence of branny particles, even when very finely divided, affects the digestibility of bread. It was found by Goodfellow, for example, that when milk is taken with wholemeal bread 3 per cent. less milk was digested than when the milk was taken alone. It is probable for this reason that the large class of wholemeal breads, sold to the public at an enhanced price, are inferior to white bread excepting when they are taken for definite medicinal reasons.

Regarding the whole question from a common-sense point of view, it is a fact that the differences in nutritive value between various grades of flour made from the same wheat are insignificant when compared with the differences between flours made from different wheats. So long as Britain derives its flour from all over the world this last question is the paramount one. The big millers are so skilful in blending wheats that the flour supply of the large towns is practically uniform in quality throughout the year.

The questions of germ and mineral requirements are fully discussed, and it is admitted that the knowledge of the latter point is still very imperfect. Here, however, Dr. Hamill ventures to draw a conclusion which will be disputed by many, namely, that to ensure as large a supply of minerals as possible it is advisable to substitute very finely ground entire wheat bread for a portion of the white bread in the diet of growing children.

He qualifies this subsequently by admitting that when bread is supplemented by other foods, such as are present in an ordinary mixed diet, the advantage which one kind of bread may possess over another becomes negligible. Many children whose food consists largely of bread do not get enough of it, and are underfed in respect of all the essential nutritive substances. It is better in such cases to increase the amount of bread taken rather than to substitute another form of bread, and still better to supplement the bread by other materials such as milk, which contains a substantial quantity of the nutritive materials lacking in bread. The effect of bread on the teeth is fully discussed: the differences between different kinds of bread in this respect would appear to be negligible. This again is a direct contradiction of recent assertions.

The preparation and properties of the so-called standard flour and bread are described at some length,

[1] Dr. J. M. Hamill's Report to the Local Government Board on the Nutritive Value of Bread made from Different Varieties of Wheat Flour. Pp. 53. (Published by H.M. Stationery Office.) [Cd. 5831.] Price 3*d*.

and it is made quite clear that standardisation of flour is impossible. Analyses made by Dr. Monier-Williams are quoted to show that the differences in protein and mineral matter between the standard flours and the household flours obtained from the same wheat are very small. These analyses should serve once for all to disprove the absurd claims made for standard bread by the Bread Reform League and other food reformers. According to Dr. Hamill, "entire" wheat flours do, however, possess additional constituents due to the presence of branny particles and germ which appear to have a value of their own in nutrition. Whilst the evidence on this point is as yet of the slenderest, it is sufficiently sponsored not to be lightly dismissed, and further experimental work is urgently needed.

Sufficient has been said to show that the report gives a very faithful summary of the present position of the subject, and it should remain authoritative until new experimental facts cause an extension of our knowledge of the obscure points. It is at all events clear that our bread supply is the best available, and that legislative action is not required.

THE INTERNATIONAL COMMITTEE OF WEIGHTS AND MEASURES.[1]

THE most interesting part of the account lately published of the proceedings of the International Committee of Weights and Measures at their recent meeting at Sèvres is the information given respecting the work of the International Bureau of Weights and Measures during the last two years. Among the researches conducted at the Bureau may be mentioned an investigation of the suitability of vitreous quartz (fused silica) for metrological purposes, which was undertaken at the instance of Sir David Gill. Although the specimens experimented upon admitted of being ground and polished with facility, it was found quite impossible to engrave on them lines of permanent shape and sufficiently fine to serve as the defining marks of standards of length. Similar negative results had been obtained at the National Physical Laboratory by Dr. Kaye, who has, however, devised a method of obtaining perfectly satisfactory defining lines by depositing a layer of platinum on the silica and engraving the lines on the platinum.

The high price of platinum has led to investigations being made with the view of finding a suitable substitute for this metal in the construction of standard weights. Tantalum, which resists all the strong mineral acids except hydrofluoric acid, has been found to satisfy the necessary requirements of permanence and hardness, and it is suggested that a series of standard weights of 100 grammes made of this metal should be established for use in chemical research. Their cost would probably not be more than one-third that of iridio-platinum standards.

Dr. Stratton, of the United States Bureau of Standards, who is a member of the International Committee, communicated the results of investigations on the spectrum of neon. These tend to show that the yellow radiation of neon of wave-length 5852 tenth metres is much superior to the red radiation of cadmium as a unit for interferential measurements. Neon is also much more convenient to employ, as it does not require preliminary heating to a high temperature; it has a longer life, is less subject to accidents, is more brilliant, and requires much less attention on the part of the observer. Dr. Stratton proposes to make use of this radiation in a new determination of the length of the metre.

[1] Comité International des Poids et Mesures. Procès Verbaux des Séances. Deuxième série, tome vi. Session de 1911. Pp. vii+247. (Paris: Gauthier-Villars, 1911.)

The president of the International Committee, Dr. Foerster, invited particular attention to the important question of end measures of length. It was decided to address a circular letter to the various bureaus of standards requesting information as to their practice in regard to these standards, and describing certain patterns which the International Bureau regard as suitable for general adoption in the interests of uniformity. The patterns include three types of standards, viz., cylindrical plug gauges for measuring small thicknesses, end bars of 12 mm. diameter with spherical caps, for greater lengths, and plane-parallel blocks or plates for either the greater or smaller dimensions. The method of comparing end measures which was first employed by Airy some sixty years ago in connection with the reconstruction of the Imperial Standard Yard, has recently been tried at the Bureau, and has been found to give very satisfactory results. The verification of a series of gauges with plane ends, made by the Swedish firm Johansson, has demonstrated the extraordinary degree of accuracy which can be attained in the construction of gauges of this form.

There are several important appendices to the Procès Verbaux. The first, by Drs. Benoît and Guillaume, is an account of recent experiments with invar measuring wires. The growing popularity of these wires for geodetic operations, and the consequent demand for their verification and re-verification, have necessitated an immense number of comparisons at the Bureau, and the experience thus obtained has admitted of definite conclusions being arrived at as to how far the lengths of these wires under standard conditions can be regarded as permanent. The investigations show that in general the wires, when manipulated with the care usual in geodetic work, retain their original lengths well within one part in a million. Where greater deviations were found to occur they could in general be accounted for either by the small graduated scales at the ends of the wire having become in the course of use slightly displaced from their true tangential directions, or else by the wire having been used in regions bordering on the tropics, where it would be exposed to quite abnormal temperatures.

In the second appendix Dr. Guillaume describes a comparator designed by him for rapidly testing both line measures and end measures. The instrument, which was destined for use in the Chinese weights and measures service, in which both the metric and the native systems are recognised, was constructed to admit of measurements in both these systems to a degree of accuracy of nearly 0·01 millimetre. A simplified form of this comparator, intended for use in testing metric measures only, has also been designed by Dr. Guillaume, and promises to be a convenient apparatus for making rapid comparisons with a fairly high degree of accuracy. A measuring machine suitable for use in manufactories for checking workshop standards or for general purposes is also described by Dr. Guillaume (appendix 3).

The flexure of the 4-metre geodetic standard at the Bureau has been determined. This measure, which is made of invar, has a section of the **H**-form, the outside dimensions of which are about 4 centimetres. The results of the observations on this bar exhibited remarkable agreement with the calculated values based on the Euler-Bernoulli theory of the deflection of elastic beams (appendix 4).

The fifth appendix deals with the recent progress of the metric system of weights and measures. On January 1 last Bulgaria joined the Metric Convention, raising the number of contracting States to twenty-five. The metric carat of 200 milligrams has, up to the present, received express legal sanction in nine

European States, as well as in Japan; while in Germany, with the tacit consent of the Government, it has been adopted by the industries concerned. In eight or nine other countries the use of the metric carat is permissible, but other carats are not prohibited. Early in 1908 some of the principal diamond merchants in the United Kingdom were approached by the Board of Trade with the view of ascertaining whether the trade were prepared to adopt the metric carat. The replies received were mainly unfavourable to this project. It would be interesting to learn whether the fact that the metric carat is now generally recognised abroad has had any effect in modifying the views of the trade in this country on the subject.

Tome xv. of the Travaux et Mémoires of the Bureau is being rapidly prepared for the press. It will contain an account of the investigations by MM. Benoit, Fabry, and Perot on the determination of the metre in terms of wave-lengths of light, and an article by Dr. Guillaume on the recent progress of the metric system. If space permits, a memoir on end measures of length will also be included.

AUSTRALIAN ZOOLOGY.[1]

It is a somewhat humiliating reflection for British zoologists that such an important and prosperous part of the British Empire as the Australian Commonwealth should have to depend so largely upon German enterprise for the investigation of the native fauna. It is, of course, true that a vast amount of good work has been done by naturalists resident in Australia, and by British scientific expeditions, and as regards the vertebrates, we perhaps already have a fairly complete knowledge of the Australian fauna.

So far as the invertebrates are concerned, however, the work seems to be little more than begun. The Australian Museum at Sydney has published in the "Records" and "Memoirs" numerous important contributions to our knowledge of special groups, and also the results of various collecting expeditions, which deal with more extensive sections of the invertebrate fauna. We remember also that the late Sir Frederick McCoy published several volumes of a prodromus of the Australian fauna, in which many invertebrates were excellently figured, but the series came to an untimely end. The late Mr. Bracebridge Wilson, again, made extensive collections of marine invertebrates in the neighbourhood of Port Phillip, but a portion only of these has ever been properly investigated. Individual workers, whose names are well known in the scientific world, have made most valuable contributions to our knowledge of special groups, such as the Sponges, Hydrozoa, Polyzoa, Earthworms, Land Planarians, Mollusca, Crustacea, Onychophora, Insecta, and Arachnida. One might almost say, however, that although a good many mouthfuls have been taken (especially in the plummiest parts), Australian zoologists have not as yet developed a sufficiently keen appetite to make any very serious combined attack upon the invertebrate pudding as a whole. This is by no means altogether their fault, for it is useless for men of science to devote their lives to laborious investigations—and those of a kind which brings but little credit except amongst a narrow circle of specialists—if there is not sufficient financial support forthcoming to publish the results in a satisfactory manner, to say nothing of paying the investigators. Even the greatest enthusiasm is soon damped for want of appreciation.

It is here that our German colleagues, with their usual thoroughness, are again leading the way. The Hamburg expedition to South-West Australia in 1905 must have reaped a rich harvest, and the results are now being given to the scientific world in a series of handsome and copiously illustrated volumes which do great credit to authors and publishers alike, and far excel any attempts which have been made for many years past to deal with the Australian fauna. The third volume is now in progress, and we have before us Lieferungen vi.–x. In these parts Dr. Carl Graf Attems deals with the Myriapods (excluding Scolopendridæ); Prof. Kieffer describes the Serphidæ and Evaniidæ; Ester Lager the Phyllopods; and Dr. Hentschel continues his account of the Tetraxonid Sponges. We notice that all the illustrations in these parts are text-figures, evidently reproduced by some photographic process, and the results obtained appear to be on the whole quite satisfactory. They are doubtless comparatively inexpensive, but from the artistic point of view they cannot be considered as equal to good lithographic work. This is more especially evident in the case of the sponge spicules.

It is, of course, quite impossible to notice such a work as this in any detail. We may say, however, that the volumes will be absolutely indispensable to future investigators of the Australian fauna, and we venture to hope that they will serve as a stimulus to the numerous British naturalists in Australia to continue their own excellent work in the same systematic and thorough manner.

[1] "Die Fauna Südwest-Australiens. Ergebnisse der Hamburger südwest-australischen Forschungsreise 1905." Herausgegeben von Prof. W. Michaelsen und Dr. K. Hartmeyer. Band iii., Lieferung 6–10; Lief. 6, "Myriapoda exkl. Scolopendridæ," von Dr. Carl G. Attems; Lief. 7, "Serphidæ und Evaniidæ," von Prof. J. J. Kieffer; Lief. 8, "Actiniaria," von E. Lager; Lief. 9, "Phyllopoda," von Dr. E. Wolf; Lief. 10, "Tetraxonida," 2 Teil, von Dr. E. Hentschel. Pp. 147–393. (Jena: Gustav Fischer, 1911.) Price 18 marks.

PROF. W. SPRING.

As already announced, Prof. W. Spring, professor of chemistry in the University of Liège, died on July 17, in his sixty-third year; by his death Belgium has lost one of her foremost men of science, and physical chemistry has been deprived of an eminent investigator.

From the point of view of British chemists and metallurgists, the work of Spring has been to some extent hidden by being published almost entirely in the proceedings of the Royal Belgian Academy, so that only the more striking results of his work have become generally known. Thus Spring's name is principally associated with his work on the effect of high pressures upon chemical combination and upon the welding of particles of metals and alloys. The progress of our knowledge of physical chemistry generally, and that of metals particularly, has made us very familiar with the idea and the phenomena of diffusion in solid bodies, even at temperatures far below their fusion-point, but the researches of Spring were among the earliest to give actual data on such phenomena. Thus Spring showed in 1894 that carefully surfaced pieces of copper and zinc placed in contact in vacuo became welded together, and that at the interface a layer of yellow alloy was formed. It was not until 1896 that the late Sir William Roberts-Austen published his own classic work on the interdiffusion of solid lead and gold. Spring's work on the effect of pressure in bringing about chemical reactions between finely-powdered bodies also tended to demonstrate the molecular mobility of solids.

Perhaps the best-known work of Spring was that in which he showed what he believed to be the formation of actual alloys by the action of high-pressures upon mixtures of the pure metals in powder form. His experiments were very striking, and showed clearly that by compressing metallic powders, solid blocks of metal could be produced, and he showed further that this was accomplished without any fusion of the metal under pressure. The fact that the resulting masses were true alloys he sought to demonstrate by showing that, if the metallic powders were correctly proportioned, the resulting metal showed the low melting-points of fusible alloys and eutectics. Unfortunately the aid of the microscope was not called in for the study of these "alloys," and, indeed, the greater portion of Spring's researches were carried out before the modern methods of metallography were available, but it has since been shown that the compressed masses of solid metal produced by Spring consisted of the practically unaltered particles of the original powder, simply welded together under the action of the pressure, but without the formation of those structural constituents of the corresponding true alloys. The low melting-points of such mixtures must be attributed to local action at the boundaries of the constituents and the rapid diffusion following the appearance of liquid metal at these points. Although, therefore, Spring's original conclusions were not entirely confirmed by subsequent research, his work has borne much fruit; his demonstration of the possibility of extruding bismuth in the form of thin wire shed new light on the whole question of brittleness and plasticity, and has largely contributed to the development of the modern processes of extruding metals and alloys for industrial purposes.

Spring's activities were not confined to the physical chemistry of metals, however, but extended to researches on the colour of sky and water and on colloidal solutions—to mention only a few of the other sides of his work. It is even claimed for Spring by his friends that in his researches on turbid media he anticipated the "ultra-microscope" in principle to such an extent that the apparatus he describes differs from that now in use only in regard to the power of the microscope employed.

The sum-total of the late Prof. Spring's researches constitute a monument of a life of intense scientific activity, and it may be hoped that these researches may now be gathered together so as to make them more readily accessible, and thus to secure for them the full recognition which they deserve.

NOTES.

THE German Emperor has conferred upon Sir William Ramsay, K.C.B., F.R.S., president-elect of the British Association, the order "Pour le Mérite."

WE notice with regret the announcement of the death, on August 18, at eighty years of age, of Mr. S. H. Burbury, F.R.S., distinguished by his work in mathematical physics, especially in the theories of electricity and magnetism and the kinetic theory of gases.

A REUTER message from St. Petersburg states that the Minister of the Interior has prohibited for the year 1911 the trade in marmots along the Eastern Chinese Railway, and also the forwarding of marmot skins, flesh, and fat by rail. This measure has been taken as a precaution against pneumonic plague.

THE divisions of vertebrate and invertebrate palæontology and palæobotany in the U.S. National Museum have been combined, we learn from *Science*, into a new division of palæontology, with Dr. R. S. Bassler as curator in charge, Mr. J. W. Gidley as assistant curator of fossil mammals, and Mr. C. W. Gilmore as assistant curator of fossil reptiles.

IT is officially announced that the Governor of British Guiana has reported the adoption, as from August 1, of maritime time, which is standard time four hours slow on Greenwich time. The same standard time has been adopted in the island of Granada, as from July 1, the effect being to put back the local time of that colony by seven minutes.

IT is surprising at the present day, when the system of time-reckoning by reference to standard meridians is being adopted throughout the civilised world, that the city of Canterbury seems determined to maintain its own local time. The Dean and Chapter, in mediæval spirit, refuse to recognise any such "modern innovation" as Greenwich time, and have recently distributed cards intimating that the time observed in Canterbury Cathedral is 4½ minutes ahead of Greenwich time. The post-office and railway clocks are kept to Greenwich time, and the others anywhere between that and the cathedral clock. The resulting confusion has induced Mr. A. Lander, of 17 High Street, Canterbury, scientific instrument maker, and secretary of the East Kent Natural History Society, to make an electric clock which is kept to standard time by means of the wireless time signal from the Eiffel Tower. The first of the three time signals is received on Môrse tape travelling at the rate of half an inch per second, and the half-minute contacts of the electric clock are also recorded on the same tape, so that the rate of the clock can be accurately determined. The second signal is utilised to correct the pendulum of the master clock, and the third signal is again received on the tape to show that the clock is exactly correct. This master clock works a number of clocks and instruments on Mr. Lander's premises, such as a rain-gauge, sunshine recorder, barograph, and also a large dial in the shop window, and drops a time-ball exactly at each standard hour.

THE twenty-second annual general meeting of the members of the Institution of Mining Engineers will be held at Cardiff on Wednesday, September 13, under the presidency of Dr. J. B. Simpson. The following papers will be read, or taken as read:—the reduction, control, and collection of coal-dust in mines, S. Mavor; a rope-driven coal-cutter, W. Maurice. A number of papers which have already appeared in the Transactions of the institution will also be open for discussion.

THE death has occurred, in his seventy-second year, of Dr. J. P. Schweitzer, who was connected with the University of Missouri from 1872 to 1906 as professor first of chemistry and later of agricultural chemistry. He was a native of Berlin, and after studying at Göttingen was for a time assistant to Heinrich Rose at Berlin. He went to America in 1865, and held posts at the polytechnic institute of Philadelphia and the Columbia School of Mines before receiving his Missouri appointment.

A REMARKABLE crystal of aquamarine was described by Dr. G. F. Kunz before the New York Academy of Sciences on April 3. It was discovered by a miner on March 28, 1910, in a pegmatite vein at Marambaya, near Arassuahy, on the Jequitinhonha River, in Minas Geraes, Brazil. Its colour was greenish-blue, its form a slightly irregular hexagonal prism terminated at both ends by flat basal planes, its length 48·5 cm. and width from 40 to 42 cm., and its weight 110·5 kg., and its transparency was so perfect that it could be seen through from end to end. It is estimated that 200,000 carats of aquamarines of various sizes could be cut from it.

MR. J. ALLAN THOMSON, who has been appointed palæontologist to the Geological Survey of New Zealand, was the first New Zealand Rhodes scholar at Oxford, where he was also Burdett-Coutts scholar. He received his university training in geology and palæontology both in New Zealand and at Oxford, but for the last five years or so his work has been mainly in the direction of petrology. The New Zealand Geological Survey possesses more than one hundred thousand fossils from various horizons, but little appears to have been done hitherto to describe them or to make them available for study. It is hoped that now the survey has appointed a palæontologist on its staff the specimens will be properly described and arranged.

AT the 1909 meeting of the International Mathematical Congress, held at Rome, the subject of mathematical teaching was brought forward, and upon the initiative of Prof. D. E. Smith, U.S.A., it was decided to form an International Commission on the Teaching of Mathematics, this commission to report to the next triennial meeting of the congress, which will be held at Cambridge (England) in 1912. The commission will meet at Milan on September 18–20 of this year to take stock of the work done so far. As regards the United Kingdom, the work of collecting and issuing reports has been taken up by the Board of Education, which has appointed as delegates Sir George Greenhill, Prof. E. W. Hobson, and Mr. C. Godfrey. A number of reports have already been issued (Wyman, price 3*d.* each), and when the international series is complete it will form the most valuable collection of material at present available for the use of teachers of mathematics. The central committee consists of Prof. F. Klein (Göttingen), Sir G. Greenhill (London), and M. H. Fehr (Geneva).

IT is announced in *Science* that the Nantucket Maria Mitchell Association offers an astronomical fellowship of 200*l.* to a woman, for the year beginning June 15, 1912. The year will be divided into two periods. June 15 to December 15 will be spent on Nantucket, where the observatory is equipped with a five-inch Alvan Clark telescope, and this period will be occupied in observation, research, or study, and in lectures or instruction. February 1 to June 15, 1913, will be spent at one of the larger observatories, and the time occupied in original research and study. Every fourth year the fellowship will be available during the entire year for study at one of the larger observatories in Europe or America. The fellowship will be awarded annually, but in order that the work at Nantucket may be combined advantageously with the work at the selected observatory, the preference will be given to the same candidate for three successive years. A competitive examination will not be held. The candidate must present evidence of qualifications, giving an account of previous educational opportunities and training, and of plans for future work, as well as examples of work already accomplished. Application for the year beginning June 15, 1912, should be made, before March 1, 1912, to Mrs. Charles S. Hinchman, 3635 Chestnut Street, Philadelphia, Pa., from whom full particulars can be obtained.

THE long drought has been brought to a termination, and the excessive temperature which has continued with such persistence over England has given place to more normal conditions. The anticyclone which has so long been centred over our islands and their immediate neighbourhood has given way to shallow cyclonic disturbances which have arrived over us from the Atlantic. At Greenwich there was no rain from August 2 to August 18, and the aggregate fall from July 1 to August 18 was 0·32 inch, which fell on four days. Copious rains have, however, now fallen over London, and on three successive evenings, August 19, 20, and 21, sharp thunderstorms were experienced. On August 22 the highest temperature in London was 68°, which is the lowest maximum reading since July 2, a period of more than seven weeks. The disturbances which occasioned the recent thunderstorms over England were moving away to the eastward of our islands, and an anticyclone, centred in the Atlantic, was extending to our area. This change in the general conditions is likely to occasion a return of the fine weather with a gradual increase of temperature, although it is improbable that the temperature will be so high as that recently experienced. The summary of the weather for the week ending August 19 issued by the Meteorological Office shows that the mean temperature for the period was from 6° to 7° in excess of the normal over the entire kingdom, except in the north and east of Scotland and in the north-east of England; the excess of temperature, however, was not so great as in the preceding week.

MR. D. E. HUTCHINS, Chief Conservator of Forests, British East Africa, after ten years' forest service in India, twenty-three in South Africa, and four in Equatorial Africa, has now retired on pension. It fell to his lot both in South Africa and in Equatorial Africa to demarcate and arrest the further destruction of large areas of the beautiful extra-tropical forest that extends with but little change from the extreme south of Africa along the eastern highlands to the equator. As the latitude decreases the altitude increases. The forest that occurs at sea-level in the Knysna district of the Cape, at 3000, 4000, and 5000 feet in Natal and the Transvaal, is seen at an elevation of 7000 to 10,000 feet under the equator. The distribution of this forest is governed by the topography and rainfall of the highlands. There are wide gaps in its extension along the highlands. As one goes north, it changes somewhat in species, though but little in character. It is seen at its best on the equatorial highlands in what is now British and German East Africa. Here the trees grow with greater vigour than in the south, and the forest is enriched by the addition of a very valuable timber, the pencil cedar of Abyssinia (*Juniperus procera*). The preservation of this forest is of national importance to Africa, especially to extra-tropical Africa, the White Man's heritage; for it is a forest resembling that of the Nilgiri Shola forest of India, a forest with a dense couvert and slow-growing—the ideal water-holding forest. As a fact, it is a forest from which streams of water flow on every side, perennial streams that feed the rivers when they are most wanted. The future of this forest is assured in South Africa, the bad forestry of Natal having happily come to an end with Union. The Germans are preserving it carefully in German East Africa, no forest of this class having been alienated since 1900. But in British East Africa there hangs out a danger signal! The Colonial Office will have to see that its forest policy there is duly upheld. There is a danger that settlement, so right and necessary, in a new country may be pushed too far, to the ruin of the most valuable public assets of the country—its water and timber. Settlement is obviously the first requisite; but settlement must not be allowed to touch an acre of highland forest in a country where the forest area is only 1½ per cent. of the total area, and that is the position in British East Africa.

A SPECIAL "tuberculosis" number of the Bulletin of the Johns Hopkins Hospital has been issued (vol. xxii., No. 245). The principal article is on stereoscopic X-ray examination of the chest, with special reference to the diagnosis of pulmonary tuberculosis, by Drs. Dunham, Boardman, and Wolman. It is illustrated with three excellent stereoscopic views of the condition present in three cases of pulmonary tuberculosis.

Writing from Chinanfu, Shantung, China, Mr. Alfred Tingle refers to a statement made in a note in Nature (June 8, p. 493) that "rice in China takes the place of wheat with us as the chief source of starchy food," and points out that in Shantung rice is little used, other cereals being substituted, and that the diet is a liberal one. The statement, of course, was only a general one; and obviously in a country so huge as China, with climates varying from tropical to almost Arctic, the diet in different districts must be equally variable.

In a paper on the chemical differentiation of species, Miss Muriel Wheldale suggests that the presence of particular chemical compounds in plants may be of value either in the differentiation of, or in accentuating resemblances between, orders, families, genera, or even species. Thus the glucoside "aucubine" was first isolated from *Aucuba japonica* (Cornaceæ), and subsequently from seven species of Garrya, another genus of the Cornaceæ. It is also stated to be present in various species of Plantago (Plantaginaceæ). It would be interesting to discover if there are other connecting links between these two groups. Some of the purins are known only in the genus Thea (*Bio-Chemical Journal*, v., 1911, No. 10, p. 445).

In his report on the Giza Zoological Gardens for 1910 Captain Stanley Flower states that the number of visitors continues to show a gratifying increase, and that the number of animals, other than fishes, in the collection is larger than in any previous year, comprising at the annual stock-taking 1464 specimens, referable to 391 species. Among the more important additions were a rhinoceros and a Blue Nile elephant.

In *The Field* of August 12 Mr. R. I. Pocock illustrates the different ways in which the Indian and the African elephant use the tip of their trunks. In the former, some small object, such as a handful of bran, is held by the tip of the trunk being bent on itself, so that the object is squeezed between the tip and the lower surface of the trunk, whereas in the latter the object is held between the two lips of the trunk-tip, much after the fashion in which fruit is placed in a cornucopiæ.

The recorder of Section D (Zoology) of the British Association sends us the following provisional programme of the section for the forthcoming meeting at Portsmouth:—Presidential address, Prof. D'Arcy W. Thompson. *Discussions:* On the origin of the Mammalia, Prof. G. Elliot Smith, Dr. C. W. Andrews, Prof. A. Keith, and Dr. Marett Tims; on Wallace's line, C. Tate Regan and Guy Marshall; on the systematic position of the cyclostomes, Dr. Woodland, Prof. Dendy, and E. S. Goodrich; on the nutrition of marine organisms, Dr. Dakin, Prof. Herdman, Prof. Gamble, and Prof. V. H. Blackman. *Lectures* (with illustrations): Mr. F. Enock, on fairy flies; Dr. C. W. Andrews, on the extinct reptiles of the Oxford Clay of Peterborough. *Papers:* Recent advances in sex problems, G. Smith; some points in the anatomy of Squilla, Dr. Woodland; new species of Balanus collected by the *Siboga* in the Malay Archipelago, Dr. P. P. C. Hoek; a new epizoic hydroid on a copepod (n.g.+n.sp.) parasitic on *Scopelus glacialis*, Prof. H. Jungersen; note on the manus of a young Indian elephant, Prof. R. J. Anderson; some points in the manus and pes of Primates, Prof. R. J. Anderson; on the effect of Sacculina on the fat metabolism of its host, G. C. Robson; notes on a trypanosome found in a sheep tick, and its probable connection with the disease known as louping-ill, Major C. F. Bishop, R.A.; on the dorsal vibratile organ of the rockling (Motella), Dr. J. Stuart Thomson; momentum in evolution, Prof. Dendy; Polytrema and its allies, Prof. S. J. Hickson; the life-history and metamorphosis of Murænoids, Dr. J. Schmidt (Copenhagen); le cycle animal des glandes génitales de l'*Echinocardium cordatum*, Prof. Caullery (Paris); the hypostome and antennæ in a reconstructed trilobite (Calymene), Prof. Malcolm Laurie; (1) the vernal-plumage changes in the adolescent blackbird (*Turdus merula*) and their correlation with sexual maturity; (2) case of a remarkable egg of *Falco tinnunculus* laid in remarkable circumstances, Prof. C. J. Patten; (1) the lantern of Aristotle as an organ of locomotion; (2) solaster development, Dr. James F. Gemmell.

Messrs. Friedlander, of Berlin, have conferred an inestimable benefit on zoologists and palæontologists by the issue of a second edition of the "Zoologischer Adressbuch" (International Zoologist's Directory), which contains the names and addresses, so far as they could be ascertained, of all living persons specially interested in zoology, anatomy, physiology, and animal palæontology throughout the world, together with taxidermists and natural history dealers. The previous edition was published by the German Zoological Society in 1895, to which a supplement appeared in 1901. The present volume comprises 1109 pages, of which 88 are devoted to the index of names. As in the American "International Scientist's Directory," the names of the persons referred to are entered under the heading of their respective countries, but in place of the names being arranged in alphabetical order, they are classified according to the place of residence. Whether this is an improvement or the reverse we do not propose to discuss; but, whatever may be the general opinion on this point, the index renders it perfectly easy to find the individual addresses. Taking the British Isles as a sample of the whole, we find, so far as we are acquainted with them, both the names and the addresses entered with what is really marvellous accuracy. The names of a few deceased naturalists, such as the late T. Southwell and C. J. Cornish, are retained on the lists, while a few living naturalists, *e.g.* Mr. Hugh Gladstone, are omitted; and we notice some confusion between the officials of the Victoria and Albert Museum and those of the Science Museum. Errors of this nature are, however, practically unavoidable, and the publishers are to be heartily congratulated on the manner in which they have carried out an arduous task. As the expense in producing the work must have been very heavy, it is to be hoped that they will receive liberal support from that section of the public interested in natural history.

In the current issue of *Scientia* M. J. Costantin directs attention to some of the recent phases of the culture of orchids. He points out that 600 hybrids have been produced in the genus Cypripedium alone, many of which do not resemble their parents but look like new species, and are indefinitely fertile, and so can be crossed with each other. Observations are added on the association with orchids of a mycorhiza, three species of which have been recorded; one of these is found in the roots of Cypripedium, Cattleya, and Lælia, another in Phalænopsis and Vanda, and the third in Odontoglossum. The inoculation of an orchid with a species of mycorhiza other than that usual to it leads to one of three results: either the plant dies, the fungus dies, or they become accommodated to each other; but in this case a plant of unusual form is produced. The author suggests that these facts indicate that the environment may be responsible for the appearance of new characters.

PROF. EMIL ROHDE (in *Zeitschr. f. wiss. Zool.*, Bd. xcviii., 1 Heft) shows that chromatin diminution occurs in various tissues other than the germ cells. In the blood cells of various vertebrates the nuclei undergo a maturation process similar to that exhibited in oogenesis, portions of chromatin being cast out of the nucleus and out of the cell. In the red blood cells of mammals this process goes on to such an extent that the whole nucleus is lost. The nuclei of other tissue cells, especially those of the central nervous system of vertebrates, exhibit diminution of chromatin which the author compares with that observed in spermatogenesis. The nuclei of the nerve cells in karyokinetic division give off spherical masses of chromatin, which later lie between the resting nuclei. In other cases the nucleus breaks up into several small daughter nuclei, which Prof. Rohde compares with the division of the sperm mother cell into spermatozoa. The fact that diminution of chromatin takes place in so many different tissues and animals (those investigated range from Mustelus to man) indicates that it has a general significance; the author regards it as a characteristic of adult, that is, of maturing and dividing cells in general. Other memoirs in the same journal deal with the innervation and sense organs of the wings of butterflies and the nephridial funnels of earthworms.

To *The Journal of Economic Biology* for July Dr. H. B. Fantham contributes an important article on coccidiosis in game-birds and poultry. Owing, it is suggested, to the great increase of motor traffic, and the consequent pollution of the air in many parts of the country, white diarrhœa and other forms of coccidiosis, which chiefly affect young birds, appear to be on the increase, and there is, accordingly, urgent reasons that every available means should be taken for keeping them in check. The two important objects which should be kept in view are, first, the taking of such precautions as will tend to prevent the pollution of air and soil by coccidian oöcysts, and, secondly, to endeavour to raise the vitality of young birds, and thus enable them the better to resist the onset of the disease. In the case of domesticated poultry, cleanliness is a matter of the first importance, both as regards the young birds themselves and their surroundings; and it is probable that if such preventive measures were properly enforced and carried out, coccidiosis would eventually disappear. The author gives a full and detailed account of the structure and life-history of the parasite of coccidiosis and of its effects on the intestinal tract of its victims, but these are too long and too technical for quotation, even in brief abstract, on this occasion. *Eymeria avium*, or *Coccidium avium*, as it was formerly called, is a minute animal parasite belonging to that section of the Protozoa known as the Sporozoa, on account of the production of resistant spores. Although in some cases the whole intestinal tract of the bird may be riddled by the parasite, the duodenum and the paired cæca, or blind guts (especially long in grouse), are the parts chiefly attacked. The life-cycle of the parasite is complicated by the fact that there are two distinct phases of development, namely, an asexual phase, known as schizogony, during which there is a multiplication of the parasites by fission in the lining of the intestine of the infected bird, and subsequently a sexual phase, in which resistant cysts and spores adapted for life outside the body are produced in myriads. It is by these spores, which are swallowed by fresh birds with their food and drink, that the disease is spread.

THE difficulty of obtaining trustworthy data, at any rate in India, to prove or disprove the influence of forests on atmospheric and soil moisture is reasonably argued in an article appearing in *The Indian Forester* (July). Not the least interesting portion is the transcript of a note on the subject submitted to the Indian Government by Dr. Walker, the Director-General of Observatories. It reflects great credit upon the Government of India that, in spite of opinions mainly adverse, they assent to the initiation of a few experiments in selected localities for the purpose of tabulating information with respect to local differences in rainfall, temperature, and humidity inside and outside forest areas, as also to differences in level of the underground water table and extent of floods that might be referable to the proximity of forest areas.

AN account of the Percy Sladen Memorial Expedition (1910–11) to the Orange River through Little Namaqualand, contributed by Prof. H. H. W. Pearson, is appearing as a series of articles in *The Gardener's Chronicle*. In the current number (August 19) the author touches on the existence of a flora with a strongly marked Cape affinity occurring on the Khamiesberg range, while the low country shows entirely different vegetative formations, in which succulents predominate. The Khamiesberg is one vegetative island, while another is found on the Huilla plateau in South Angola, and possibly similar floras will be discovered on the unexplored peaks in German South-West Africa. If these islands show the remnants of a flora once continuous, whence, it is asked, and by what route, came the ancestors of the plants occupying the lowlands. The illustrations represent some of the more striking succulents, such as *Mesembryanthem digitiforme* and *Augea capensis*.

OWING to the receipt of numerous specimens of inflorescences from the graft hybrid, *Laburnum Adami*, sent to Kew Gardens for identification, Mr. W. J. Bean contributes a short article on the subject to *The Kew Bulletin* (No. 6), in which he explains how this particular novelty arose as a chance development from a graft of the dwarf purple broom, *Cytisus purpureus*, on the common laburnum. From the graft there arose a shoot which produced the intermediate type of purplish-yellow flower. Subsequently portions of trees propagated from the shoot reverted to the parent types, so that a single tree may bear at the same time the purplish flowers of the presumed hybrid, yellow flowers of the laburnum, and purple flowers of the broom. Two further examples of graft hybrids, *Crataego-mespilus Dardari* and *Crataego-mespilus Asnieresii*, are also described. They both arose on the same tree, a medlar grafted on a stock of common hawthorn, as branches showing composite characters. *Crataego-mespilus Dardari* has shown a tendency to break up into three forms, representative of the type *Asnieresii*, pure medlar, and itself. The different forms are illustrated from a photograph of three sprays gathered last June from a specimen of *Crataego-mespilus Dardari* growing in Kew Gardens.

IN the August number of *Petermann's Mitteilungen* Prof. Maurer describes a conventional projection for conveniently representing the lines of magnetic declination. For their study Mercator's projection is unsuitable, however well adapted it may be to the requirements of the navigator, since the areas in the neighbourhood of the poles are not represented, and the zones in higher latitudes are greatly distorted. In his projection the polar regions are well shown, the central point of the map being in $\phi = 0°$, $\lambda = 90°$ E. South America is considerably distorted from being unfavourably placed, but other continents suffer less.

THE Journal of the Meteorological Society of Japan for June contains original articles, with brief abstracts in English, (1) on the construction of protected rain-gauges, by Mr. J. Sato. The author gives the history of the works of some of the principal writers on this subject, and describes a gauge devised by himself, which is a modification of one adopted by the late Dr. Billwiller in the Swiss Meteorological Service. (2) An analysis by Mr. H. Maruoka of the Osaka seismogram at the time of the severe earthquake felt in Mexico on June 7. The time of its commencement in Osaka was 9h. 17m. 48s. (135th meridian); its total duration was 2h. 34m. 31s. in the E.-W. component, and 2h. 31m. 23s. in the other component. (3) Discussion of rainfall observations at Osaka for the years 1883–1910, by Mr. K. Yamada. The results of this valuable investigation are not given in English.

THE experiments of Profs. Boltwood and Strutt, and of Dr. Eve, on the amounts of uranium and radium present in radio-active minerals, have led to the conclusion that the ratio of the amounts of the two present is a constant independent of the nature of the mineral so long as its age was considerable. A long series of measurements made in Madame Curie's laboratory by Miss Ellen Gleditsch seem now to cast doubt on the constancy of the ratio. The methods used by Miss Gleditsch appear to offer little ground for criticism, and her results show a variation of the ratio of radium to uranium from $1{\cdot}8\times10^{-7}$ tu $3{\cdot}7\times10^{-7}$ for the twenty-one minerals examined. These differences she is disposed to attribute to the existence of the long-period ionium and possibly another long-period element between the parent uranium and radium, but does not exclude the further possibility of the "constants" of radio-activity being influenced by external circumstances more than we at present believe.

THE sensation produced on the retina by a source of light of short duration has for the last three-quarters of a century been taken as proportional to the product of the intensity of the source into its duration. The early experiments of Talbot and of Swan, and the later ones of Bloch and of Charpentier, provided ample justification for the law so far as it related to sources of considerable intensity. In the *Journal de Physique* for July, MM. A. Blondel and J. Rey point out that for weak sources the intensities of which are not much greater than the lowest perceptible the statement cannot be true, or there would be no lower limit to perception. On this ground they argue that the sensation should be proportional to the product of the *excess* of the intensity of the source over the minimum just perceptible into the duration of the source, and this conclusion they have verified by means of the measurements made by seventeen observers by two independent methods of observation.

WE learn from *The Engineer* for August 11 that the new Italian Dreadnought *Conte di Cavour* was successfully launched at Spezia on August 10. Admiral Mirabello's crusade against lack of homogeneousness is beginning to produce its fruits; it is not likely that Italy will add to its armoured cruisers, as opinion has turned in favour of Dreadnoughts, of which four were designed by General Masdea. The *Conte di Cavour* is the second example of these. She will have a displacement of 21,500 tons, and her turbine machinery, of 24,500 horse-power, is designed for a speed of 22 knots. There will be twenty water-tube boilers of the Blechynden type. The normal coal and petroleum capacity will be 1000 tons. The armament will comprise thirteen guns of 305 mm., twenty guns of 120 mm., and thirteen guns of 76 mm. There will be three submarine torpedo tubes, two lateral and one stern.

A COPY of the "Reports and Transactions," for the year ending September 30, 1910, of the East Kent Scientific and Natural History Society has been received. Among much other interesting information contained in the report, some facts about salt rains, contributed by Mr. W. H. Hammond, may be mentioned. On December 14, 1910, a very heavy gale from the south-east with a deluge of rain in the night occurred; on the following day all the windows which faced south-east had quite a frosted appearance when dry. Some of the substance scraped off and dissolved in distilled water was proved to consist of common salt. At Milton Chapel some years ago, in the 'eighties, on one occasion a north-east window was coated with salt after a gale, and on the *Dane John* about the same time a salt gale was experienced; it made the young leaves look as if they had been scorched by fire. Mr. Hammond states that in 1871, when a student at the Royal Agricultural College, Cirencester, Prof. Church told his class that the rain which came in a gale one day from the direction of the Bristol Channel was loaded with salt; this must have travelled about sixty miles. The report also contains observations of the "nailbournes" in the Elham Valley, Petham, and Drillingore in the Alkham Valley, Dover. Useful meteorological statistics and notes for the year 1910 from various observing stations throughout east Kent are also included, as well as natural history notes and reports of lectures and addresses.

OUR ASTRONOMICAL COLUMN.

THE COMETS 1911*b* AND 1911*c*.—Numerous observations of the comets discovered by Kiess and Brooks, respectively, are now being recorded, but they contain nothing that is strikingly new; the Kiess comet is now invisible in these northern latitudes.

In No. 4517 of the *Astronomische Nachrichten* Prof. Pickering reports that a photograph of the spectrum of comet 1911*b*, secured with the 8-inch Draper telescope on July 7, shows the bands at λλ 3883 and 4737 as bright, and of nearly equal strength; the latter was much the brighter in the case of Daniel's comet, 1907*d*.

Apparent path of comet 1911*c* August 24–September 13, 1911.

From Mr. F. C. Leonard, of Berlamont, Mich., U.S.A., we have received a lengthy report of observations of both comets made during July. Kiess's comet developed appendages on both the preceding and following sides, and on July 26 a long streamer was seen to extend for some distance in a direction perpendicular to the axis.

Brooks's comet, observed on July 25, 26, 27, and 29 presented the mottled appearance of a condensed nebulous cluster, and was 3′ or 3·5′ in diameter.

The following is a continuation of the ephemeris published by Dr. Ebell in No. 4517 of the *Astronomische Nachrichten*, and on the accompanying chart the apparent path of the comet among the stars is approximately shown; the new elements, upon which these positions depend, give October 27 as the time of perihelion passage:—

Ephemeris (12h. M.T. Berlin).

1911	α (true) h. m.	δ (true) ° ′	log r	log Δ	mag.
Aug. 24	20 41·9	+46 43·8	0·1552	9·8033	8·0
,, 26	20 28·5	+48 30·6			
,, 28	20 13·4	+50 14·0	0·1345	9·7770	7·8
,, 30	19 56·5	+51 52·1			
Sept. 1	19 37·7	+53 22·4	0·1125	9·7542	7·6
,, 3	19 16·9	+54 42·0	0·1010	9·7444	7·5
,, 5	18 54·3	+55 48·2	0·0891	9·7357	7·4
,, 7	18 29·9	+56 38·2	0·0768	9·7282	7·3
,, 9	18 4·1	+57 9·6	0·0641	9·7220	7·2
,, 11	17 37·5	+57 20·4	0·0510	9·7172	7·1
,, 13	17 10·6	+57 9·4	0·0374	9·7136	7·0

It will be noted that on August 26 the comet will pass very near to ω Cygni (magnitude 4·9), and on September 10 within a few minutes of ξ Draconis (magnitude 3·9).

THE NEW CANALS ON MARS.—It will be remembered by readers of these columns that, during the last opposition of Mars, Prof. Lowell claimed to have discovered conspicuous canals which reference to the large accumulation of earlier observations showed to be new; they were not to be found on any of the earlier drawings.

Telegraphing to the Kiel Centralstelle, Prof. Lowell now states that these two new features near Syrtis are still visible. The importance of establishing the novelty and permanence of such conspicuous "canali" as these appear to be cannot be overrated.

A QUICKLY MOVING COMET-LIKE OBJECT.—Dr. Franz reports the observation at Breslau on July 22 of a rapidly moving nebulous object, which may have been a comet very near to the earth. At 13h. 4m. (M.E.T.), the position of this object was $\alpha = 4$h. 15·0m., $\delta = +20° 36'$ (1855·0), and during an interval of six minutes the R.A. altered by about 3m., while the declination remained the same. This nebulous-looking body was of about the sixth magnitude and about 6′ in diameter, not unlike the Kiess comet which had been observed just before.

The observers at Kiel searched unsuccessfully on July 23 for an object answering to the conditions named by Dr. Franz, and Dr. Graff was equally unsuccessful at Bergedorf on July 24; both he and Dr. Franz were clouded out on July 23 (*Astronomische Nachrichten*, No. 4517).

OBSERVATIONS OF NOVA LACERTÆ.—A number of magnitude and position observations of Nova Lacertæ appear in No. 4509 of the *Astronomische Nachrichten*. Prof. Eginitis shows that the colour of the star changed from red to bluish-white during the period January to March, its magnitude meanwhile decreasing from 7·9 to 8·9. M. Luizet shows that this change of colour was very rapid during the first six weeks, and then the colour became nearly constant. Herr Jost's observations of magnitude show very small oscillations up to the end of February, and then a nearly constant diminution until the beginning of May.

At the Simeis Observatory Prof. Beljawsky made an elaborate investigation of the nova's magnitude as shown on various photographs taken through different coloured screens. The results, together with the measures of position, are given and discussed in No. 41 (vol. iv., No. 5) of the *Mitteilungen der Nikolai-Hauptsternwarte zu Pulkowo*.

PROMINENCES OBSERVED ON APRIL 28.—In view of the total eclipse of the sun on April 28 last, Prof. Riccò made special arrangements for the visual and photographic observations of prominences at Rome and Catania, and now publishes the results in No. 4, vol. xl., of the *Memorie di Astrofisica ed Astronomia*. There was a large prominence in position-angle 48° (N. through E.), and lesser ones at 36°–42°, 163°–168° (given as 192°–198° on the figure accompanying the article), and 294°–300°.

A STAR WITH CONSIDERABLE PROPER MOTION.—Mr. Baldwin reports, in No. 4513 of the *Astronomische Nachrichten*, that the observations made at Melbourne Observatory show the star C.P.D. −70°447 to have a large proper motion amounting to −0·0711s. in R.A. and +1·214″ in declination. The position of the star, for 1900·0, is 5h. 45m. 41·036s., −70° 12′ 50·91″, and it was observed at Melbourne in 1892 and 1907.

AN ASTRONOMICAL SURVEY OF SOME PEMBROKESHIRE CIRCLES.

THE Rev. W. Done Bushell first directed the attention of the members of the Cambrian Archæological Association five years ago to some monuments in Pembrokeshire as illustrative of Sir Norman Lockyer's findings elsewhere, and a well-illustrated paper of fifty-two pages, published in the journal of that association, shows that, so far as Wales is concerned, the archæologists wish to give this "new thing" a hearing.

The author confines himself to ten groups of monuments on the southern slopes of the Prescelly Hills, covering a tract of land seven miles from east to west. As during the last five years he has made repeated visits to the district, he has gathered almost heartrending evidence of the progressive destruction of ancient monuments. "There were at Eithbed until very recently three circles, and probably three cromlechs also were associated with them. They are now no more. The largest was destroyed, we know not when or how" (pp. 17, 18). "We find this circle duly given in the earlier edition of the 25-inch Ordnance Map; it is entirely absent from the later edition issued in 1908." The author was able to trace its outline. "It has an average diameter of no less than 150 feet." "Two other circles . . . have both of them been wilfully destroyed," one in 1905 and the other in 1909. "These circles, with the accompanying cromlechs, must have formed a very noble and important group before they were thus demolished." The author, fortunately, had photographed some of the monuments before they were destroyed. Last year he recognised some of the temple materials in an "ugly house which stands close by, a veritable monument of shame" (pp. 19, 20). All archæologists will, of course, deplore such vandalism; but the significance of the loss is well expressed in the author's remark:—"We may add that the existence of three circles in immediate contiguity suggests, as in the case of the Hurlers and elsewhere, adjustments rendered necessary by precession" (p. 22).

At Cil-y-maen-llwyd, in the same district, an observer about the year 1738 saw "a circle of mighty stones very much like Stonehenge in Wiltshire, or rather like the Rollrych Stones in Oxfordshire" (p. 38). There remains just one of the mighty eighty stones.

Of the existing remnants of temples second to few in Britain, the author has secured most useful angular measures. He acknowledges the assistance of his son, Mr. Warin F. Bushell, and of Lieut.-Colonel Tupman, in preparing the plans given. A useful declination table for lat. 52° by the latter is given as an appendix. The paper is an admirable illustration of what may be done with little trouble in every district towards recording the testimony of the stones, the speediest and most effective method of outwitting the vandals. Photographs are good, plans are better, but measures are indispensable.

Given trustworthy data, we can put up with any deductions. Some of the author's opinions are tolerable only on such ground. Because of the difficulty in these latitudes of observing any celestial bodies right on the horizon, he is inclined to think that the alignments had only a ceremonial use. Early man, he thinks, "did not require the aid of an astronomer" (p. 44). "Nor would so many observation-circles have been required had their prime object been, as has been suggested (Lockyer, 'Stonehenge,' p. 17), the determination of the seasons. England has many churches, but only one Greenwich" (pp. 45, 46). Yet in a passage cited the author speaks of "adjustments rendered necessary by precession." Such, however, are some opinions which the author puts forth as "alternatives to any premature acceptance of Sir Norman Lockyer's interesting theory, at least in its entirety" (p. 44). Nothing like a proved alternative is offered, nor is it shown that the data supplied require any alternatives. Such a happy observation as that cromlechs generally are oriented so as to command the most extensive view obtainable is not universally true to the facts, and could not have been always "a primary consideration with the cromlech-builders" (p. 20). The exceptions prove what the primary consideration was, as at St. Lythans' fine cromlech, which is definitely oriented to the equinox in the opposite direction to the extensive view. JOHN GRIFFITH.

RECENT ENGLISH AGRICULTURAL PUBLICATIONS.[1]

SCIENTIFIC work in agriculture in this country is published exclusively in the Journal of Agricultural Science, but there are certain papers published in the technical journals which possess considerable scientific interest. These alone will be dealt with in the present article.

The Board of Agriculture publishes each month the Journal of the Board of Agriculture, which can only be described as an unqualified success. There are usually three or four signed articles, primarily of technical importance, but often of scientific value as well, followed by a number of short articles or notes summarising work done on a particular subject, or directing attention to important work being done elsewhere.

The progress of the sugar beet industry in Norfolk is described by Mr. W. E. Sawyer. Last year's trials showed beyond doubt that sugar beet could be produced in sufficient quantity, and of the necessary good quality, for the purposes of a factory. This year it is sought to ascertain whether the crop will pay as well as other crops, and in organising the work advantage is being taken of last year's experience. Generally speaking, it has been demonstrated that sugar beet can be produced in most parts of England, but we now require experiments on the large commercial scale to ascertain whether or not the industry will be profitable.

Dr. Goodwin writes on molasses and sugar foods for live stock. Molasses, whether from beet or from cane sugar factories, contains about 30 to 35 per cent. of sucrose and 25 to 30 per cent. of dextrose and other sugars. There are also present some nitrogenous compounds, betaine, amino-acids, &c., and also some ash constituents, but the great value of molasses as a food consists in its sugars. Unfortunately there are certain drawbacks to its use: it is very sticky and difficult to handle, and is said to be liable to theft. To overcome these difficulties the practice has arisen of adding some absorbent material to the molasses and making a mixture that could be dried, powdered, and handled easily. The absorbents are of the most varied kinds; cocoanut meal, hay, spent hops, bran, sugar-cane pith, and peat have all been used, and not a few extravagant claims have been put forward by the patentees about the beneficial effects of the absorbent. Dr. Goodwin examines certain of these claims, and shows by actual digestibility trials with sheep that only a small proportion of the added cellulose is digested in some cases.

The relation of weeds to crops is discussed by Miss Brenchley. Over a limited area, where the climatic conditions showed no great variation, *i.e.*, between Harpenden and Bedford, there was a clear connection traceable between the weeds and the nature of the soil, but none between the weeds and crop, with a few readily explained exceptions. The so-called "seeds" crops, clover, and rye grass, &c., effectually keep down certain weeds, no doubt because they so densely cover the ground; other weeds will only grow in the thin patches of cereal crops, and in other open situations.

It has long been an agricultural practice to grow certain crops simply with the intention of ploughing them into the ground, and thus adding organic matter to the soil to be converted into humus. Mr. Hall describes experiments made at Rothamsted on the relative effects of mustard, rape, crimson clover, and vetches: as was expected, the leguminosæ gave the largest increase in subsequent crops. At Woburn a different result was obtained, it being found that mustard gave better results than the leguminous tares.

[1] The Journal of the Board of Agriculture; The Journal of the Royal Agricultural Society.

Dr. Lander, in an interesting note, shows that small amounts of prussic acid, such as might be generated from a linseed cake in which the glucoside-splitting enzyme had not been destroyed, are not necessarily harmful to stock. In view of the widespread occurrence of cyanogenetic enzymes, it is highly desirable that authoritative information should be at hand as to the effect of continuous small doses of hydrocyanic acid on animals.

The Journal of the Royal Agricultural Society is published once a year only, and its appearance is always an event in the agricultural world. In the current number there is a paper by Dr. Russell, giving a connected account of the work he and his colleagues have been doing on the production of plant food in the soil, and bringing together a number of agricultural practices, previously unexplained, that fall into line with the recent work with which he is associated.

Mr. W. W. Skeat contributes an interesting account of the origin of some old agricultural words, directing special attention to the "Dictionary of English Plant-names," by Britten and Holland, and the "English Dialect Dictionary." Sir John McFadyean deals with the very important question of tuberculosis in cattle. The idea still finds credence that the offspring of tuberculous cattle will necessarily develop tuberculosis: experiments, on the other hand, have shown that if the calves are at once removed from their dams and kept free from infection they do not become tuberculous. Nor does Sir John admit that they show any special tendency to tuberculosis. All breeds of cattle are liable to tuberculosis, but no families exhibit any special liability not shown generally by their particular breed.

State aid to agriculture in Canada is authoritatively described by Mr. E. H. Godfrey, of the Canadian Agricultural Department. Mr. Godfrey has the enormous advantage of knowing English institutions, and his article will, therefore, be found of great interest to all engaged in agricultural administrative work in this country. In addition, there are the usual reports from the consulting botanist, chemist, and zoologist; Prof. Biffen reports a case where the somewhat rare hoary cress (*Lepidium draba*) obtained a footing on arable land, and spread to such an extent as to become a nuisance; while Dr. Voelcker reports the effect of zinc and other salts on crop growth in pots.

MEDICAL RESEARCH IN INDIA.

THE scientific memoirs by officers of the Medical and Sanitary Departments of the Government of India,[1] issued from time to time, contain matter and researches of the utmost importance and value.

Memoir 43 deals with the relation of tetanus to the hypodermic or intramuscular injection of quinine. For some forms of malaria injection of quinine is by far the most efficient treatment, but every now and then is followed by the dreaded tetanus or lockjaw, even when every possible care has been taken to ensure the sterility of the fluid and of the syringe used to inject it.

Tetanus is caused by a bacillus which occasionally is present in dust and earth, and may be introduced into a wound, and so give rise to "traumatic tetanus." It is a curious fact that tetanus spores free from other organisms and free from any adherent toxin may be injected into an animal without harm, and may remain latent at the site of inoculation for months. If, however, the spores have adherent toxin upon them, or if at the same time a little weak lactic acid is injected, the organism grows and multiplies and sets up tetanus. Apparently some agent must be present which weakens the resistance of the tissues before the tetanus bacillus can develop. Sir D. Semple, the author of this memoir, finds that quinine injected into the tissues produces necrosis or death of the tissue at the site of injection, and that pure washed tetanus spores

[1] No. 43: "The Relation of Tetanus to the Hypodermic or Intramuscular Injection of Quinine." By Lieut.-Col. Sir D. Semple, Kt. Pp. v+61. Price 1*s.* 2*d.*

No. 44: "The Preparation of a Safe and Efficient Antirabic Vaccine." By Lieut.-Col. Sir D. Semple, Kt. Pp. v+32. Price 9*d.*

No. 45: "Epidemic Dropsy in Calcutta." Being the First Report of an Inquiry carried out by Major G. D. W. Greig. Pp. ii+47+map+vi charts. Price 2*s.* (Calcutta: Government Printing Office, 1911.)

when mixed with quinine and injected invariably set up tetanus. Even when the quinine is injected into a site remote from the site of injection of the washed tetanus spores, tetanus may ensue. Sir D. Semple, therefore, suggests that tetanus following quinine injection when every precaution has been taken, may result from the fact that the individual has tetanus spores lying latent in some situation, introduced by some previous wound, and that on the injection of the quinine these latent spores become active. Tetanus spores were searched for in solutions of quinine, but were never found. Tetanus infection is also sometimes present in the bowel in healthy individuals. A small dose of tetanus antitoxin given at the same time as the quinine injection will effectually prevent the development of tetanus. Sir D. Semple also deals with the preparation of a safe and efficient antirabic vaccine in Memoir No. 44. He finds that rabies virus is killed by a 1 per cent. solution of carbolic acid in twenty-four hours at a temperature of 37° C., but still forms a safe and efficient antirabic vaccine, and he suggests that this method may be employed for the prophylactic treatment of persons bitten by rabid animals.

Epidemic dropsy in Calcutta is the subject of Memoir No. 45, by Major Greig. This disease, which occurs also in other parts of India, is much like ship beri-beri. The patients suffer from dropsy and neuritis of the lower limbs, shortness of breath, and weak heart. The general conclusion is that the disease is caused by a "one-sidedness" in diet, due to the use of "polished" rice and wheaten flour deficient in essential constituents. By the "polishing" of rice, the pericarp and seed-coat containing phosphorus compounds, and the fat and aleurone layers, are removed, leaving the inner endosperm, which contains little else than starch. Epidemic dropsy, however, occurs in severe outbreaks at particular periods, and it is necessary to correlate the food hypothesis with this fact. Major Greig states that, so far as his researches at present go, there is a remarkably close relationship between the price of food grains and the prevalence of epidemic dropsy. We shall await with interest the further report which is promised us on this subject. R. T. H.

MARINE BIOLOGY.

FOUR *Publications de Circonstance* have just been issued by the International Council for the Exploration of the Sea. Mr. Sven Palitzsch gives a very interesting account of investigations into the concentration of hydrogen ions in sea water, carried out on board the Danish investigation ship *Thor* during 1910. Of known methods of determination, the electrical method is the most accurate, but it is unsuitable for use on board a ship in a rough sea. The author has developed a colorimetric method, making use of standard solutions of known hydrogen-ion concentration, and comparing these with the water sample, using either phenolphthalein or naphtholphthalein as indicators. The standard solutions were sodium borate containing hydrochloric acid. The value of the determination of the concentration of hydrogen ions in sea water in comparison with the older methods of determining the "alkalinity" are discussed, and it is shown that the former factor is that which is of the most importance in relation to biological processes. The paper is a good example of the way in which the methods of marine biology can be supplemented by those of pure physical chemistry. The results may be quoted here: expressed as gram-equivalents of hydrogen-ions, the concentration varies from $10^{-7.95}$ to $10^{-8.35}$ per litre of sea water.

Two papers in the same series, by Mr. H. J. Buchanan-Wollaston, deal with the construction of a plankton net for making vertical hauls in a rough sea. It is well known that the difference between theory and practice is very great in such cases, and that plankton hauls which are called "vertical" are not, as a rule, truly so. The author suggests a net which "fishes" as it descends into the sea. It is lowered on a slack line, and whether or not the ship drifts during the operation, the apparatus descends vertically since it falls by its own weight. At the bottom, or at the required depth, the net is closed in the same way as the well-known Nansen net is "throttled," and it is hauled in the closed condition. The filtration coefficient of the net must now be determined—this is the factor expressing what fraction of the vertical column of water equal in section to the area of the mouth of the net does actually pass through the pores of the latter. Its calculation is so difficult, and the results so uncertain, that it has not been attempted except by the Kiel planktologists, by whom the method was originally devised. For such an inverted action of net as Mr. Wollaston suggests, however, the filtration coefficient can be approximated to with much greater accuracy than was hitherto possible. Mr. Wollaston's suggestions are decidedly novel, and since no attempt has been made since Hensen's time to improve the vertical quantitative plankton net, they constitute a real advance in methods.

The remaining *Publication de Circonstance* deals with the spawning and statistics of various species of gadoid fishes of the North Sea, and is written by Dr. P. P. C. Hoek. At the same time, the council has issued the fifth volume of the *Bulletin Statistique*. In spite of the international cooperation of the Governments of the principal European fishing countries for the purposes of fishery investigation, no uniform system of statistical collection of returns of fish landed has yet been developed. The council has therefore published a statistical statement of the fisheries of the various countries in which the returns have been converted and expressed in common units. The present instalment, edited by Dr. H. M. Kyle, deals with the fisheries of the year 1908, and the total value of the fish landed in the different countries during that year was about 18,000,000*l*. Of this total the North Sea contributed about one half, and Great Britain about 11,000,000*l*.

RURAL EDUCATION.

THE Board of Agriculture and the Board of Education have issued two reports by the Rural Education Conference dealing with rural education.

The "Report on a Suggested Type of Agricultural School" states the conclusions of a committee of the conference on the question "as to whether there is any place in the system of rural education, either generally, or in particular counties in view of special local conditions, for schools giving to boys leaving elementary schools a three years' course from the age of twelve or thirteen in the theory and practice of agriculture, together with continued general education."

The committee has considered separately the case of boys who intend to get their living as farm labourers and of boys who intend to become farmers or small occupiers. For the former, owing to the desirability of getting such boys into practical work on the farm as soon as possible, and to the expense and loss of time involved, they consider that there is no demand or place for schools of the type suggested.

A different view is taken of the case of those who intend to become farmers. The committee considers that this class of boys require something beyond the ordinary elementary school, and that they "should not leave school without acquiring a good knowledge of the theory and practice of agriculture (so far as it can be taught in school), together with good general instruction."

In districts where no facilities already exist (*e.g.* rural secondary schools), the report recommends the "trial by way of experiment" of one or two new types of school.

One they suggest might be termed a "Higher Grade Rural School," and worked on somewhat similar lines to the French École Primaire Supérieure. Practical agriculture would not be taught, but the curriculum would include practical gardening, nature-study, mensuration and surveying, and rural economy. The pupils would visit farms occasionally and receive some teaching in manual work incidental to farming.

The other type is described as a "Centralised Rural Continuation Day School," where boys actually engaged in farm work might be brought in several sets for one or two days per week and receive instruction in elementary science and rural economy.

The report on the "Qualification of Teachers of Rural Subjects" deals with the question of the "lack of teachers properly qualified to give instruction in rural subjects in elementary schools and the means which should be taken to raise the standard of efficiency in these subjects."

It appears that attempts hitherto made by the Board of Education to give teachers a special training in rural subjects have not been successful, and the only real progress made in this direction has been due to the efforts of local education authorities in providing special courses for the teachers in their rural schools. The report recognises that there is no inducement for teachers to qualify themselves for rural schools. The rate of pay is lower and chance of promotion less than in town schools, so that young teachers naturally object to become earmarked for country schools.

The chief recommendations of the committee are:—the extension of the training-college course so that teachers would be able to specialise in rural subjects during the third year; the provision by county local authorities of classes and courses in rural science; the encouragement of rural teachers by making their pay more nearly equal to that of the town teacher; the inclusion of rural subjects in the curriculum of secondary schools attended by intending rural teachers; and increased grants by the Treasury to the local education authorities.

Summaries of the evidence received is given in the appendices contained in both reports. J. J. G.

ESKIMO MUSIC.[1]

In 1888 Franz Boas published nineteen melodies of the central Eskimo in his well-known work on this people. In 1899 and 1900 R. Stein obtained thirty-nine songs from the Eskimo of Smith Sound, on the land west of the extreme north of Greenland. Between 1903 and 1906 William Thalbitzer collected a far greater number of melodies from North-West and East Greenland. It is good to hear that from some twenty-five of his many phonographic records permanent matrices in bronze were made, and that these are now deposited in the phonogram archives of the Danish Folklore Collection at Copenhagen.

Possessed of such extensive material first- and second-hand, Herren Thuren and Thalbitzer have endeavoured to review "the whole musical system of the Eskimo." Herr Thuren is responsible for the work of transcribing the phonographic records. This he appears to have been able to do with all the care that such an operation demands. For instance, "as in most cases an A (435 wave-lengths) was blown into the phonograph before the beginning of the melody, we were able in writing this off to set the phonograph to the speed used when the tunes were played, and thus frequently knew the absolute pitch." It is, however, a pity that equal care was not bestowed on the English dress in which this valuable monograph appears. Herr Thalbitzer is the collector of the music; a great number of melodies which were not sung into the phonograph were noted down by him "directly on the spot, the singer repeating his song for me several times whilst I used my violin to help in fixing the notes."

Unfortunately, the music of the western Greenlanders is much contaminated by European influence. In South-West Greenland "it is the European music which interests the Greenlander, and not rarely we hear Danish street melodies, to which the Greenlanders themselves put the words." The melodies, however, are always altered by adoption, and it is often difficult to determine whether these melodies are transformed European tunes or have been composed by Eskimo who have had some knowledge of European songs. In North-West Greenland European influence is less, and here "we might certainly talk of the pentatonic scale." The authors of this monograph believe that this choice of pentatonic intervals is due to the recent acquaintance of the Eskimo of North-West Greenland with European music, and that "their earlier, individual choice of intervals" is that "still found in East Greenland."

The North Greenlanders' songs resemble in several respects those of the Smith Sound Eskimo. On the other hand, the East Greenlanders differ from the latter in "that the melodic recitatives of the Smith Sound Eskimo are interwoven with or end in more complete melodic periods, whilst the East Greenlanders carry the recitative throughout the whole melody when the recitative is at all used. The very prominent East Greenland motifs constructed on the first, fourth, and fifth are not found at all among the Smith Sound Eskimo. Lastly, even the joining of the strophes to form a melody is different for the two tribes." Herr Thuren divides the East Greenland music into the following groups:—(i) recitative melodies; (ii) melodies based on the scale CFG (15) or CFGA (17); (iii) melodies based on the scale FAC (15), or F(G)AC (27), or F(G)ACD (20); (iv) melodies not included in the above (9). The arabic numbers enclosed in brackets give the number of songs belonging to these groups and subgroups.

The writers direct attention to a curious feature of East Greenland music, the tendency for the melody to rise instead of to fall at its close. They find that just those divergencies from our own diatonic scale which occur there have been noted among the Indians of British Columbia. They also lay stress on the complexity and accuracy of the rhythms characterising East Greenland music. "The more we study the songs of the East Greenlanders, the more we become convinced that not even the smallest rhythmic feature is due to chance. The same complicated accentuation, the same extremely fine subdivision of the melody come again when the periods are repeated."

These extracts are sufficient to demonstrate the importance of the study of primitive music, alike for comparative æsthetics and for ethnology.

[1] "The Eskimo Music. (1) On the Eskimo Music. (2) Melodies from East Greenland." By H. Thuren and W. Thalbitzer. Pp. ii+112. (Copenhagen: Printed by Bianco Luno, 1911.) Reprinted from "Meddelelser om Grønland," xl.

THE KNEE-JERK.

A RECENTLY issued number of *The Quarterly Journal of Experimental Physiology* (vol. iv., No. 1, p. 67) is notable in containing a paper by Dr. W. A. Jolly, of Edinburgh, which finally settles a long-disputed question as to whether or not the knee-jerk is a reflex action. Everyone knows that when the tendon just below the knee-cap is tapped smartly, the leg is suddenly jerked forward, and the importance of this phenomenon arises mainly from the fact that its presence, absence, exaggeration, or diminution is a valuable diagnostic sign in certain nervous diseases. A reflex action demands the journey of a nervous impulse from the point struck up to the spinal cord, and down again from the spinal cord to the muscles of the thigh, and the statement has been generally credited that the time interval between the tap and the jerk is so short that it is impossible for this to occur. It was therefore held that the jerk was the direct result of stimulating the muscle itself. Nevertheless, the knee-jerk increases and decreases under the same conditions as those which increase and decrease actions which are undoubtedly reflex.

Various elaborate explanations, the best known of which is that of Sir William Gowers, have therefore had to be invented to reconcile these two statements. Such explanations are no longer necessary, now that we know that nerve impulses are in man propagated at the rate of 120 metres per second, and not at the rate of 30 metres per second, as was formerly supposed.

Dr. Jolly has made careful time-measurements, and shown that in the knee-jerk there is sufficient time for the nerve-impulse to travel to the spinal cord and back again, but that the time occupied in the cord itself is only about half that which is necessary in the case of ordinary co-ordinated reflex actions, such as the withdrawal of the feet when the soles are tickled. This is explicable on the assumption that, in the case of the knee-jerk and other similar tendon reflexes which do not involve the cooperation of several muscles, the number of nerve cells traversed in the cord is less. The increased rapidity of a tendon reflex is useful, for a sudden strain on a ligament would rupture some of its fibres or lead to injury of the joint surfaces if too great a time intervened before the muscles could contract to save the joint.

We should like to add a word of congratulation to Prof. Schäfer, the editor of the journal in which this paper appears, on the continued excellence of the new physiological periodical, which has now entered on the fourth year of its existence.

AFFORESTATION IN SCOTLAND.

When a board or council is constituted for promoting afforestation, it is evidently essential that the body should be invested with considerable freedom of action, because many of the schemes will present special problems requiring special consideration and localised knowledge. The council of the Scottish Arboricultural Society has published as a separate volume (xxv.) of their Transactions a report, compiled with great care and labour by Lord Lovat and Captain Stirling of Keir and other experienced authorities, providing a specimen example of a scheme that illustrates very definitely the complex factors that arise for consideration.

The concrete example presented is situated in the Highland district of Glenmore, Inverness-shire, and has been selected for various reasons, but chiefly because it contains wintering land of sheep farms and deer forests, and is also well suited for the creation of small holdings. Economic considerations, especially avoidance of an increased local rate, occupy a prominent place in the proposition, and it becomes obvious that the scheme of afforestation, to be financially sound, must fit in with farming and sporting conditions. The nature of the staff, and particularly the requirements of the foresters, is a second matter. The sylvicultural problems comprise a working plan, stocking of the ground, and utilisation of existing woodland produce. The afforestable land is computed at 15,000 acres, of which about two-thirds falls within deer forests and the remainder is sheep ground; according to the proposed scheme, 450 acres would be planted annually for fifteen years, and thereafter 300 acres per annum.

The tenor of the conclusions is to indicate that under a well-framed scheme large areas of land can be afforested without injury to existing interests; further, that afforestation should eventually pay its way, besides providing a great deal of permanent and periodic employment. Suggestions are also offered with regard to the nature of a proposed Central Forest Authority for Scotland, different systems of land tenure under afforestation, and the conditions of agreement between landowner and State.

PLANKTON STUDIES ON THE WEST COAST OF SCOTLAND AND IN THE IRISH SEA.

The areas in which plankton studies have been carried on during recent years in European seas, under the official international scheme of investigation, have not included the west coast of Great Britain. With the view of filling, at least in part, this lacuna in our knowledge of the plankton of the British area, Prof. Herdman has, during the years 1907 to 1910, made numerous vertical and surface hauls from his yacht during July off the west coast of Scotland, and during August and September in the Irish Sea. The material collected has been examined, and the results are presented in an interesting account by Prof. Herdman and Mr. William Riddell.[1]

In the Irish Sea the phyto-plankton reaches a maximum in April or early May, the sea swarming with diatoms (chiefly Chætoceras, Thalassiosira, and Lauderia); then the phyto-plankton gradually dies away, and is replaced by the zoo-plankton (copepods, Oikopleura, &c.), which is characteristic of the summer months. In September and October diatoms (chiefly Rhizosolenia, Chætoceras, and Lauderia) again appear in profusion, constituting an autumnal phyto-plankton maximum, usually not so marked in bulk or duration as that in the spring. This in its turn dies away, giving place to the scanty winter zoo-plankton—the minimum plankton of the year—which persists until the reappearance of diatoms in the spring. There is thus in the Irish Sea a clear periodicity in the plankton and marked differences in the nature of the plankton of the different seasons.

Examination of the gatherings made off the west coast of Scotland shows that localities not very far apart differ considerably in the nature of their plankton at the same time of the year. For instance, a vertical haul taken in the Hebridean Sea, off Canna, is a typical fine phyto-plankton, consisting chiefly of diatoms of the genus Chætoceras, whereas a vertical haul, at the same time of the year, at the entrance to Loch Fyne shows a typical coarse zoo-plankton containing large numbers of copepods. This is in marked contrast to the conditions in the Irish Sea, where a zoo-plankton and a phyto-plankton do not occur simultaneously a few miles apart. A list of the Scottish stations is given, with some particulars of the nature of the catch at each, and a detailed analysis in twenty-six cases. The evidence shows that, off the north-west coast of Scotland, at one time of the year (July), in several successive seasons, the plankton was of different types in different localities, but maintained a fairly constant character in each.

A comparison of the Scottish records with those from the Irish Sea shows that, in species present and in their abundance, the Loch Ranza plankton in July is much more nearly similar to the September than to the April phyto-plankton of the Irish Sea. But the phyto-plankton gatherings made north of Mull show resemblances to the vernal rather than to the autumnal phyto-plankton of the Irish Sea. There are three possible explanations of the differences observed between the summer plankton of the Hebrides and of the Irish Sea:—(1) the great vernal maximum, which dies away in May and June in the Irish Sea, passes off more slowly further north, and is found lingering, in some parts of the Hebrides, until the end of July, or even longer; (2) in some of the deep northern channels the diatoms, which elsewhere constitute the vernal maximum, persist in comparative abundance throughout the greater part of the year; (3) the diatoms of the July phyto-plankton may have invaded the Hebridean Sea from the North Atlantic at some period subsequent to the vernal maximum. The authors are inclined, on the evidence available, to regard the first of these suggested explanations as the most likely, but point out that further periodic observations are necessary before the matter can be decided definitely.

The authors discuss briefly the classification of diatoms into oceanic and neritic species, and give a provisional list of the two categories. A consideration of the phyto- and zoo-plankton shows that the west coast of Scotland is divisible into three well-marked areas, not merely geographically, but by reason of the distribution of its summer plankton:—(1) the Clyde sea-area to the south of, and inside, Cantyre, characterised by zoo-plankton, the species of which are, in the main, oceanic; (2) the area around and to the north of Mull, extending from Cantyre to the south of Skye, which contains in July a well-marked phyto-plankton, mainly neritic in character; (3) to the north of Skye, where a zoo-plankton again appears, which contains some oceanic species.

The plankton distribution of the west coast of Scotland may be explained in terms of hydrographic movements if it be supposed that Atlantic water gains access more freely in summer to the Clyde sea-area and to the region north-east of Skye than to the large intervening area of the west coast, that is, that an oceanic current reaches the Clyde area and another flows in round the north of Skye, while little or no such current invades the area north and south and around Mull. The authors conclude by pointing out that further observations are required in order to determine how far this explanation holds good, and also to gain fuller knowledge of the changes in the plankton. These changes are bound up with many problems of a fundamental and far-reaching nature connected with the nutrition of marine organisms, and an intimate knowledge of the changes in the plankton is essential to an understanding of the movements of the shoals of migratory fishes.

THE PRUNING OF TREES IN TOWNS.

The services of Prof. Bayley Balfour, F.R.S., have been obtained by H.M. Office of Works to inquire into the justness or otherwise of complaints made in regard to the treatment of the young trees in the Mall. His report, which has just been issued from the Stationery Office (Cd. 5823, price $2\frac{1}{2}d.$), must be gratifying to those who have charge of the trees, for he finds nothing to justify adverse criticism of the pruning. On the contrary, he was impressed by the evidence of sound practical knowledge and

[1] Trans. Biol Soc., Liverpool, vol. xxv., pp. 60–113, 11 figures.

scientific principle shown in their treatment. It was high time that someone in a position of authority should have been called on to lay down the principles that govern, or should govern, the pruning of trees in public thoroughfares. The outcry periodically made in the daily Press is usually marked by want of knowledge and unfairness. As a matter of fact, there is no work more thankless in nature than the management of street trees. In London and other great urban areas the planter's choice is restricted to a few species (of which the plane is the chief and best) which experience has proved will thrive, but which, as regards size, are quite unsuited to the spaces usually available for them. In the Mall this difficulty does not arise, for the space is ample. The object there is to control the growth of the trees that have been planted so that the foundations of a stately avenue may be laid.

Perhaps the most valuable portion of Prof. Balfour's report is that in which he shows that nature herself is always pruning. That is an aspect of the case which never strikes the lay critic. Yet the smothering out of weakly and overcrowded growths is continually going on. Correct pruning anticipates nature's end, and substitutes the prompt action of the knife for that of slow decay. If one compares the branch-system of a fully grown plane with that of a young specimen, and notes how few of the numerous branches of the latter survive, we see how drastic nature's pruning is. In such a place as the Mall it is essential that the trees should possess a certain uniformity and balanced proportions. The means to secure this end have been admirably chosen, and there the matter may be allowed to remain. But we may recommend Prof. Balfour's report to those who desire to gain some insight into the fundamental laws of tree growth with which the pruner's art should be in unison.

AN EXHIBITION OF BIBLICAL NATURAL HISTORY.

AS a supplement to the literary and historical Biblical exhibition which has been arranged at Bloomsbury for the tercentenary of the Authorised Version, an exhibition of the animals, plants, and minerals mentioned in the Bible has been arranged in one of the bays of the Central Hall of the Natural History Museum, South Kensington. The animals and minerals, respectively, have been selected, arranged, and labelled by Mr. R. Lydekker, F.R.S., and Dr. G. F. Herbert Smith, under the general supervision of the keepers of zoology and mineralogy; the plants have been dealt with by Dr. A. B. Rendle, F.R.S., the keeper of botany. The interesting guide-book to the collection is in great part a reprint of the exhibited labels, which were mainly based on the careful work of the late Canon Tristram. The minerals, which Tristram did not consider, are dealt with in a scholarly essay by the director, Dr. L. Fletcher, F.R.S., who explains how modern interpretations of the ancient names of Biblical minerals have been deduced.

The collection, and the guide to it, will be of special interest to those to whom Bible plants and animals are rich in picturesque associations; but it is, of course, part of a liberal education to know that the "unicorn" was probably the extinct wild ox or aurochs, "behemoth" the hippopotamus, the "coney" the hyrax, and the "leviathan" of Job the crocodile. Some of the corrections are curious; thus the "ferret" of Lev. xi. 30 was probably a gecko, and the "mole" of the same verse a chamæleon, and the "chamæleon" of the same verse a monitor, and the "spider in king's palaces" a gecko. An up-to-date suggestion is noticed, though not accepted—that the "badger" of Exod. xxvi. 14 was the okapi. We do not see any reference to the "fiery serpent," though the museum used to have a specimen of *Filaria medinensis*, the guinea-worm, with a label indicating that *it* was probably that reptile.

What must strike the reader most, especially perhaps when he comes to the botanical part, is the large proportion of misses that the translators made. And if we might venture on a criticism of a carefully executed piece of work, we would suggest that a little more might have been said in explanation of this. A paragraph or two on the backward state of natural history when the authorised translation was made three centuries ago would have been interesting. We also wonder why our leading scientific institution has not used this opportunity, which is undoubtedly one of wide popular interest, to tell us—who could do it better?—what is scientifically interesting in the fauna and flora of Palestine.

LIEBIG AND HIS INFLUENCE ON THE PROGRESS OF MODERN CHEMISTRY.[1]

A HUNDRED years ago Europe was still plunged in the misery of war. Almost every country had suffered the bitter experience of seeing the devastation caused by the passage of contending armies, the death and suffering of thousands of fighting men, and the want and desolation spread over still greater numbers of a helpless population. Amid all the wretchedness of the time, insecurity of property, dearness of food, frequent changes of governments, and every condition which would appear to be unfavourable, the study of nature steadily went on. France, still staggering from the fierce shocks of the revolutionary period, had still many distinguished men of science, Laplace, Berthollet, Lamarck, Cuvier, while the memory of Lavoisier was fresh and green, and Gay-Lussac, Dulong, Arago, and Chevreul were among the coming men. England, still engaged in the struggle with Napoleon, possessed Humphry Davy, Rumford, and Dalton, and Herschel among the astronomers. Henry Cavendish was still living, though an old man, and Priestley was but lately dead. In Germany, Goethe might be counted among the votaries of science, and Prussia had sent forth Humboldt to survey the world, while in Italy, Volta was busy in the study of electricity, and Avogadro, little noticed by the world, was meditating on the properties of gases and preparing for the enunciation of the great principle which is now associated with his name, though it took the chemical world half a century to recognise it. One other name must not be forgotten, and that is Berzelius, the Swede, then young, and preparing, by his eager activity in research, for that great position of almost undisputed authority in the chemical world, which he filled for nearly forty years.

To understand the influence which any one man appears to have had in his day and generation, it is necessary to bear in mind the condition of the world into which he was born, as well as the quality of his genius. The one reacts on the other. In endeavouring, therefore, to estimate the nature and extent of the services rendered to science, and to the world in general by Liebig, it is necessary to get a clear view of the state of knowledge in chemistry at the time when he appeared on the scene.

Born in Darmstadt, on May 12, 1803, where his father was a colour manufacturer, he passed through an unsuccessful school career at the local gymnasium, and, at the age of sixteen, was apprenticed to an apothecary. It soon became evident, however, that he was as little fitted to become a pill-maker as he was to be a Greek scholar, and he ultimately persuaded his father to allow him to go to the then newly-founded University of Bonn, whence he followed Kastner, the professor of chemistry, to Erlangen. But Liebig soon became convinced that he could not study chemistry effectively in Germany, and after taking his degree at Erlangen, at the age of nineteen, he proceeded to Paris. There, after many difficulties, he ultimately obtained the privilege of working in Gay-Lussac's laboratory, where he remained about two years. In 1824, on the recommendation of Humboldt, he was appointed extraordinary professor of chemistry at Giessen, being then only twenty-one years of age. He became ordinary professor two years later, and remained at Giessen until called to Munich, in 1852. There he died on April 18, 1873.

Such was the main course of Liebig's career; but to draw a picture of the man from descriptions of his personal characteristics is not easy. In early youth he became familiar with the poet Platen, who noted in his diary "the friendly earnestness in his regular features, great brown eyes, with dark shady eyebrows, which attracted one instantly."

Those brown eyes, shining with earnestness, remain in the portraits which have come down to us, and as a

[1] Lecture delivered at Oxford on August 23, at the Fifteenth Summer Meeting, by Sir William A. Tilden, F.R.S.

family feature, reappear in the faces of some of his children. Ardent, eager, enthusiastic in the pursuit of experiment, his remarkable power of exact observation stood him in good stead. Kindly and tender with children, there were times when eagerness in research or controversy led to exhibitions of impatience, but the steadfast character of the man is illustrated by the persistence of his lifelong intimacy with Friedrich Wöhler. This intimacy resulted in a correspondence which extended over more than forty years, and had consequences in the lives of both men, which were full of importance for the progress of chemical science. To this reference must be made further on.

We may now endeavour to sketch, in outline, the state of knowledge and theory when Liebig entered on his career.

The modern use of the term element, which had been introduced by Robert Boyle in the seventeenth century, was by this time universally adopted, and to the metals on the list had been added such important substances as oxygen, hydrogen, nitrogen, and chlorine. To use the words of Davy, in one of his researches on chlorine, "Neither oxygen, chlorine nor fluorine are asserted to be elements; it is only asserted that they have not been decomposed." And that is the sense in which the term has, in modern times, always been used. The process of burning or combustion was, of course, now always explained by Lavoisier's doctrine, according to which a body in burning combines with the oxygen of the air, and forms one or more chemical compounds with it. At the time that Liebig went to Giessen, in 1824, Sir Humphry Davy was still living, but his scientific career was practically closed, and Berzelius was the predominant authority in matters of theory. Gay-Lussac, in Paris, had made important discoveries relating to the proportions in which gases enter into combination. Dalton's atomic theory, propounded in 1808, though not generally accepted, was gaining ground. Broadly, the position was this: elements were clearly distinguished from compounds, chemical combination was explained by the supposition that it was due to the close approximation of atoms of opposite kinds, and the union of atoms to form a chemical compound was attributed to the attraction caused by charges of electricity of opposite nature, which were supposed to be resident on the atoms.

But the composition and nature of "organic" compounds were practically unknown. A few such substances had been isolated, *e.g.* milk sugar and grape sugar were known as distinct substances, and were differentiated from common sugar. Alcohol, nearly pure, had been known, in the form of spirit of wine, from early times. Acetic acid was known, as well as several acids found in vegetable tissues, such as oxalic, formic, malic, tartaric, and benzoic acids. There were, however, no means of determining their composition, and although Lavoisier had devised an apparatus in which organic compounds could be burned in oxygen, and the water and carbon dioxide thus formed could be collected, the process was both cumbrous and incapable of yielding exact results.

A most interesting autobiographical sketch was discovered among Liebig's papers many years after his death, and from this we learn that in his early life "at most of the universities there was no special chair for chemistry. It was generally handed over to the professor of medicine, who taught as much as he knew of it, and that was little enough, along with toxicology, materia medica, &c." But the total neglect of experiment was the source of much mischief, and the persistence of the degenerate deductive method led to neglect of the careful observation of nature. The lectures of Prof. Kastner Liebig describes as without order, illogical, and they resembled the jumble of knowledge which he carried about in his own head. When he got to Paris all was different, and the lectures of Gay-Lussac, Thénard, and Dulong had for the young student an indescribable charm. The lecture consisted of a judicious series of demonstrations—experiments of which the connection with each other was pointed out and explained; and soon the consciousness dawned on him that all chemical phenomena, whether exhibited by the animal, vegetable, or mineral kingdoms, are connected together by fixed laws.

Liebig therefore returned from Paris to his own country with the intention of founding an institution in which students could be instructed in the art and practice of chemistry, the use of apparatus, and the methods of chemical analysis. In view of the total absence of such provision elsewhere, it is not surprising to learn that, so soon as its existence became known, students streamed into the Giessen laboratory from every civilised country. It is interesting to learn from Liebig's own words what was the method he adopted. Obviously, in order to teach a large number at one time, it is necessary to have a systematic plan, and in his case this had first to be thought out and then put to the proof, as no course existed which could be used as a model. He says, however, that "actual teaching in the laboratory, of which practised assistants took charge, was only for the beginners; the progress of my special students depended on themselves. I gave the task and supervised its carrying out. There was no actual instruction. Every morning I received from each individual a report on what he had done the previous day, as well as his views about what he was engaged on. I approved or criticised. Everyone was obliged to follow his own course. In the association and constant intercourse with each other, and by each participating in the work of all, everyone learned from the others. Twice a week in winter I gave a sort of review of the more important questions of the day. We worked from break of day till nightfall. Dissipation and amusements were not to be had at Giessen. The only complaint which was continually repeated was that of the attendant, who could not get the workers out of the laboratory in the evening when he wanted to clean it."

Such was the spirit and such the method by which a great school was created! Nor was this the only result. To the influence and example of the school at Giessen may be attributed the rapid spread of the new method of teaching chemistry. In 1824 there were no laboratories devoted to the purposes of instruction. A few of the most eminent professors of chemistry—Berzelius in Stockholm, Gay-Lussac in Paris, for example—admitted one or two students already advanced in the subject to practise in their private laboratories, but only as a great favour. In this way Mitscherlich, Rose, Wöhler, and Magnus had repaired to Berzelius in Stockholm as Liebig had gone to Paris. But in a few years the fame of what Liebig was doing in Giessen penetrated to other countries of Europe, and many of the men who had studied under his direction became teachers in other lands. Here in England no chemical laboratory for general instruction existed, and only in the medical schools were a few tests described and shown. In London the Society of Apothecaries had a laboratory which had existed since 1671; but this was not used for teaching, but as a place of manufacture of drugs for use in medicine. At Cambridge the professor of chemistry was a country clergyman, who came up once a year to give a course of lectures. At Oxford the professor of chemistry was also, later, professor of botany, and in neither university was there a laboratory for instruction, nor was chemistry a subject recognised in the curriculum for a degree. Twenty years later things began to improve. In this country the first laboratory for instruction in practical chemistry was provided by the then newly instituted Pharmaceutical Society of Great Britain at their premises in Bloomsbury Square. This was in 1844, and in the following year a new and enlarged laboratory was fitted with places for twenty-one students.[1] About this time the College of Chemistry was established in temporary quarters in George Street, Hanover Square, and soon afterwards the Birkbeck Laboratory, modelled on that of the Pharmaceutical Society, was built at University College. Many other laboratories were opened about this time. In 1848 Pélouze founded in Paris a laboratory to which some English chemists resorted. But the Giessen laboratory under Liebig's direction continued to supply the majority of the teachers who in the succeeding generation founded schools, not only in Germany, but in other countries—Hofmann, for example, at the Royal College of Chemistry, and Williamson, who was appointed at University College in 1849.

Liebig's career as a chemist and investigator was influenced in no small degree by his friendship with Wöhler. Born three years before Liebig, Friedrich Wöhler

[1] I saw this laboratory about 1857. It had the aspect which one usually associates with ideas of the alchemists. Many of the operations were connected with the use of furnaces, such as fusion, sublimation, &c., and the place was full of smoke and fumes.

studied medicine at Marburg, but subsequently pursued chemistry at Heidelberg under Leopold Gmelin. Having relinquished medicine on taking his degree, he obtained the privilege of working with Berzelius in his laboratory at Stockholm. On his return from Sweden in 1824 he was appointed teacher of chemistry in the Trade School in Berlin. Some years later he became professor in the University of Göttingen. Soon after his return from Sweden he met Liebig in Frankfort, and a close intimacy at once sprang up, which continued for more than forty years to the end of Liebig's life. Two volumes of their correspondence have been compiled by Hofmann, and the perusal of these letters, extending from 1829 to 1873, affords a view of the subjects which occupied the minds of both, as well as many of the incidents of their lives. One only we have time to notice here. Liebig paid several visits to England, and in a letter to Wöhler dated from Giessen, November 23, 1837, he tells him that he has travelled through England, Ireland, and Scotland in every direction, and has seen many surprising things, but has learned little. The absence of scientific knowledge in England he attributes to the badness of the teaching. In another letter, addressed to Berzelius nearly at the same time (November 26), he says:—"England ist nicht das Land der Wissenschaft," only there is a widespread "dilettantismus," and he complains that "die Chemiker schämen sich Chemiker zu heissen, weil die Apotheker, welche verachtet sind, diesen Namen an sich gezogen haben."

Liebig's contributions to pure chemistry, though so numerous and important, can be recalled only briefly. They may be placed under three heads, namely, first, the invention and perfecting of a method for analysing organic compounds, which in all essential features is still practised everywhere.

Secondly, the discovery of a large number of new compounds, of which even the names cannot now be mentioned for want of time, but which include chloroform and chloral and many cyanides. He also established the formula of uric acid and the nature of aldehyde.

Thirdly, we owe to Liebig the conception of the theory of compound radicals, which arose out of his researches jointly with Wöhler (1832) into the products from essential oil of bitter almonds.

In a letter to Wöhler (May 26, 1839), Liebig writes that he is occupied with the study of the phenomena of fermentation and putrefaction, and having sent an account of his views to Wöhler, another letter, dated June 3, discusses the criticism which he has received from him. In the postscript to this long and interesting letter, we find a concise statement of Liebig's hypothesis concerning the action of ferments.

Before proceeding further, it will be well to understand what is meant by fermentation. If we take a solution of sugar, and add to it a very small quantity of brewers' yeast, or, if we take grape juice without any addition, in a short time, especially in warm weather, a frothing, due to the escape of minute bubbles of gas, soon sets in, and this continues until the liquid has lost its sweet taste, and has become more or less alcoholic and intoxicating. The escaping gas is carbon dioxide, vulgarly called carbonic acid, and the liquid retains, beside alcohol as the chief product, small quantities of other things. Somewhat similar changes go on in the leavening of bread, the souring of milk, the putrefaction of meat, and apparently also in the animal body in the course of many feverish diseases. One peculiarity of the process consists in the fact that the ferment, the yeast for example, serves to bring about chemical decomposition in a relatively large, almost indefinitely large, quantity of the sugar or other substance in solution.

Liebig's explanation of these changes was based on purely mechanical ideas as to the motions of the hypothetical particles or atoms. He imagined the atoms of a substance which causes fermentation or putrefaction to be in a state of unceasing vibratory motion, and that this state of agitation was communicated to the molecules of the sugar, causing them to undergo an internal rearrangement, and to break down into simpler structures of a more stable nature, in the case of alcoholic fermentation of sugar, in fact, into alcohol and carbon dioxide.

Liebig made the mistake of ignoring, as nearly all chemists and biologists of that time ignored, the constitution of the ferment. In 1859 and following years, Pasteur, the great French chemist, demonstrated the essentially vitalistic character of the phenomenon, and showed that the destruction of the sugar was an effect concomitant with the growth and multiplication of the cells of a minute organism, visible under the microscope. A special form and character of organism is concerned in each type of fermentation.

The organised character of yeast had been proved many years before by the observations of Kützing, Cagniard Latour, and Schwann. Nevertheless, the views of Liebig prevailed for some time. In the English version of his famous letters on chemistry, in the fourth edition, which appeared in 1859, there is a chapter headed "Theory which ascribes fermentation to fungi refuted." As a matter of fact, it was about this time established.

Liebig was ultimately convinced of the organic nature of yeast, but he still contended for his theory of molecular destruction by communicated agitation, as furnishing the explanation of the physiological act which comes about within the cells of the yeast. An important step was taken much later, when, in 1897, it was shown by Buchner that something can be dissolved out of yeast which, independently of the cells, is capable of resolving sugar into alcohol and carbon dioxide. Thereupon, it seemed to some that Liebig's views might be resuscitated. But the changes which occur are now known to be very complicated, involving, in the first place, a process, not of destruction, but of building up molecules of a more complex nature, before they are broken down into the final products of fermentation. Liebig's theory, therefore, disappears from the scene.

Before 1840 it may be stated as almost literally true that physiology in the modern sense of the term did not exist, and certainly there was but a small basis for chemical physiology. The chemical production of urea independently of animal life, by Wöhler, in 1828, was a fact of which the deep significance appeared only much later. The studies in organic chemistry, into which Liebig had plunged alone, or in conjunction with his friend, necessarily attracted his attention to problems connected with the phenomena of animal and vegetable life. His visit to England, in 1837, was largely occupied with observation of the methods of agriculture then prevalent, and during the succeeding years we find in the catalogue of his scientific papers, many signs of his activity in pursuit of questions connected with the application of chemistry to agriculture, the growth and nutrition of plants, the formation of fat in the animal body, the composition and classification of foods, the source of animal heat, and the chemical processes connected with respiration and digestion. It is not possible for us to enter freely into the discussion of all these great subjects, but we must glance at Liebig's views in regard to two of them, not because those views have retained their predominance, but because of the stimulus they gave to inquiry and the encouragement he gave by precept and example to the fundamental principle on which the greater part of modern science is built, namely, the constant appeal to nature, not only by observation, but by systematic experiment.

In Liebig's time all biological processes were supposed to be controlled by what was called "vital force," that is, something which is not mechanical force, nor heat, light, electricity, nor chemical affinity. We are still a long way from knowing what life is, but to show how far some physiologists have travelled in the opposite direction, I will make a very short quotation from a recent book. Concerning the use of the word "metabolism," which is a comprehensive word covering all chemical changes which go on in the body during life, the writer directs attention to its implication "that all the phenomena of life are, at bottom, chemical reactions. When a muscle twitches no less than when a gland secretes, it is not too much to say that when we are moved to tears or laughter, it is chemical reactions that are the underlying causes to which ultimate analysis must lead us." I quote this as an extreme view.

Let us turn first to Liebig's classification of foodstuffs. It is necessary to account for the maintenance of the animal functions, the growth and repair of the body, the maintenance of its temperature.

Liebig attributed, as we believe correctly, the heat produced in the body to the process of burning, which goes on in the tissues in consequence of the absorption of atmospheric oxygen. Liebig was also right in his assertion that animals do not necessarily derive fat from their food, but the animal body is a laboratory, in which fat may be manufactured from carbohydrates, such as sugar and starch. The substance burned in the body is material derived from the food, but it has long been known that the substance thus burned does not consist exclusively of sugar, starch, and fat, which Liebig called *respiratory* foods.

The other constituents of food, now included under the general term protein, which contain nitrogen, and are more or less like white of egg in properties, he called *plastic* foods. These were supposed to produce new tissue, or repair waste, and to be the source of muscular energy or power to do work.

It is now known that the case is by no means so simple, and, in fact, this classification now possesses only historical interest. The whole question when considered in the light of modern knowledge is, in fact, a mass of difficulties, and very far from being clear of serious controversy. Liebig's name is associated in the public mind almost exclusively with the extract of meat, which he prepared for the first time in connection with his studies of food. This is to do him less than justice. Liebig never proposed it for use as a substitute for meat, because it contains only a part of the constituents of flesh. It appears that his idea, in the first instance, was to turn to account the flesh, which would otherwise be wasted, of animals which in Australia and South America were then bred solely for the sake of their wool and fat. Extract of meat is to be regarded as a valuable stimulant to be consumed together with bread or other vegetable food.

Let us now turn to the investigations into the operations and theories of agriculture with which Liebig's name should be for ever associated. Whence do plants get their carbon and nitrogen, which, together with hydrogen and oxygen and water, form the material of their tissues? What is the use of the mineral substances found in the ash left on burning vegetable matter? Why are different soils adapted to different crops, and what is it that gives fertility to a soil?

The state of knowledge on such subjects is indicated roughly by the summary which had been provided by the lectures of Sir Humphry Davy in 1813. During the subsequent twenty-five years very little had been done in the way of experiment, but it would be only fair to mention the name of the great French agricultural chemist Boussingault as one of the pioneers a little in advance of Liebig in the study of such questions. Briefly, the position was somewhat as follows: it was known that plants decompose the carbonic acid of the air, using the carbon and letting the oxygen go free, but it was commonly supposed that the brown or black substance in the soil, which is usually called *humus*, and is the result of the decay of preceding vegetable growth, was the chief source of the carbon in growing vegetables. Liebig pointed out that this was impossible, because it failed to show from what source the original plants from the decay of which humus was formed derived their carbon. Liebig was the first to study carefully the mineral constituents of plants and to recognise the importance of certain substances, especially potash and phosphates. The services which Liebig rendered to the world in connection with plant physiology and agriculture are, however, less to be recognised in the shape of positive contributions to knowledge than in the example set and in the influence of that example in stimulating systematic investigation of agricultural questions. By 1840 Liebig was one of the most famous chemists in the world, and the effect of his inquiries is shown in the activity which became manifest almost immediately after the communication of his first report to the British Association at the Glasgow meeting in 1840. In Germany the Government instituted a large number of Versuchs Stationen in different parts of the country, and in 1843 the systematic experiments were started at Rothamsted which must for ever place the names of Lawes and Gilbert among the benefactors of the world.

But here I must pause to remind myself and my hearers that the subject of my lecture is Liebig and his influence on the progress of modern chemistry. He died in 1873; but the period of his greatest activity in science lies further back by thirty years. Since either period vast changes have been brought about by chemical discovery, which, be it always remembered, is based on experimental work in the laboratory. That is the reflection which supplies the explanation of Liebig's great influence on the progress of science. That influence was fully recognised by the generation of chemists now passing away, or almost gone, and it seems to be a duty to preserve as long as possible a memory so rich in past benefits and so full of suggestion for future use.

Liebig made many discoveries in chemistry; but his great and permanent service to the world was not in the isolation and study of individual compounds or series of compounds, nor in the conception of theories of chemical action, nor even in views which he promulgated concerning the operations of agriculture, the composition of food, the processes of digestion, or the source of animal heat. His great service consisted in showing how chemistry should be studied and how it should be taught, in setting the example of submitting all questions to the light obtained by direct experimental study of nature, and in thus affirming and illustrating the principle that what is called pure science is of greater permanent value than what is called applied science; a knowledge of the laws of nature is more useful than many inventions.

In the Giessen laboratory were trained a considerable number of chemists, many of whom became the teachers of the next generation. From these teachers and their pupils, guided by the same principles as those of the Giessen school, came discoveries of first-rate importance. If Hofmann, a student of Liebig's, had not been attracted to the study of aniline, an inconsiderable constituent of coal tar, if his pupil, Perkin, had not been led to a further study of its transformations, we should have had to wait a long time for the coal-tar dyes and the industries connected therewith. If a host of workers trained in Liebig's laboratory, and others emulating their example, had not cultivated the study of all sorts of carbon compounds, often unimportant in themselves, we should not have seen the numerous applications of chemistry to medicine—the saccharin, aspirin, antipyrin, sulphonal, &c.—nor the artificial perfumes, such as those of violet and lilac, which are now made independently of the original source in the flowers. Without the foundation work I have mentioned we could not now have the beginnings of the true physiology based on the study of chemical and physical processes and reactions, nor the possibility of following the changes brought about by all sorts of ferments, on the combined results of which we may hope to have a complete development of a scientific system of medicine and the treatment of disease.

But there is one other direction of Liebig's activity to which I have not alluded. Discoveries in the study of nature are of little value unless they can be communicated to that part of the world which can and will make use of them. Up to the end of the eighteenth century there were no means of publication except, on one hand, through the transactions of the half-dozen academies, and these were the only scientific periodicals, or, on the other, by the special treatises prepared by investigators for the purpose of making known their own discoveries or opinions. Thus we have the famous works of Robert Boyle on the Spring of the Air, and the Sceptical Chemist, Scheele's works on Air and Fire, Priestley's Experiments and Observations on different kinds of Air, Dalton's New Chemical Philosophy, and many others. The publication of such books was often accomplished only after years of preparation. In 1832 Liebig founded the *Annalen* which have ever since borne his name. Out of Trommsdorff's old *Annalen der Pharmacie* Liebig created a journal which has been for eighty years one of the chief repositories of the best products of the laboratories of the German Empire. Into this journal were poured the results of Liebig's and Wöhler's several or joint researches. At the time of Liebig's death, in 1873, 165 volumes of the *Annalen* had appeared, and there has been an equal number since that date.

I need do no more than mention the titles of the "Handwörterbuch" which Liebig, with the cooperation of his friends Poggendorff and Wöhler, produced between 1836 and 1856, the "Handbuch der Chemie" in 1843, and the famous "Letters on Chemistry," which were originally published as newspaper articles in the *Augsburger Allgemeine Zeitung* with the object of bringing within the ken of the general public some of the more important consequences of the advance of knowledge in connection with the affairs of everyday life.

Again, up to 1847, Berzelius had for many years prepared annually a "Jahresbericht über die Fortschritte der physischen Wissenschaften," but near the end of his life this laborious undertaking was no longer possible for him, and Liebig, in association with Hermann Kopp, the physical chemist, commenced the "Jahresbericht," which, so far as chemistry and the allied sciences is concerned, continues to this day. It is no longer so important as formerly, having fallen behind in date, but for certainly forty years it was indispensable to every practising chemist who was directly or indirectly interested in the progress of the science.

Since the days of seventy or eighty years ago, when Liebig set these enterprises in motion, the number of periodical publications devoted to recording advances in chemistry has greatly increased, and a number of journals now appear at regular intervals of a month, a fortnight, or even a week, which have become necessary in consequence of the specialisation which is characteristic of our time. We have therefore journals of inorganic chemistry, physical chemistry, applied chemistry, and some limited even to one topic, such as electrolysis or radium. Liebig's ***Annalen***, however, continues to hold an honoured place in every chemical library.

Since Liebig's day we have advanced in many directions very far. Not only has the atomic theory given us by Dalton long since become the mainstay of the chemist, but we confidently assume, on good evidence, that we know the order in which these small bodies stand in a molecule of sugar, for example, and the relation of this order to the visible forms of the crystals in which such substances are often presented. We know, too, the relative masses of these minute bodies—the atomic weights, so called—and it is certain that these weights are directly connected with the properties of the bodies the atoms compose. There is also a relation among the atomic weights, which is broadly summed up in what is known as the periodic law, from the study of which most chemists are convinced that the so-called elements were evolved out of something of a simpler order, possibly one or two primal matters to which the term element would more properly belong. Nor is this all. Everyone has heard of radium, but few of the public, I suppose, know its history. Henri Becquerel, so late as 1897, observed that compounds of the metal uranium emit something which passes through many bodies opaque to ordinary light, and which renders the air around it conductive of electricity. Following up this observation, Madame Curie discovered radium. Radium is a metal in many respects like others previously known, but differing from them in the extraordinary power of throwing off electrically charged particles with enormous velocity, together with a remarkable gaseous emanation. According to the generally received view, which we owe to Prof. Rutherford, we are face to face with a process which is the reverse of that by which we may suppose the ordinary elements, or some of them, to have been formed. The decay of matter is thus indicated, and, though the process affects only minute quantities of stuff in the earth, it is sufficient to provide food for reflection to the geologist who wants to account for the rate of cooling of the earth and to the cosmogonist who can imagine the operation proceeding elsewhere on a far larger scale. There is temptation enough here to the speculative mind. Everything is now supposed to be expressible in terms of electricity, concerning the nature of which no one knows anything. Chemical action is attributed to exchanges of electric units, and matter of all kinds is supposed to be made up of the same. In the midst of all this confusion the clear duty of the chemist, at any rate, is to follow the practice inculcated by Liebig and stick to experiment, observation, and careful inductive reasoning.

One word in conclusion. The creation of a school of thought, such as that of which the chemical school at Giessen was the centre, requires originality as well as learning in the teacher, intelligence in the taught, and a sympathetic relation between professors and students. These are more important than buildings and appliances. But much influence is exercised by the environment; that is, by the attitude of the public. Appreciation of learning and interest in the results of research have long been provided more freely in Germany than in England. Though we cannot now admit, without qualification, the reproach of Liebig, already quoted, it is still true to some extent that what the public in England wants is invention rather than discovery; the applications of knowledge before the knowledge itself.

Some people will doubt, perhaps, whether we are so much behind Germany, "learned, indefatigable, deep-thinking Germany," as Carlyle called her. We have an immense amount of popularisation of the results of science, but it is to be feared that much of this is too easy, shallow, and misleading.

I think the difference between the two peoples is to be partly acounted for by the attitude of the Governments in the two countries. In England it is the custom to leave the investigation of many important subjects, like agriculture, to the chance of private benefaction or voluntary effort. In England, again, it is only in comparatively recent times that assistance out of public funds has been given to the universities. This attitude of the Government has an immense influence in directing popular views of institutions, of things, of men. That which the masses find placed in positions of advantage by the powers set over them are naturally held in higher esteem than those which are always kept in the background or in a position of evident inferiority. In Germany the university chairs are occupied by the greatest specialists in every department, and these are men who are honoured at Court, consulted by Ministers, and trusted by manufacturers. But, after all, when we have exhausted the enumeration of all the adventitious influences at work in both countries, it seems as though there were some elements in the mental constitution of the different peoples which leads them to handle the same subject of inquiry in different ways. It has been so in the study of chemistry.

At the beginning of the nineteenth century, with the aid of the principles bequeathed by Lavoisier, the facts which had been established by Priestley and Cavendish, the discoveries of Humphry Davy, and the atomic theory of Dalton, France and England were engaged in laying the foundations of the new science. At that time Germany had no chemists. Liebig himself bears witness, in his autobiography, that in his youth "it was a very wretched time for chemistry in Germany." During the latter half of the century there arose in nearly every German university a famous school of chemistry, and in practically all cases it has been a school for the cultivation of so-called "organic chemistry," in which department German chemists have achieved the most brilliant successes. Nothing can be more important than Kekulé's theory of the aromatic compounds. Nothing can be finer than the synthetical work of von Baeyer and Emil Fischer in connection with indigo, the sugars, and the proteins, or albuminoid substances, the chief basis of the animal tissues. But it cannot be maintained that they have been equally distinguished for the discovery of broad general principles. German triumphs have been more frequently the result of that patient attention to detail which seems characteristic of the German mind.

Take, by way of illustration, the problems which at the present time loom largest before the chemical world. There are first the relations among the atomic weights, discovered by Newlands, an Englishman, and worked out by Mendeléeff, a Russian; next, the arrangement of atoms in space, or stereo-chemistry, to which the clue was furnished by Le Bel, a Frenchman, and van 't Hoff, a Dutchman; next, the process of electrolysis and the constitution of salts in solution, of which by far the most important theory, the theory of free ions, was supplied by Arrhenius, a Swede. Again, there is radio-activity with all its consequences, the isolation of radium by Madame Curie, and the greater part of its wonderful history, worked out by Rutherford and Ramsay, both British chemists. To those great fields of inquiry Germany has, doubtless, made contributions, but she did not discover them.

My own impressions are strengthened by a passage which I will venture to quote from a modern work, "The History of European Thought in the Nineteenth Century," by Dr. Theodore Merz, himself a German, though domiciled in England. He says (vol. i., p. 300): "The largest number of works, perfect in form and substance, classical for all time, belongs probably to France; the greatest bulk of scientific work probably to Germany; but of the new ideas which during this century have fructified science, the larger share belongs probably to England."

After all, German chemistry can always point with just pride to the great teacher of us all, Justus von Liebig.

EXCAVATIONS AT MEROË IN ETHIOPIA.[1]

THE ruins of the Meroë were noticed so long ago as 1772 by the famous traveller James Bruce; but his identification was not generally accepted, and it was not until three years ago that Prof. Sayce, in the course of an official inspection on behalf of the Sudan Government, recognised that unquestionably they were the remains of Meroë, and invited Prof. Garstang, then at work in Egypt, to undertake the excavation.

The Government of the Sudan encouraged the work by facilities and assistance, including the construction of a railway siding, the provision of water tanks, and materials. In this way the wants of 500 or 600 workmen were provided for. The camp became a stopping place for certain trains, which brought provisions, and it marks the site of a new station which will shortly be available to visitors. Practically nothing of the ancient city was visible above the soil when the party arrived upon the scene—no ruined buildings or connected walls, only mounds of débris and a few carved stones here and there—for the well-known pyramids of Meroë that mark the spot lie back several miles in the solitude of the desert.

The gates of the city opened, as it were, one by one before the ordered and methodical attack of the excavator's trained Arab workmen. Great temples, royal palaces, and public buildings emerged gradually from the sands; the city walls and gates and quays stood once more in their places; colossal statues, altars, and public monuments disclosed their whereabouts; the tombs yielded up their secrets; and numbers of small, artistic remains were trapped in the busy sieves.

[1] From the Guide to the tenth annual exhibition of antiquities discovered at Meroë, and the second interim report upon the excavations, by Prof. J. Garstang.

In addition to the visible results, archæology has received some new and important contributions, for, until this work was undertaken, nothing was known of the subject of the Ethiopian civilisation from the specialist's point of view, and this fact naturally doubled the difficulties of an excavation of this kind. For this reason, primarily, the first experiments (season 1909–10) were made in the tombs and isolated knolls, as being the most accessible sources of information as to the character of ordinary Meroitic objects.

The tombs, being of unknown type and securely cemented down, for some time baffled the workmen, but at last there came to light some thousands of vases—found, in some instances, as many as thirty or forty in a single tomb chamber. They were all of a style new and peculiar, without any noticeable trace of Egyptian influence. In the tombs furthest to the north vases of a special and rare kind were recovered made of thin pottery, decorated with paintings in colours (the subjects being animals, trees, or natural features), or with designs stamped upon the clay. Similar vases in more perfect state were found in 1911 among some ruined buildings in the west of the city area.

FIG. 1.—View in the Temple of Amon. Place of sacrifice in the foreground, the high altar beyond.

In addition to pottery vessels there were in the tombs a variety of objects not merely funerary in character.

In obedience to primitive instinct, the dead was laid to sleep on his bed in his subterranean chamber surrounded by the things which would be to him the most useful upon his awakening. The soldier had his weapons (sword, lance, dagger, &c., all of iron); the huntsman his bow and arrows—even his hounds were sometimes sacrificed with him. The women had equally their beads and their jewels. In a few cases the frame of a decayed wooden bed might be traced; and in every tomb the vases and dishes seemed to have contained drinks and food. It is probable that originally one of the doors was left so that it might be opened for the regular renewal of the offerings.

While this experiment was in progress, the position of the great temple of Amon was determined, and the task of uncovering it was begun. The entrance proved to be a pylon in the Egyptian style, and the central aisle leads through a series of columned halls to the sanctuaries, at a distance of 130 yards, beyond which the temple abuts on the great wall of the city. Towards this end, in the main axis, there still stood the high altar, carved in a single block of stone, decorated in relief with the figures of gods and of the king in his character of chief priest. At the foot of the altar were found the last votive offerings where they had been laid just previous to the destruction of the city.

Two small temples in the neighbourhood gave further information. One was dedicated to the Egyptian goddess Isis. In this ruin two buildings were superposed, and in the foundations of the later one (which was built, for the most part, out of the ruins of the earlier) were found two great statues of columnar form representing the king and queen of Ethiopia. The upper building did duty at a later time as a Christian church.

FIG. 2.—Deep excavation to the north of the royal enclosure.

The second temple seemed to have been dedicated to the lion god, a primitive cult of which there are a number of indications. It was situated on the east side of the town towards the desert, a fact which recalls to mind that travellers of last century speak of the great number and the ferocity of the lions in this district. Inside were found two sculptured lions in stone, one on each side of the door, and several other emblems of the same animal. Included among these was a slate plaque, carved on both sides, on the one with the design of the king in his gorgeous state robes, on the other the lion god in human form standing upright upon a man's legs. Each sculpture was also inscribed in the language and writing of Meroë; and in the inscription, thanks to the assiduous study of philologists, there can now be recognised the names of gods and personages.

The temple of the sun was discovered and uncovered at the same time. The building is surrounded by a square enclosure wall with four doorways, but the chief entrance is from the east; in this direction also there are two shrines, also constructed in stone. The outside wall of the temple is decorated with scenes of war, of triumph, and of sacrifice. A sloping way leads up from the east to the chief platform, which is entirely surrounded by a cloister. The architecture, both in the proportion of its columns and interspaces, as well as in the elegance of form and the exactness of construction, recalls the best Greek works of antiquity, and not at all the styles common upon the Nile. The sanctuary is in the middle and raised above, being approached by a number of steps in black stone. Its floors and its walls were originally covered with glazed tiles, blue and yellow, of which a number are still in position. Round the sanctuary was a kind of corridor or perambulation, exposing to view on the outside the processions and the ceremonies of the priests.

Such were the results of the first year's explorations of Meroë. There was no doubt that it was necessary to continue the excavations, and funds were provided by which the work was able to go forward during the past winter. Some of the results of this season's work are described below.

The temple of Amon was completely excavated; previously the chambers around the sanctuary alone had been cleared, but in this season's work chambers 272, 278, and 277 were found to form a part of the main building. The first two were unimportant, except that in No. 272 there was found just at the foundation-level a remarkable cameo of Greek workmanship representing a pair of galloping horses, one black and the other white; its date may be approximately fixed at 300 B.C. In the same chamber there was found a small tablet of stone decorated with low reliefs representing the king and the queen making offerings respectively to Ram-headed Amon and the goddess Isis. Below were several lines of inscriptions in Meroitic cursive character. It is unfortunate that this object (now in the museum at Khartoum) was much broken, as it is a characteristic specimen of Ethiopian art. In the chamber 277 there were evidences of a colonnade, and at its western extremity a small shrine enclosed within a screen of columns. In the main avenue, in the centre, that is to say, of chamber 270, there was found in the paved floor of the building a place specially prepared for the sacrifice of larger animals; it was about 3 metres square, surrounded by a trench and enclosing a central space about 1 metre square, in which had stood a dish of stone lined with glazed tiles. In the outer hall (No. 271) the base of an obelisk of black granite was found *in situ* just to the left hand of the entrance to chamber 270. This obelisk must have been originally about 3 or 4 metres in height above its plinth; the upper part of it, however, was broken entirely away, so that only about

FIG. 3.—Roman Bronze portrait head, probably Augustus.

half a metre of the inscribed faces remain. The inscription is in lines of Meroitic cursive script clearly engraved, and, supplemented by the numerous fragments found scattered around, constitutes one of the longest Ethiopian texts hitherto discovered. To the south of the central sanctuary 279 there was found against the main wall of the hall a stone dais approached by several steps and carved in a single piece. It is decorated around the outside with a design of bound prisoners, while upon the steps themselves are similar representations of humble captives upon which anyone mounting the dais must place his feet.

The general plan of the temple of the sun, as previously published, was confirmed. A number of subsidiary chambers were found, however, against the southern wall, and these are represented in the new plan. On this side from the west there may be seen also an ascending ramp, leading up, doubtless, to a door in the southern wall of the building. On the same side to the east there came to light a small chamber enclosed between the main wall and the colonnade. In the floor of this were numerous vases of earthenware filled with incinerated bones and charcoal, a proportion of the bones being apparently human. Just above, upon the outer face of the main wall, there are scenes representing the slaughter of young men and boys, while among the sculptures which decorate the walls (some of them now falling away from their original places) there may be recognised scenes of torture. Of special interest is a group of decorative carvings upon the west wall of the main building, supplemented by fragments, which give a contemporary picture of the whole temple as it originally stood. The wall of the inmost sanctuary may be seen rising above the colonnade which represents the cloister upon the main platform; both the inner and outer pylon are also quite distinct. Another part of the scene represents a four-columned building, apparently that of which the ruins are traceable just to the east of the enclosure wall of this temple. The sloping way leads up to this building, and a number of figures included in the decorative scheme are arranged in two groups similar to one another in which a bound captive may be seen dragged up the slope by a cord attached to his leg, while a soldier from behind encourages him to mount with the point of his spear. The representations of the king seated upon his throne and of warriors mounted on galloping horses complete these interesting scenes.

FIG. 4 —Royal jewels discovered with a board of gold.

Several other smaller buildings have been included in the season's explorations—temples, houses, baths, chambers for workers in metal, the furnaces for pottery and bricks, and all the evidences of the active life of a great city of the East. But of even greater immediate interest was the discovery and excavation of the royal city and its palaces. Following under the surface the great wall, bounding the Amon temple on the west, which all the time was the centre of these investigations, it was found that it continued with the same width of five or six yards for a length of more than 300 yards. At last, instead of turning towards the east, and thus including the temple of Amon, it turned at each corner to the west and enclosed a space of 150 yards wide. On the west side, without doubt, it touched the river in ancient times—a fact which corresponds with tradition—and here there were noticeable specially built terraces to resist the action of the water, as well as a place of disembarkation and a quay communicating with the interior.

Inside there were two prominent mounds. That to the north covered a great columned hall, with frescoes of the king and queen in scenes of ceremonial and triumph painted on its walls. In the middle there had been constructed, at a second period, a massive pedestal, as if for an equestrian statue or group, with its foundations half as high as the original columns. In front of the entrance, interred in a pocket of clean sand, there was found, on the third day of the excavations, the massive bronze head represented in the illustration. It is a wonderful specimen of Roman art, in perfect condition, and clearly work of the age of Augustus, about the time of the birth of Christ. The eyes are of alabaster, with the iris inlaid, and pupil of dark glass, while the eyelashes are in bronze. It is twice life-size. To judge from the profile, it is just possible that this head represents Germanicus (B.C. 15–A.D. 19), who during his military career was stationed at one period in Syria, and is known from the Annals of Tacitus to have made a voyage by the Nile to Aswan; but the resemblance to the Prima Porta head of Augustus makes it more probable that it represents the first emperor.

Lastly, towards the end of the season, work was concentrated upon the palaces covered by the southern mounds. In a rubbish well were found pieces of glaze-work, sistrums, ankh-signs, and vases on which were the names of several royal personages of Ethiopia, of date probably towards the sixth or seventh century B.C. Among them may be noted *Aspelut*, whose other name was *Mer-Ka-Ra*; also *Uaz-Ka-Ra* (*Hor-ma-ti-leq*) and *Mal-nefer-neq*. In another place a piece of a big scarab gave the name of the Queen Tiyi and Amenhetep III., names familiar in the eighteenth dynasty of Egypt, in the fifteenth century B.C. Finally, towards the end of the work there were found two jars of pottery full of gold-dust and nuggets, of 22½ carats, and sterling value about 1700*l*. One jar contained also some royal jewels, inscribed with the two royal names last noted, as well as money, rings, scarabs, crude amethyst, and beads of coloured glass. This, without doubt, formed part of the traditional treasure of the Ethiopians; the vases must have been stolen in ancient times from the treasury, which was found destroyed to the very last stone, and the thieves had hidden them in the place where the excavators' spades have now disclosed them.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

It is announced in *Science* that Mr. John G. Archbold has made a further gift of 8000*l*. to Syracuse University, and that Governor Dix has approved two Bills passed by the recent New York Legislature, one granting 28,000*l*. for the Oswego Normal School, and one granting 10,000*l*. for an Agricultural College, Cobleskill.

Dr. A. N. Whitehead, F.R.S., fellow of Trinity College, Cambridge, has been appointed to succeed Mr. E. Cunningham, as lecturer in the department of applied mathematics and mechanics in University College, London; and Dr. J. Sherwood New to succeed Dr. F. N. Kay Menzies as assistant and lecturer in the department of hygiene and public health.

FOLLOWING the example, set first by the London County Council, of arranging annual conferences of teachers of science for the discussion of methods of teaching and other important matters, the Director of Public Instruction for Ceylon, Mr. J. Harward, was instrumental in bringing about a second conference on science teaching in Colombo last March. We have received a report of the proceedings at this year's meetings, which were largely attended. The interest with which the proceedings were followed showed clearly that the conferences are a movement in the right direction. Four papers were read and discussed, as follows:—the teaching of elementary mechanics, by Mr. C. W. B. Arnold; the value of ugliness in electrical apparatus, by Mr. A. J. Bamford, of Colombo Observatory; the position of biology in education, by Dr. J. Pearson; and physiology in boys' schools, by Mr. E. Evans, of the Government Training College.

THE Department of Agriculture and Technical Instruction for Ireland has issued its "Programme of Experimental Science, Drawing, Manual Instruction, and Domestic Economy for Day Secondary Schools" for the session 1911–12. Among the more important alterations which have been introduced are: a course of physical and commercial geography has been substituted for that in geology in the special courses; students who have worked satisfactorily through the third-year syllabus of physics will be permitted to proceed to the fourth-year syllabus of mechanics, without having worked previously the third-year syllabus of the latter subject; students who are more than eighteen years of age on June 1 in the year in which the course is entered upon will be ineligible for grants; and grants will be payable, under certain conditions, upon the attendance of students at instruction in a fourth-year syllabus during a second year. We notice that summer courses for instruction for teachers will be continued as heretofore, but the hope is expressed that the courses will shortly have satisfied the need of qualifying teachers, and will develop into "post-graduate" courses on special subjects for those already qualified.

REFERENCE was made in the issue of NATURE for July 20 (vol. lxxxvii., p. 101) to a scheme arranged by the Royal Commissioners for the Exhibition of 1851 for the award of industrial bursaries to young men who, after a course of training in a university or approved technical college, desire to enter engineering, chemical, or other manufacturing works. The scheme is another indication of the desire of educationists to establish a link between education and industry; it is based on the assumption that college-trained men are not able, as a rule, to obtain remunerative employment in industries immediately after the completion of their college course. Its main characteristic is to lead the students to the manufacturers. In the issue of *The Times* for August 14, the writer of an article on "Commerce and the Universities," after directing attention to this scheme, gives an interesting account of the industrial fellowships inaugurated in the University of Kansas. They were initiated by Prof. Duncan in 1907. The fellowships are tenable in the chemical department by students appointed by the University, and the emoluments are provided by manufacturers. To illustrate the conditions under which the fellowships are held, those attaching to a fellowship (No. 7) established by a glass company may, says *The Times* contributor, be taken as typical. The object of the fellowship was investigation into the optical properties of glass in relation to its chemical constitution. The fellow contracted to devote the whole of his time to this investigation, with the exception of three hours a week, which he gave to teaching in the University, in return for which he was exempted from the payment of university fees. The tenure of the fellowship was for two years, and the emoluments, 300*l*. a year, were provided by the company. All discoveries made by the fellow during the tenure of the fellowship become the property of the company, subject to the payment of 10 per cent. of the net profits to the fellow; and any patents taken out by the fellow are assigned to the company. The fellow is allowed to publish any results the publication of which, in the opinion of the company, would not injure their interests. At the end of the tenure the fellow is required to present to the University a complete monograph on the work done, and, after the expiration of three years, the University is at liberty to publish the results for the use and benefit of the people.

THE executive committee of the General Council of Church Training Colleges has presented a memorandum to the President of the Board of Education dealing with the qualification and supply of teachers. The memorandum states there has been a marked and general falling off in the number of candidates for entrance into training colleges owing largely to the agitation of the last two years, which arose out of the over-supply of teachers and consequent difficulty in many cases of obtaining employment. A careful investigation leads the council to the conclusion that a pressing need of the time is the framing and publication by the Board of Education of a definite and comprehensive policy with reference to the qualification and supply of teachers. If such declaration be made, the following steps would follow in due course: (1) The definite announcement would be made that after a certain date no more (or, according to policy, a much smaller percentage of) untrained or uncertificated teachers would be appointed. Special arrangements would have to be made in the case of smaller country schools. (2) A thorough inquiry would be made into, and a careful estimate formed of, the consequent requirements of the schools throughout the country and of the existing provision to supply their needs. (3) The council feels strongly that as the revised staffing would involve increased expenditure, more care should be taken in the preliminary selection of candidates for the teaching profession, and suggests (i) that no young person should be appointed as bursar who has not shown some qualities and aptitude (apart from merely intellectual tests) for the teacher's profession; and (ii) that no bursar should be allowed to proceed to a student-teachership who has failed to prove such fitness. (4) To avoid any possible hardship to any person now engaged in teaching, existing qualifications should be recognised, subject to the requirements of efficiency, although the council is of opinion that it might be reasonable to require, or at any rate useful to encourage, untrained, uncertificated, and supplementary teachers to improve their qualifications within a certain period.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 7.—M. le Général Bassot in the chair.—Sir William **Ramsay**: The action of niton (the radium emanation) on thorium salts. Commenting on a recent paper by M. Herschfinkel on this subject, the author gives details of the method of purification of the thorium nitrate used in his experiments, with especial reference to the destruction of any organic matter which might have been present in the crude salt.—Kr. **Birkeland**: Are the rings of Saturn due to an electrical radiation from the planet? A description of the phenomena observed when a magnetised globe is placed in a strong electric field. Three photographic reproductions of the appearance of the globe under these conditions show the similarity of the luminous ring with that of Saturn. Observations by other workers are also cited in support of this view.—J. **Guillaume**: Observations of the Kiess comet (1911*b*) made with the Brunner equatorial of the Lyons Observatory. Data are given for July 15, 17, 20, and 21.—J. Ph. **Lagrula** and H. **Chrétien**: The Kiess comet (1911*b*). Its photographic aspect and its spectrum. One photograph showed a well-defined tail to the comet 1° in length. The spectrum contained cyanogen bands and the blue hydrocarbon band.—Marcel **Brillouin**: Crystalline elements and molecular orientation.—Daniel **Berthelot** and Henry **Gaudechon**: The photolysis of alcohols, acid anhydrides, ether oxides, and esters by the ultra-violet rays. Alcohols are characterised by evolution of hydrogen and formation of aldehydes. Ethers give carbon monoxide, hydrogen, and saturated hydrocarbons. Various esters were also submitted to ultra-violet light, and the gases produced are tabulated.—Amé **Pictet** and Alphonse **Gams**: The synthesis of berberine. Starting with homopiperonylamine, hydroberberine has been synthesised with homoveratryl-homopiperanylamine, and veratryl-norhydrohydrastinine as intermediate steps. Berberine has already been obtained from tetrahydroberberine, so that the synthesis is complete.—L. **Tchougaeff** and G. **Pigoulewsky**: Dithiocamphocarbonic acid.—S. **Losanitch**: The constitution of divalolactone.—E. **Caille**: A modification of the Friedel and Crafts reaction yielding α-naphthalenic ketones exclusively. The reaction is effected in carbon bisulphide at a temperature of 0° C. The yield of ketone is high, 60 per cent. to 80 per cent.; five examples of the application of the method are given.—Maurice **Arthus**: The specific characters of the antivenom serums. Anticobra serum and the poisons of the hamadryas (*Naja bungarus*) and krait (*Bungarus coeruleus*).—J. **Courmont** and A. **Rochaix**: Negative attempts at antituberculous immunisation by the intestine.—J. Kunckel **d'Herculais**: Observations on the habits of a myriopod (*Scutigera coleoptrata*). Its utility in destroying flies. The action of its poison: its supposed accidental presence in the digestive apparatus of man.—Pierre **Girard**: The preponderating *rôle* of two electrostatic factors in the osmosis of solutions of electrolytes. Normal osmotic movements.—Em. **de Martonne**: Results of the morphological analysis of the erosion levels of the Arc and Isère valleys.

August 14.—M. Armand Gautier in the chair.—J. **Boussinesq**: The spontaneous vibrations of a bar fixed at the ends and impermeable to heat, which is put in thermal equilibrium with an atmosphere at constant temperature. Simplified solutions for two problems previously studied by M. Roy and M. Annycke.—H. **Douvillé**: The geological explorations of M. Perrier de la Bathie in Madagascar.—Édouard **Heckel**: The cultural bud mutations of *Solanum maglia*, and on the first cultural results of these mutations. The first result has been the production of a violet variety. The plants show great resistance to cryptogamic diseases, and suggestions are put forward as to a means of obtaining strains of potatoes from wild plants capable of resisting disease.—A. **Calmette** and L. **Massol**: The antigenic function of the tuberculins.—M. **Verschaffel**: Observations of a double shooting star.—Armand **Denjoy**: *Analysis situs* of the plane.—Victor **Henri**: The influence of various physical conditions on the ultra-violet radiation of quartz mercury vapour lamps. Using the citrate of silver method described in a previous note for measuring the intensity of the ultra-violet radiation, the author has made determinations of the activity of a Westinghouse Cooper-Hewitt lamp under varying conditions of cooling. It was found that the ultra-violet radiation of the lamp is more intense as the temperature of the luminous tube increases. Cooling the tube with water gives only one-fourteenth of the ultra-violet radiation obtained when the lamp is in air, the watts consumed remaining the same. A study of the activity of six lamps of different makes and ages showed that for experiments in photochemistry a quartz mercury vapour lamp may be relied upon as a constant source of ultra-violet rays, the radiation being defined when the voltage, amperage, and length of the tube are known.—G. **Chesneau**: The analysis of monazite sands. Full details of the suggested method are given, accompanied with a complete analysis of a monazite sand from Madagascar.—M. **Kunz**: Feeling at a distance as a factor in the power of orientation possessed by the blind. A study of the so-called "sixth sense" of the blind. This is found to be localised on the skin, and is not exclusively an attribute of the blind. It is not connected with the sense of hearing, as is shown by the results of numerous experiments specially directed to this point.—Émile **Yung**: The insensibility to light and the blindness of the vine snail (*Helix pomatia*).

MELBOURNE.

Royal Society of Victoria, June 8.—Prof. E. W. Skeats in the chair.—A. M. **Lea**: A new Australian genus of Phoridæ, associated with termites.—F. **Chapman** and A. O. **Thiele**: A limburgite rock occurring as a volcanic plug at Balwyn, near Doncaster.

July 13.—Prof. E. W. Skeats in the chair.—Kathleen E. **Oliver**: The displacement of the optic lobes during the development of the brain of the fowl. The paper consists mainly of a series of drawings in the round of the different stages.—Helen **Kelsey**: Subdivision of the spinal canal in the lumbar region of chick embryos. In chicks of fifty-two hours' incubation the canalis centralis is bifurcated in the lumbar region. The observations extended over three years, and a large series was examined.—A. **Grouvelle**: Description de quelques nouveaux espèces de Coleoptères australiennes.—F. **Chapman**: Some Silurian species of the genus Lingula, with notes on its shell structure and a parasitic plant. Canals in the corneous laminæ were found in the fossil as in the recent *L. albida*.—J. H. **Gatliff** and C. J. **Gabriel**: Some new species of Victorian Mollusca. One new genus, Edenttellina, and eight new species, are described.—J. H. **Gatliff** and C. J. **Gabriel**: Additions to, and alterations of, the catalogue of Victorian marine Mollusca.—F. L. **Stillwell**: Notes on the geology of Broadmeadows.

CAPE TOWN.

Royal Society of South Africa, July 19.—Mr. S. S. Hough, F.R.S., president, in the chair.—J. C. **Beattie**: Terrestrial isomagnetic lines in South Africa.

CONTENTS.

THURSDAY, AUGUST 31, 1911.

THE FOUNDATIONS OF MATHEMATICS.

Principia Mathematica. By Dr. A. N. Whitehead, F.R.S., and B. Russell, F.R.S. Vol. i. Pp. xv+666. (Cambridge: University Press, 1910.) Price 25*s*. net.

THIS work contains some thousands of propositions, each, with its proof, expressed in a shorthand so concise that if they were all expanded into ordinary language, the room taken up would be ten times as large at least; space, time, and mass are not considered at all, and arithmetic is merely foreshadowed by the introduction of the symbols 0, 1, 2, and 2_r. How then, it may be asked, can the authors pretend to be writing about mathematics? The answer amounts to saying that for every branch of the tree of knowledge there is a corresponding root, and every advance in climbing seems to compel a similar advance in delving. Just as the discovery of non-Euclidean geometries led to the reconsideration of geometrical axioms, so Cantor's invention of transfinite numbers has reacted upon the theory of elementary arithmetic, and hence upon the whole of analysis and all its applications.

Besides this, there has grown up a school of mathematicians intensely interested in the logical side of their subject. Indeed, this was inevitable as soon as the primary distinction between ordinal and cardinal number was fully grasped, and the nature of the arithmetical continuum had been strictly defined. The inquirer was driven back and back to questions of order, and correspondence, and relations, and classes, until he felt bound to construct a symbolical logic fit to express the chain of deductions he found latent in the most familiar processes of arithmetic. This has led to an immense aggregation of what may be called mathematical prolegomena; and with this the first volume of the "Principia Mathematica" is almost exclusively concerned.

Thus the actual titles of its two parts are "Mathematical Logic" and "Prolegomena to Cardinal Arithmetic," and both are so elaborate that only a meagre account of them can be given in a review. The theory of deduction is based upon seven assumptions, called primitive propositions, and upon the notions of disjunction (p or q) and implication (either not-p or q). In about thirty pages the authors obtain the main results of the purely formal logic of propositions. This is followed by a very interesting section on "apparent variables," including the theory of propositions of different orders. A real advance seems to have been made here in the analysis of vicious-circle fallacies, and false generalisations, especially as they occur in mathematical reasoning. It is pointed out that such phrases as "all propositions" or "all properties of x" are strictly meaningless, and a legitimate use of such terms is based upon an axiom of reducibility (pp. 173–5) which is stated in the form: "Any function of one argument or of two is formally equivalent to a predicative function of the same argument or arguments," and its main use is at the beginning of the calculus of classes (p. 197). Whether this axiom is really simpler than the introduction of "class" as a primitive term seems debatable, but it does not matter much for practical purposes.

The next three sections deal with classes and relations, and introduce a large number of new symbols and a long series of propositions. Fortunately here, as elsewhere, each section is preceded by a summary, giving the principal theorems; and, in fact, the reader will find it helpful to go through all these summaries (after the introduction) before attacking the chapters in detail.

Coming now to the more directly mathematical part, we have first of all (p. 356) a discussion of unit classes, which illustrates the subtleties of this new calculus. Thus it is found necessary to construct a symbol for "the class of which the only member is x," as distinguished from x itself. At first this seems to be superfluous, but when we suppose x to be a class, we see that it is not. The next step is to define the cardinal number 1 as the class of all unit classes. Similarly the cardinal number 2 is defined as the class of all couples (x, y) such that (x, y) and (y, x) are equivalent; and the ordinal number 2_r as the class of ordered couples (x, y) such that (y, x) is different from (x, y). Besides these we have a symbol $\dot{2}$ for the class of all relations consisting of a single couple, including couples (x, x). Then we have a series of theorems on subclasses, relative types of classes, one-one and one-many relations, &c., leading up to the fundamental notion of similarity of classes which is the necessary basis of all arithmetic proper.

We next come to the difficult question of selections, from relations and from classes of classes respectively.

"If k is a class of classes, then μ is called a selected class of k when μ is formed by choosing one term out of each member of k."

(It would perhaps be more precise to say "a class selected from k," because μ, as a class, is not generally a member of k.) Now at first sight it looks as if a selected class could always be formed, but this is not really obvious when k is infinite, and, in fact, it has not been proved in general. If it could be, it would follow that every class can be well-ordered, and the difficulty of asserting this in general can be seen from a special case. Consider the aggregate of colours, merely as sensations of my own; how can I order them, without importing some additional foreign element, such as the time when I first became conscious of a particular one, or its analysis by a colour-box, or something of that sort? Besides this, there is the logical difficulty of making an assertion about "every" class, for one reason because assertions form a class.[1] Hence the section (p. 561) on the conditions for the existence of selections is one of special interest: its most important bearing on arithmetic is in the theory of multiplication.

The final section is on inductive relations, especially

[1] This is undeniable, because "assertions do not form a class" is itself an assertion, and only a formal, not a real contradiction of the above statement.

the ancestral relation, which, to avoid a vicious circle, is defined so as to apply to members of an infinite class. As the authors explain in a note, this section is mainly based upon Frege's work, and is used afterwards to deduce the properties of finite cardinals and the transfinite cardinal $\aleph$. Here we find the Peanesque notation in all its development, and must make up our minds to learn it thoroughly, or else to express its formulæ in an equally exact, but less unfamiliar symbolism. This leads us to the few critical remarks that we venture to offer on this admirable and elaborate work. Every communication of ideas from one mind to another is made by means of a conventional symbolism; no symbolism can be more *exact* than language, because language is, in the last resort, required to explain and define it. But it may be more *concise* than language, and this is the real virtue of the Peano notation and its derivatives. To show how easy it is to exaggerate the value of the notation as such, we may take an example from p. 16 of the present work. The authors say that "it is an obvious error, though one easy to commit," that "No A is B" is the contradictory of "every A is B," and proceed to add that the symbolism exposes the fallacy at once. Really it does nothing of the kind; truly the symbol $\sim \{(x).\phi(x)\}$, the contradictory of $(x).\phi(x)$, is different *in form* from $(x). \sim \phi(x)$, but how can we tell from looking at them that these last two symbols are not equivalent? Again, the authors profess to give a proof of the law of excluded middle; they assume it in defining the assertion symbol, for they practically say "if the proposition to which this sign is prefixed is false the book is in error," tacitly assuming (here) that all their propositions are significant. The law of excluded middle is surely axiomatic for a significant proposition, the only trouble is in being quite sure that our assertions are really significant, and in this it is reason that must guide us, not symbolism, though a proper choice of symbolism may conduce to economy of thought. As an illustration, we may refine a little on the paradox of Epimenides. Suppose a Frenchman or a German asserts "Every statement that has ever been made by an Englishman is false." This is a significant statement, and *as such* must be true or false. But suppose an Englishman says the same thing: the proposition ceases to be significant, unless he adds "except one," when it again becomes significant. Questions of this kind are not so trivial as they appear, and a really philosophical study of language might do a good deal towards making more definite the metaphysical basis of knowledge.

G. B. M.

MOVEMENT AND ESCAPEMENT.

Le Mouvement. Mesures de l'étendue et mesures du temps. By Prof. J. Andrade. Pp. vi+328. (Paris: Librairie Félix Alcan, 1911.) Price 6 francs.

SOME literary effusions—for instance, the novel with a purpose—present to the reviewer an awkward problem, namely, whether to concentrate his attention on the novel as such, or on the purpose. The present work might almost be included in some such category, inasmuch as it may be regarded from the point of view of a mathematician pure and simple, of a more or less practical mechanic, or even of an astronomer, while all the time it apparently claims to be a philosophical treatise, and as such to appeal to what may be called the general reader. In some parts of the book the philosopher is much in evidence, and in many places the absence of diagrams, and the assumption that the reader will understand determinants, vectors, or even ordinary equations of motion without explanation, would certainly repel the ordinary reader. The mathematician will find perhaps little that is novel. The suggestions of non-Euclidean space, whether that of Lobatchewsky or of Riemann, are little more than suggestions, and can only give those to whom such ideas are new the kind of shock the earlier cyclists felt on first riding a free-wheel. On the other hand, a very good historical sketch, amply provided with diagrams, is given of the development of scientific clockmaking with due respect to the great English horologists.

A brief sketch of the contents of the book will serve to indicate the scope of the author's endeavour, and it is difficult to conceive how, within the limits of such a volume, a perfectly satisfactory result could have been achieved. Perhaps only a fellow-countryman of the great French philosophers of the past would ever have attempted such a task. The first part treats of geometrical ideas of number and space, the author showing a decided preference for vectorial or polar coordinates, and for rotation as a means of translation. The finite straight line is elaborately discussed, and ordinary geometrical propositions regarded from the point of view that came into vogue about a quarter of a century ago, when Nixon's Euclid began to oust Todhunter's in some schools. Triangles and solids, plane and spherical areas, volumes, velocity, vectors, the theorems of Ampère and Stokes, moments, composition of vectors and vectorial quantities, bring us through trigonometry and statics to non-Euclidean geometry by a somewhat tortuous route.

The second part introduces force, one chapter being devoted to the notions of astronomy and celestial mechanics from Hipparchus to Newton, and another to the principles of dynamics, equilibrium, and the two fundamentals, which, in the author's view, are clock and orientation; a third dwells on the vital importance of a function of forces, on stability and conservative systems, on isolated systems, Painlevé's theorem and Laplace's invariable plane; and these are followed by simple and damped oscillations, spiral movement, elastic bodies, and fluids, and the bending of springs. The third part deals with optics more especially of the telescope, with a more special devotion to different methods of geodesy from Picard to the use of invar and the Jäderin wire, and the correction of the units of the metric system.

The fourth and last part deals with the chronometer in general, and escapements in particular, calling for continued experimental work on indicated lines, touches on chronographs and synchronisation of clocks, and gives extracts from the annual trial-numbers from the Greenwich volumes, showing the improvements makers have been able to secure in the last sixty odd years. W. W. B.

COSMICAL PHYSICS.

Researches on the Evolution of the Stellar Systems. By Prof. T. J. J. See. Vol. ii., "The Capture Theory of Cosmical Evolution, founded on Dynamical Principles and Illustrated by Phenomena Observed in the Spiral Nebulæ, the Planetary System, the Double and Multiple Stars and Clusters, and the Star-clouds of the Milky Way." Pp. viii+734. (Lynn, Mass.: T. P. Nichols and Sons; London: W. Wesley and Son, 1910.)

IT is with mingled feelings that, after reading through this immense volume of Dr. See's, the reviewer attempts to present it fairly to the readers of this journal. This book and the theory presented therein is "the culmination of continued labor extending over more than a quarter of a century." It calls therefore for a full and careful discussion. It is a great pity that the writer over and over again by loose dogmatic statements repels the critic, and that he so frequently makes claims as to the rigorousness of the methods he employs, claims which a careful examination quite fails to endorse. As an example of the former fault we choose the extraordinary statement on p. 152, which comes at the end of an account of some quite inconclusive mathematical work on the effect of a resisting medium. The italics are the author's.

"*Whatever doubt may arise as to the effect of the resisting medium in the present state of the solar system, there can be no possible doubt as to its power in our system at the epoch when the planets were formed. The observed roundness of the orbits of the planets is an everlasting witness to the presence of a resisting medium against which these bodies revolved for immeasurable ages. There is no other admissible explanation of this phenomenon, and as the resisting medium is a* vera causa, *on the secular effects of which all mathematicians are agreed, we may hold that it has as surely rounded up these orbits as if we had witnessed the transformation within the short period of human history covered by exact observations.*"

For the author's claims to mathematical rigorousness of treatment reference may be made to pp. 237, 259. The answer to these claims is twofold. On the one hand rigorous proof is from the nature of the case impossible in cosmogony. Too many uncertainties are necessarily involved in the premises for any amount of exact mathematical reasoning to lead to a rigorous proof, and even in this mathematical reasoning Dr. See is by no means perfect. It is a pity that his reply to the mathematical point raised by Mr. Brodetsky in the *Astronomische Nachrichten* (No. 4408) should be limited to the suggestion that "Mr. Brodetsky is unfortunate in writing from Cambridge." If Dr. See's views do not meet with the full attention that he desires for them (or to do them justice, that they deserve), the fault lies partly with his method of presenting them.

After these strictures we may turn to the more pleasant task of dwelling on the theory that Dr. See has built up. In his view the solar system has developed from a spiral nebula. Condensations round various nuclei have gradually developed into planets. The resistance of the medium through which these bodies have revolved about the central condensation or sun, has led to the gradual falling in and rounding of their orbits, and also to the capture by the planets of all their satellites. Thus the moon, which originally revolved outside the present orbit of Neptune, was captured by the earth while in the process of falling into the sun through the slow decrease of its orbit. The theory is supported by arguments adduced from many branches of astronomical research. Some of the material which Dr. See has brought together to support his views is of very decided interest, notably chapter ix. on the capture of comets, and chapter xxi. with its welcome extracts from the papers of Herschel. Dr. See has been very generous in the extracts he quotes from the work of other people. It is not obvious, however, why chapter xii., with its long extracts on lunar motion, should figure in this work. There is no independent criticism made of the controversies referred to, and a bare statement of the results arrived at, with references, should have amply sufficed. In some of his criticisms of other contributions to cosmogony, Dr. See is much happier than in his own constructive work. Thus some of his criticisms of Messrs. Chamberlain and Moulton on p. 106 are distinctly to the point; while independently of other workers in the same field, he has brought forward some cogent reasons against the nebular hypothesis of Laplace in its ordinary form; he also criticises some conclusions frequently drawn (though not always correctly) from the papers of Sir George Darwin.

Many points of detail offer themselves for criticism in the treatment accorded by Dr. See to all the problems discussed in his book. But we have said enough to give the general scope of the work. While not able to accept Dr. See's views as to the important part played by the resisting medium in the evolution of our system, we are prepared to find in this resisting medium a *vera causa* the effect of which has been frequently overlooked by other workers. This book is an exaggeration. It may serve to restore the true balance of forces.

It remains to be added that the book has been very well prepared for publication. It is produced in a manner that does credit to its author and publishers alike. The photographic reproductions are very good. The moon, nebulæ, and star-clouds are well represented in a series of very fine plates. It is a pity that the headings used were added to the fine photographs by Barnard. A useful summary of the whole book is added in chapter xxiv., which gives a formidable list of problems explained by the theory.

BOTANICAL MONOGRAPHS.

Das Pflanzenreich. Regni vegetabilis conspectus. Edited by A. Engler.

41. Heft. (iv. 56*a*) Garryaceæ; (iv. 220*a*) Nyssaceæ; (iv. 220*b*) Alangiaceæ; (iv. 229) Cornaceæ. By W. Wangerin. Pp. 18+20+25+110. Price 9.20 marks.

42. Heft. (iv. 147) Euphorbiaceæ-Jatropheæ. By F. Pax. Pp. 148. Price 7.40 marks.

43. Heft. (iv. 228) Umbelliferæ-Apioideæ-Bupleurum, Trinia et reliquæ Ammineæ heteroclitæ. By H. Wolff. Pp. 214. Price 10.80 marks.

46. Heft. (iv. 94) Menispermaceæ. By L. Diels. Pp. 345. Price 17.40 marks.

(Leipzig: Wilhelm Engelmann, 1910.)

THE four volumes of which the titles appear above are sufficiently diverse to indicate various general features of this elaborate series. In the first place, sufficient material for the first volume on the Euphorbiaceæ is supplied by the account of the tribe Jatropheæ, while Mr. H. Wolff includes no more than a portion of the subtribe Ammineæ in the first volume dealing with the Umbelliferæ. The termination Jatropheæ follows the official rules that tribe names shall end in -eæ, and the suffix, -ineæ, indicates that Ammineæ is a subtribe. The Menispermaceæ are amenable to treatment in a single volume, while the inclusion of four families under one cover is due to the circumstance that certain genera, formerly included in Cornaceæ—notably by Dr. Harms in the "Pflanzenfamilien"—are now severed from that family and placed in three distinct families. Of these, Garryaceæ and Alangiaceæ are both monogeneric, while Nyssaceæ comprises Nyssa, Camptotheca, and Davidia. Garrya has always been a puzzle, and even now Dr. Wangerin expresses himself somewhat dubiously as to the proposed location in the Amentales near Salicaceæ. Alangiaceæ and Nyssaceæ are referred to a relationship with the Combretaceæ in the order Myrtifloræ, the only doubtful point being the exact position of the monotypic genus Davidia. With regard to the Cornaceæ, the author has no hesitation in placing them at the very bottom of the Umbellifloræ, immediately anterior to the Caprifoliaceæ. Dr. Wangerin pays special attention to the various forms of inflorescence in the Cornaceæ, and submits an analytical key to the genera founded upon anatomical characters. The family consists of ten genera, of which Cornus is the largest with fifty species.

The tribe Jatropheæ comprises thirteen genera, including the well-known Hevea and two small new genera; Jatropha far outnumbers the other genera with 156 species, as Hevea approaches next with 17 species. Prof. F. Pax has worked out a phylogenetic arrangement of genera and species based upon a detailed study of the geographical distribution. Seven genera are wholly American, five are palæotropic, and Jatropha is tropically cosmopolitan. The chief centre of development is situated in Brazil, but other centres occur in Central America and East Africa, chiefly owing to the species of Jatropha found in those regions. Diagrams are provided to illustrate natural affinities of the genera and of different sections and subsections of the genus Jatropha.

The elucidation of the genus Bupleurum, which now extends to 100 species, is the chief feature of the Ammineæ-heteroclitæ. It is interesting to note that in a family showing such diverse fruit characters the most satisfactory characters for splitting up the genus are furnished by the leaves. The criticism of unnecessary diffuseness must be urged against the author; the extreme instance is supplied by the description of subspecies and varieties under *Bupleurum falcatum*, extending over thirteen pages.

As might be expected from a botanist of such wide experience, Prof. L. Diels has produced one of the most interesting monographs. The various sections in the general introduction of the Menispermaceæ are carefully elaborated. The family contains a very large number of lianes, not one of which climbs by means of tendrils; twining is the usual device; the extent of anomalous stem development is still a matter for investigation. The value of Miers's contributions to the classification of the family is generously emphasised, although the author finds it necessary to make a number of alterations in the constitution of the tribes. Much useful information is supplied in the notes inserted after the diagnoses of the genera. One new genus is proposed, and several new species are indicated which are scattered generally through the genera.

OUR BOOK SHELF.

The Animals and Man: an Elementary Text-book of Zoology and Human Physiology. By Prof. V. L. Kellogg. Pp. x+495. (New York: Henry Holt and Co., 1911.)

ALTHOUGH written from an American point of view, with American animals as the chief types, this well-illustrated volume may be confidently recommended to the English student on account of its lucid style, orderly arrangement, and the method of treatment of the various sections of its subjects. Based on two still more elementary text-books of zoology by Prof. Kellogg, the volume includes chapters on human structure and physiology by Miss McCracken, a fellow professor of the author at Stanford University; this lady's contribution forming eight chapters in the fourth part. The other chapters on physiology are by Prof. Kellogg.

The first six chapters are devoted to the constituent parts of animals and their respective functions; the subject being introduced by contrasting the organisation of a grasshopper—or rather a locust—with that of a snail; while in subsequent chapters a so-called sunfish (in reality a member of the perch group), a sparrow, a toad, a crayfish, and an amœba are made to serve as types of their respective classes. With part ii., containing three chapters, we have summaries of the life-histories of certain kinds of animals; mosquitoes and caterpillars, with their transformations, serving to illustrate insects, while frogs and birds are taken as examples of two vertebrate groups broadly distinguished by the great divergence in their development.

Systematic zoology and the classification and habits of animals form the subject of part iii., with eleven chapters; the author commencing his survey with the protozoa and concluding with mammals. The account of the former group is well up to date, and particular attention may be directed to the excellent description of the mode in which man becomes infected with malaria by means of mosquito bites. It is the clearest and most simple account of a complex and puzzling phenomenon which we have had occasion to read. Neither are domesticated animals left out; and in this section it may be mentioned that the author follows Prof. Keller in regarding humped cattle as descended from the bantin of the Malay countries. On pp. 270–1 Hainan is misprinted Hainau, and *cygnoides* rendered *cygmoides*, while an altogether misleading figure of a lamb is made to serve as the representative of the handsome wild sheep of Transcaspia. A brief account of fossil animals, or rather fossil vertebrates, concludes this section of the work, which is followed by the aforesaid chapters from the pen of Miss McCracken.

Chapters on the relation of micro-organisms and sanitation, on ancient and modern man, the struggle for existence, communal life, &c., conclude a very readable book on a very technical subject. R. L.

How to Enamel: being a Treatise on the Practical Enamelling of Jewellery with Hard Enamels. By H. M. Chapin. Pp. xii+70. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd., 1911.) Price 4*s.* 6*d.* net.

THIS is an unpretentious little book written by a practising enameller. It describes in plain language the simplest methods of enamelling on metals, and has the merit of avoiding all air of mystery pertaining to the craft. The writing has no claims to literary finish, and the Americanisms scattered up and down the pages will come upon an English reader with something of a shock. But the writer's gift for expressing his meaning plainly, and his practical hints as to helps and hindrances in the work, obviously the result of direct personal experience, will earn the gratitude of the reader who goes to him for instruction.

In so small a compass, of course, no more than the elements of the subject are treated, and the beginner is very properly warned that only experience can teach him his craft. By omitting some not very helpful pages on transferring photographs to enamel, room might have been found for illustrating and commenting on a few fine examples of enameller's work of former ages; or, perhaps more stimulating to craftsmen, some specimens of the handiwork of such modern masters as Lalique, Thesmar, Du Suau de la Croix, Fisher, and Dawson, would have set before the beginner something to remind him that the result of all his efforts will be worth nothing unless quickened by the breath of art.

History of Geology. By H. B. Woodward, F.R.S. Pp. vi+154. (The History of Science Series.) (London: Watts and Co., 1911.) Price 1*s.* net.

No more appropriate writer could have been found for this condensed history of geology than the author of the recently published "History of the Geological Society of London." The personal touches which abounded in that volume have of necessity been curtailed in the treatment of a wider theme; but we meet here pleasantly with Mary Anning (p. 63) and Etheldred Benett (p. 126), side by side with Humboldt and James Hall. The book is clear and interesting in all its chapters. Stratigraphy naturally assumes most importance, since it includes the succession of organisms on the earth, and this is the aspect of geology that appeals most directly to the mind of man. Perhaps there are almost too few references to the difficulty experienced by the early geologists in making headway in countries where adherence to a Jewish system of cosmogony was held to be an act of public morals. Those who begin with Mr. Woodward's present book may well pass on, guided by his fourth chapter, to the opening pages of Lyell's "Principles of Geology."

Petrology is treated less systematically, and few will agree with the statement (p. 143) that "the petrology of the Igneous rocks has the advantage of being a more exact science than that of Palæontology."

The pertinacity of Romé de l'Isle and the self-sacrificing life of Haüy receive only slight mention on p. 43. We should have liked some reference to the successful stand made by English-speaking geologists against the view that igneous rocks assumed a new facies with the passing of Mesozoic forms of life, and of the part played by Jull in this matter—since other living workers are mentioned—and in the development of the teaching of geology. The heading "Early Geological Maps" (p. 50) does not include William Smith or Macculloch, the maps of the former being described on p. 34, while Macculloch's Scotland has to wait until p. 80. "Progress in British Geology" occurs twice as a heading in chapter iii. These are small points of arrangement and are easy to correct. The portraits of geologists have been selected from good and thoroughly interesting originals. We feel that we must mention specially the early Lyell, the William Buckland expounding the tooth of a hippopotamus, and the thoughtful von Buch resting so naturally in the open air. G. A. J. C.

A Treatise on Wireless Telegraphy and Wireless Telephony. By Prof. T. Mizuno. Pp. ix+563+x+208 Figs. Written in Chinese characters. (Tokyo: The Maruzen-Kabushiki-Kaisha, 1911.) Price 4.50 yen, or 9*s.*

SEVEN years ago Prof. Toshinojo Mizuno, of the Imperial University of Kyoto, published a popular work on wireless telegraphy and telephony. At that time it was difficult to transmit messages more than two hundred miles. The present volume is in the main a theoretical consideration of the same subject, and is intended for the use of students at the university. With the exception of the numerous formulæ and equations which suggest a treatise on higher mathematics, the fact that the text is in Chinese idiographs, places this work beyond the reach of European students. The references to Maxwell and Hertz in the early chapters indicate that the author has started on good foundations. Following these, references are made to the work of many investigators in England, Germany, Italy, and other European countries.

The description of instruments, which are illustrated diagrammatically, concludes with a reference to the telephonic relay of Mr. S. Brown, which shows that the writer is well up to date in regard to modern inventions. The author says but little about his own work, or the contributions to improvements in practical wireless telegraphy made in his own country, but these exist. The whole work may be compared to a play of Shakespeare with actors in Eastern costume, but it also suggests that Japan is abreast with the abstruse researches of the West in connection with which she has made advances.

Les Machines à écrire. By J. Rousset. Pp. 177. "Encyclopédie Scientifique des Aide-Mémoire." (Paris: Gauthier-Villars and Masson et Cie., n.d.) Price 2.50 francs.

IN this little book the author dissects the typewriter of commerce, and in a series of chapters shows how in different machines each function is performed. There are fifty-eight figures. The descriptions and figures are clear, and the book should fulfil its purpose. It is a little difficult, however, to see what this purpose is, for ingenious as the mechanism of typewriters may be, it is all visible, and anyone with any sense of mechanics can see it all for himself and understand it, and, moreover, in the larger towns at any rate, there is no difficulty in finding all the better-known examples, and willing expositors in the shops in which they are sold. Still, it is well that the subject should be dealt with systematically.

Lissajous'sche Stimmgabelkurven in stereoskopischer Darstellung. By J. W. N. Le Heux. Pp. 8+18 plates [loose cards in case]. (Leipzig: Johann Ambrosius Barth, 1911.) Price 6 marks.

The author refers to the interest which Lissajous figures have in physics and mathematics, more especially when presented in their most attractive form so as to appear in stereoscopic relief. As is well known, pairs of figures otherwise identical but slightly different in phase appear when viewed in a stereoscope (or by accustomed eyes without a stereoscope) to blend together and form a single picture in three dimensions. The author discusses eighteen plates as follows, three of ratio 1 : 1, five of 1 : 2, two of 2 : 3, three of 3 : 4, two of 3 : 5, and two of 4 : 5 ratios. Some show a single line only, others give ten or more closely spaced lines. The plates are so clear that the stereoscopic effect is perfectly seen without a stereoscope.

Europe in Pictures. By H. Clive Barnard. Pp. 64. (London: A. and C. Black, 1911.) Price 1*s.* 6*d.*

The pictures in this book will serve admirably to illustrate geography lessons in schools. The text is scarcely so suitable for school purposes; it is arranged unattractively and in such a manner that the plates often have little to do with the letterpress facing them.

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.*]

A Pseudo-Aurora.

For some time I have been staying at the Kurhaus, St. Beatenberg, Switzerland, and my window commands a view of the Bernese Oberland from the Wetterhorn to the Balmhorn. The Eiger Mönch, Jungfrau, and Blümlisalp stand out most clearly above the lower mountains in front of them, of which the Faulhorn and Mesen are members. There has been a continuance of hot and dry weather for many weeks, and there have been occasional thunderstorms with both forked and sheet lightning. On the night of August 21, about ten o'clock, semicircular flashes of light shot up apparently behind the Mönch, quivered for a few seconds, and then disappeared. I counted twenty-eight in a minute. The light was sometimes intense at a central point, which was steady, and from this a quivering glow proceeded and lighted up from 15° to 20° of the horizon. The outline of the Jungfrau group could occasionally, but not always, be seen.

The appearance seemed to me very like an aurora borealis which I saw in Scotland in the 'fifties, but the centre of the light here was to the south-west of where I stood. I do not know how long the light had appeared before I saw it, but it continued to flash with great brilliancy for about twenty minutes. It then became less bright, and did not shoot so high into the sky, but extended laterally to the south for about 30° behind the Oberland chain. After half an hour more these died away, and on looking out two hours later nothing was to be seen. I am informed that a similar phenomenon was visible on the previous night, but was less brilliant. The resemblance to a true aurora was so great that I have thought it might be worth description. Lauder Brunton.

Rainless Thunderstorms.

During the long-continued drought local storms have been reported here and there, and have been described as rainless. Will you or any of your readers explain this phenomenon? I have always imagined that raindrops played a large part in the manufacture of atmospheric electricity, but I suppose that there are electrical storms in rainless countries.

A. A. M.

Hove, August 16.

The point raised in the foregoing letter is one of considerable interest in connection with the origin of the electrical phenomena of thunderstorms. The fact that thunderstorms are usually accompanied by clouds of a special character and heavy rain is common knowledge, and after Wilson's discovery of the difference in the effectiveness of the positive and negative ions as condensation nuclei it was generally assumed that condensation produced the necessary separation of the positive and negative electricity, and was an essential feature in thunderstorms. Simpson in his recent paper on the "Electricity of Rain and its Origin in Thunderstorms" makes splashing and breaking up of actual raindrops a necessary part of the mechanism of a thunderstorm.

Published accounts of rainless thunderstorms are not common, but one was contributed by Mr. E. J. Lowe to Nature for September 7, 1893. He says, "On August 9 (at Shirenewton, near Chepstow) there was no rain but more lightning than I had seen since the memorable storm of August 9, 1843. It commenced at 9 p.m., and lasted five hours. From very frequent counting there could not have been less than 10,000 flashes."

More recently, Captain A. Simpson, of the s.s. *Moravian*, described a thunderstorm near Cape Verde lighthouse, when there was no rain nor even lower clouds. "For fully an hour the sky was one blaze of lightning, and the wire ropes, mast heads, yard arms, derrick ends, &c., were lighted up." See M.O. Pilot Chart of the North Atlantic and Mediterranean, April, 1903. E. G.

Meteorological Office, South Kensington,
London, S.W., August 22.

Habits of Dogs.

Can any of your readers inform me whether it is common for dogs to eat wasps, or if it is likely to prove injurious? A young bulldog of mine ("Billy") now finds his chief amusement in catching flying wasps with his mouth, and I think he must swallow them, as they generally vanish, though occasionally I have found the corpse on the floor. It seems evident from the dog's demeanour that the sting makes some impression; he shakes his head and licks his lips energetically, and occasionally runs to a corner and rolls on his back kicking. But the next moment he is off after another. That he is not invulnerable appears further from the fact that yesterday, after treading on a wasp, he lifted a paw and limped on three legs, until I applied ammonia. There was a tender spot where the skin had been grazed between the toes; possibly the sting lit there.

The same bulldog had another curious habit. When I was on the Cornish coast he spent much of his time in rolling boulders backwards along the beach or in shallow water. His method was to embrace the stone with his powerful fore-arms and fling it towards his hind paws, licking it well over at every pause. As he generally chose the biggest stone he could well move, it was laborious work; but he was tremendously enthusiastic about it. In the garden too, if not watched, he would drag the stones from the rockery across the lawn. This pursuit has now lapsed from lack of opportunity, though he occasionally practises on a stray brick or flower-pot.

It testifies to the hardiness of the national breed that "Billy" was undamaged by a "head-on" collision with a motor-car which he had charged. I saw him knocked forward, and then struck by the wheel, but at my cry of horror he came galloping back to me as cheerful as ever. The driver had doubtless put on the brake as soon as possible, for he kindly stopped a moment later to see if the dog had been hurt. A. Everett.

Woking, August 21.

THE KACHÁRIS OF ASSAM.[1]

THIS, the last volume included in the excellent series of monographs for which we are indebted to the Government of Eastern Bengal and Assam, differs from its predecessors in that it contains less pure ethnography and more of the charming personality of the author, of whom his old friend, Mr. J. D. Anderson, contributes an appreciative memoir. Mr. Sidney Endle worked as a missionary under the Society for the Propagation of the Gospel, and as chaplain to the tea-gardens of Upper Assam, from 1864 to 1907, when, exhausted by long and devoted labour among the people he loved so well, he died in a steamer on the Brahmaputra while on his way to Europe.

The Kacháris, to use the name given to them by the Hindus, are usually known to the Bengalis as Mech, from the Sanskrit Mleccha, meaning "barbarian," but call themselves Bodo or Baro. Their Hindu name seems to be connected with that of the powerful Koch empire, which once included, roughly speaking, the present British provinces of Eastern Bengal and Assam, the name now surviving in the small native State of Koch Behar.

The people now described form part of the northern group of a once widespread race, divided from the southern group by a line closely following the Brahmaputra valley. In the southern group the strongest tribes are the Garos and the people of Hill Tippera. The separation of the northern from the southern group is complete, as is shown by the absence of common tradition and intermarriage; and their languages, though possessing much in common, differ from each other nearly as much as Italian does from Spanish. How this once united people became divided history does not tell. But Mr. Endle, with much probability, suggests that it resulted from the invasion of the Ahoms, a Shan tribe from whom Assam has acquired its name, who early in the thirteenth century entered the province from the Upper Irawaddy valley.

The Bodo Kacháris, numbering about 272,000 souls, now occupy the Kachári Duárs or passes and the districts of West Darrang and North Kamrup. In stature they are much smaller and shorter than the races of North-west India, and bear some resemblance to the Nepalese. Their physical type—square-set faces, projecting cheek-bones, almond-shaped eyes, and the almost complete absence of beard and moustache—connects them with the Mongoloid peoples. Mentally they are much inferior to their Hindu neighbours, but what they succeed in learning they retain with much tenacity. They are intensely clannish and obstinate. Owing to their comparative isolation they have acquired few of the vices of civilisation, an occasional bout of indulgence in rice-beer being one of their most obvious failings. Their standard of female chastity is much higher than that of the neighbouring tribes.

They are a prosperous people, well skilled in agriculture, growing the valuable Eri silk, out of which they weave an excellent cloth. It is curious that Col. Gurdon, the director of the Ethnographical Survey, and the author are at issue on the question whether their subdivisions are endogamous or exogamous, a matter easily solved by local inquiry. In their manners and customs they much resemble the Garos, who are described in a monograph included in this series.

In religion they are in the animistic stage, with a pantheon containing groups of household and village deities. The leading members of the former group are Bathau, the tree spirit embodied in the *Euphorbia splendens*, found in nearly every house yard, and his consort Mainao, who is, as her name implies, the guardian goddess of the rice fields.

Two appendices, one describing some of the allied tribes, the other adding three additional folk tales collected by Mr. Anderson, increase the value of the book, which, if not the work of a trained anthropologist, gives a sympathetical account of an interesting people.

Photo.] [*Mrs. H. A. Colquhoun.*

Kachári Girls playing Jew's Harps (Gongina). From "The Kacháris."

[1] "The Kacháris." By the late Rev. Sidney Endle. With an Introduction by J. D. Anderson. Pp. xix+128. (London: Macmillan and Co., Ltd. 1911.) Price 8*s*. 6*d*. net.

THE PROMOTION OF AGRICULTURAL RESEARCH AND LOCAL INVESTIGATIONS.

THE Board of Agriculture and Fisheries has been in communication with the Development Commissioners with a view to the formulation of a scheme for the promotion of agricultural research and local investigations in England and Wales, and the Treasury, on the recommendaton of the commissioners, has now sanctioned the allocation of funds to be distributed by the Board in accordance with the general principles set out below. The total maximum sum which will be expended when the scheme is in full operation will be about 50,000*l.* per annum.

The scheme provides for—

(1) A system of agricultural research which will secure for each group of the problems affecting rural industry a share of attention roughly proportional to its economic importance.

(2) The concentration of the scientific work on each group at one institution or at institutions working in combination.

(3) Grants for special investigations for which provision may not otherwise be made.

(4) The grant of scholarships with a view to the increase of the number of men fully qualified to undertake agricultural research.

(5) The carrying out of investigations into problems of local importance, especially those involving the application of modern research to local practice, and the provision of scientific advice for farmers on important technical questions.

Subjects of Research.

In making arrangements for the separate investigation, so far as possible, of each group of allied subjects the commissioners and the Board have been impressed with the importance of securing continuity in work which is necessarily of considerable duration, and at the same time of providing staffs of specialists and experts who will be permanently engaged on work arising from the investigation of the same group of problems. By this means concentration and economy of effort will be better secured than it would be if a number of institutions were dealing at the same time with the same group of problems.

It is neither desirable nor possible to prevent all overlapping or duplication of work, but it is obviously necessary to proceed on a plan by which research work subsidised from public funds will not be unnecessarily duplicated. It is also desirable to arrange that each problem shall be undertaken by the institution best fitted to deal with it, and usually by the institution which has specially devoted its attention to problems of an allied nature.

It is also important to avoid the giving of undue attention to one part of the field of agricultural research, to the exclusion of other parts which are of equal scientific and economic importance.

With these considerations in view, it has been arranged that grants should be made for research in the following groups of subjects:—

(1) Plant physiology.
(2) Plant pathology and mycology.
(3) Plant breeding.
(4) Fruit growing, including the practical treatment of plant diseases.
(5) Plant nutrition and soil problems.
(6) Animal nutrition.
(7) Animal breeding.
(8) Animal pathology.
(9) Dairying.
(10) Agricultural zoology.
(11) Economics of agriculture.

Special Grants for Research.

A sum not exceeding 3000*l.* per annum will be available for assistance in respect of special investigations for which provision is not otherwise made.

Grants from this fund will be made on the recommendation of the Board's Advisory Committee on Agricultural Science, which will consider, not only whether the proposed investigation is desirable in itself, but whether it could not be better carried out at one of the special research institutions referred to above. The grants will be made from year to year, and will be for one year only in each case.

Scholarships.

In order to secure the services of a number of carefully trained men for work in connection with the scheme, the Board proposes in each of the years 1911, 1912, and 1913 to offer twelve scholarships of the value of 150*l.* per annum, tenable for three years.

It is proposed that candidates for scholarships should be selected by a special committee, representing the institutions in which the selected candidates will subsequently work. The award of twelve scholarships will be conditional on a sufficient number of thoroughly suitable candidates presenting themselves.

Local Advice and Investigations.

Grants will also be made to certain universities, university colleges, and agricultural colleges in England and Wales, for the purpose of enabling them to supply scientific advice to farmers on important technical questions, and to carry out investigations into problems of local interest, which can be more conveniently studied on the spot than at one of the research institutions.

By means of these grants it is hoped to provide an expert staff possessing both scientific and practical qualifications, the members of which will devote themselves to solving difficult local problems, and in other ways endeavour to secure the application of science to practice.

THE RECOGNITION OF PALÆOBOTANY.

IN *The Times* of August 24 a correspondent appeals for the adequate official recognition of palæobotany in Britain, and suggests that "some millionaire, anxious to be of service to his day and generation" might "do a unique and serviceable deed in endowing this neglected but important science." It is indeed strange, though true, that there is no professorship or lectureship in palæobotany in any of our universities, Cambridge alone having an ill-paid demonstratorship; and hitherto there has been no special curatorship of fossil plants even in the British Museum. This country only takes an honourable place in the promotion of the science at present because a few distinguished men of private means, and some enthusiastic students working in the midst of other duties, are devoted to it; and also because the actual occupants of the chairs of botany in Cambridge, London, and Manchester happen to make it their chief line of research.

When, however, *The Times* correspondent compares the general recognition of palæobotany in Britain and the British possessions with that which it receives in other countries, his statement is weakened by a tendency to special pleading. The distinguished professor of the Swedish State Museum, who is mentioned as "decorated with Royal Orders," is not merely a palæobotanist, but also a great geographer, the hero of several important Arctic expeditions. The United States Geological Survey may be well equipped for the study of fossil plants; but it should be added that no more important and fundamental contribution to palæobotany has emanated from America during recent years than that of the assistant curator of a university museum who pursues his researches in the intervals of many other duties. The Canadian Geological Survey may not have a palæobotanist on its permanent staff; but it does not fail to recognise the importance of fossil plants when necessity arises, and it is employing a professional palæobotanist on special service at the present time.

Finally, the statement that "our country, with all her colonies and dependencies, with their thousands of square miles of coal-bearing, fossil plant-bearing rocks, does nothing" to help the prospector, is made in forgetfulness of the exhaustive and well-illustrated "Catalogue of the Glossopteris Flora" which was published by the Trustees of the British Museum six years ago, partly with the view of helping the development of the coal-fields in India and the southern hemisphere, where the handbook is extensively used.

S. H. BURBURY, F.R.S.

By the death of Mr. Samuel Hawksley Burbury, on August 18, at eighty years of age, we have lost an ardent worker in the domain of mathematical physics who did much to elucidate the mysteries of several problems in molecular dynamics. Mr. Burbury was the son of Mr. Samuel Burbury, of Leamington, and was born at Kenilworth in May, 1831. He was educated at Shrewsbury and St. John's College, Cambridge; he was Craven University scholar, Chancellor's medallist, Browne medallist, twice Porson prizeman, and fifteenth Wrangler and second in classical tripos, 1854. He was called to the Bar at Lincoln's Inn in 1858, but his new profession did not prevent him from continuing his mathematical studies, and he thus became one of the few workers in this country who have produced original mathematical investigations while engaged in duties other than that of a mathematical teacher.

Much of Mr. Burbury's work was done in collaboration with the late Rev. H. W. Watson, F.R.S., with whom he shared the joint authorship of treatises on "The Application of Generalised Coordinates to the Dynamics of a Material System" (1879) and "The Mathematical Theory of Electricity" (1883–5), in the latter of which the authors endeavoured to place electrostatics and electromagnetism on a more formal basis than had been done by Clerk Maxwell in his original treatise. It is perhaps a pity that this book appeared at a time when experimental developments were beginning to break down many of our preconceived electrical theories, and, so far as we can gather, Watson and Burbury's treatise is not studied so much as it deserves. It affords a fairly satisfactory representation of electrical phenomena as known at the time, but, of course, every mathematical or dynamical theory of physical phenomena can only be regarded as a scheme for coordinating results of experiments in the simplest form; and with the discovery of new facts every such scheme is liable to be found inadequate when the necessity arises of superseding it by a more comprehensive scheme. It is thus probable that at the present time there is no scheme which represents our existing knowledge of electrical phenomena much better than Watson and Burbury's represented our knowledge at the time it was written.

But, like his friend Watson, Burbury seems to have chosen as his favourite study that branch of molecular dynamics in which Boltzmann occupied a central position. Burbury and Boltzmann were certainly in constant correspondence with each other, and many of Boltzmann's papers were evidently the result of Burbury's criticisms. Perhaps Burbury's training as a barrister gave him special qualifications for playing the *rôle* of critic; at any rate, if there was a weak point in any argument Burbury would certainly find it out in a very short time. A great amount of time was spent in examining Boltzmann's "Minimum Theorem," according to which an assemblage of molecules representing on the kinetic theory a perfect gas, tends to assume the distribution commonly known as "Maxwell's Law." In the proof of this theorem the question of reversibility plays an important part, and it cannot be said that the introduction of probability considerations altogether overcame the difficulty of accounting for an irreversible phenomenon by means of a system the elements of which were subject to the equations of motion of reversible dynamics.

In his "Kinetic Theory of Gases" (1899), Burbury advanced a novel theory as to the distribution of velocities in a medium the molecules of which were too close together to satisfy the fundamental hypotheses involved in the proof of Maxwell's law. According to Burbury, the velocities of neighbouring molecules would become *correlated*, the probability factor involving, besides the usual exponential of the energy, the exponential of the vector product of the velocities of pairs of molecules. Burbury further offered, on this hypothesis, a tentative explanation of liquefaction. According to Burbury, Maxwell's law would thus become inapplicable to a dense gas. On the other hand, if applied to rare gases, it leads to the conclusion that helium and hydrogen cannot escape from the earth's atmosphere, a conclusion which the late Dr. Stoney stated was not in agreement with his observations. Thus the kinetic theory of gases affords another instance of a scheme which covered our knowledge of physical phenomena at one time but no longer does so. To overcome this difficulty we are now resuscitating kinetic theories, but employing them on a smaller scale than before—to electrons instead of molecules.

Another question which occupied Burbury, especially during recent years, was the loss of availability which occurs when two gases mix by diffusion of constant temperature. As Burbury argued, if this happens when different kinds of molecules mix by diffusion, the same thing should be true when molecules of the same kind mix by diffusion. Burbury's views on this subject were stated in *Science Progress* a few years ago. This problem again gave Burbury scope for his critical mind. It cannot be said, however, that he, or, indeed, anyone else, has succeeded in giving a reason *why* the total entropy of a litre of one gas and a litre of a second gas is equal to the entropy of the mixture when its volume is *one* litre, while if two litres of the *same* gas at the same pressure are allowed to mix, the sum of their entropies is equal to the entropy of the mixture when its volume is *two* litres. What Burbury really showed by his arguments was that the truth or otherwise of these statements can only be tested by experimental evidence.

At the present time the study of mathematical physics is rather out of fashion in this country, and it is not unusual to deprecate this study on the ground that it frequently fails to account for the results of observation. Is not this failure one of its most valuable features? Whenever a new physical phenomena is discovered, plenty of people are ready enough to invoke molecules, the æther or electrons, to account for it, and to talk about the motions of these which give rise to the observed phenomenon. The mathematical physicist comes along and says, "Very well; then let us write down the equations of motion and see if the reasoning works out correctly." He obtains a result which does not account for experimental conclusions. Which is wrong? Not the mathematician who has merely attempted to place the reasoning on an exact basis, but the *unmathematical physicist* who has endowed his ether molecules, his ether, or his electrons with properties that are incompatible with each other. In Mr. Burbury we have had a worker who never flinched from the task of following a line of argument up to its logical conclusions, however much these might run counter to orthodox views. He would drive his opponent from one stronghold to another, the controversy being conducted in the most friendly way the whole time. The contest would frequently end in a truce, both sides agreeing that there was much in Nature that we could never understand. But Burbury was rarely the first to give in. It is these passages of arms which very often enable men to appreciate each other's good qualities, and to realise the useful part which men like Burbury may play in evolving order out of chaos. G. H. BRYAN.

PROF. A. LADENBURG.

THE death occurred at Breslau, on August 15, of Dr. Albert Ladenburg, professor of chemistry in the University of Breslau. Dr. Ladenburg was born at Mannheim in 1842, and graduated as doctor of philosophy in 1863. In 1873 he accepted an invitation to take up a position as professor of chemistry and director of the laboratory at Kiel. In 1886 the honorary degree of doctor of medicine of Berne University was conferred on Dr. Ladenburg in recognition of his scientific investigations, and British and other societies, including the Pharmaceutical Society of Great Britain, also honoured him with honorary membership. He was also awarded the Hanbury gold medal for his services in the promotion of research on the chemistry of drugs. It was in 1889 that Dr. Ladenburg took up the post of professor of chemistry at Breslau, and he occupied the office with very great success.

Ladenburg's name is best known by his synthetic work on the production of homatropine. On splitting up atropine, tropic acid and tropine can be formed as derivatives; the latter Ladenburg combined with amygdalic acid to form a compound which is converted into oxy-toluyl-tropeine, or homatropine, an artificial alkaloid which, with its salts, has proved of the greatest service in ophthalmic surgery. His mathematical method of treating synthetic formulæ, and his prismatic benzene ring, place him in the first rank of chemists as a theorist; while as to his practical work, his list of communications to scientific societies and literature in this country and elsewhere includes articles on "The Valency of Nitrogen," on "Synthetic Alkaloids," on "The Relationship between Hyoscyamine and Atropine and the Conversion of the one Alkaloid into the other," on "Hyoscine," on "The Mydriatic Alkaloids occurring in Nature," on "The Synthesis of Coniine," and on "The History and Constitution of Atropine," in addition to the compilation with other collaborators of a dictionary ("Handwörterbuch der Chemie"), consisting of thirteen volumes dealing with inorganic and organic chemistry.

THE BRITISH ASSOCIATION AT PORTSMOUTH.

BY the time this issue reaches the readers of NATURE the eighty-first meeting of the British Association will have been inaugurated at Portsmouth and, given fair weather conditions, we trust it will be a useful and enjoyable gathering. Judging from the number of distinguished men of science who have expressed their intention of being present, the meeting should be of importance as regards its scientific work, as well as successful from a social point of view.

The reception-room is the large Connaught Drill Hall, which appears to be ideal for that purpose. It gives under one roof a large reception hall with post office, telephone, &c., and a comfortably furnished reading and writing room for the members. In addition to this there is also a small room set apart for the use of ladies.

In point of view of numbers, the Portsmouth meeting may not reach that of Sheffield last year, but this is accounted for partly by the absence of any special industry attached to the town, and also may, to some extent, be due to the absence of any university or university college. Most of the accommodation available is, however, booked, and those who arrive late may have difficulty in finding quarters.

The meeting rooms are a little scattered, but this was unavoidable, and notices will be displayed making the routes to be taken to the various section-rooms easy to find.

In passing, mention may be made of a convenient plan for communication between members of the association. It is a box which will be placed in the reception-room, into which notes may be dropped addressed to other members. This box will be frequently cleared, and the notes delivered on request to those to whom they are written.

The pleasures of the meeting commence to-day (Thursday), when at 2.30 a party will be taken over the dockyard and battleships. A garden-party is to be given this afternoon by Sir John and Lady Brickwood at their beautiful residence in the town. In the evening the Mayor will give a reception at the South Parade Pier, which is the property of the Corporation.

On Friday afternoon there will be a special visit to the new filtration works of the Borough of Portsmouth Water Company, and Saturday will be entirely devoted to all-day excursions, including two to the Isle of Wight, and three drives in the South Downs, starting from Chichester, to which city there will be a special train. The drives are to (1) Kingly Vale, West Dean, and Goodwood; (2) Boxgrove Priory and Arundel Castle; (3) Bignor (with the Roman remains) and Parham Park.

On Sunday the Bishop of Winchester is to preach at the Portsea parish church, and on Tuesday the Mayor will entertain the members at a garden-party. In addition, the naval authorities have organised a naval display in Stokes' Bay, consisting of an attack by torpedo-boat destroyers and submarines. Visitors should not neglect a visit to the old *Victory*, one of the most interesting "links with the past" in existence, and a full description of which, written by Mr. W. L. Wyllie, R.A., will be found in an interesting little handbook to Portsmouth which will be presented to members.

INAUGURAL ADDRESS BY PROF. SIR. WILLIAM RAMSAY, K.C.B., PH.D., LL.D., D.Sc., M.D., F.R.S., PRESIDENT.

IT is now eighty years since this Association first met at York, under the presidency of Earl Fitzwilliam. The object of the Association was then explicitly stated:—"To give a stronger impulse and a more systematic direction to scientific inquiry, to promote the intercourse of those who cultivate science in different parts of the British Empire with one another and with foreign philosophers, to obtain a more general attention to the objects of science and a removal of any disadvantages of a public kind which impede its progress."

In 1831 the workers in the domain of science were relatively few. The Royal Society, which was founded by Dr. Willis, Dr. Wilkins, and others, under the name of the "Invisible, or Philosophical College," about the year 1645, and which was incorporated in December, 1660, with the approval of King Charles II., was almost the only meeting-place for those interested in the progress of science; and its Philosophical Transactions, begun in March, 1664–5, almost the only medium of publication. Its character was described in the following words of a contemporary poem:—

"This noble learned Corporation
Not for themselves are thus combined
To prove all things by demonstration,
But for the public good of the nation,
And general benefit of mankind."

The first to hive off from the Royal Society was the Linnean Society for the promotion of botanical studies, founded in 1788 by Sir James Edward Smith, Sir Joseph Banks, and other Fellows of the Royal Society; in 1807 it was followed by the Geological Society; at a later date the Society of Antiquaries, the Chemical, the Zoological, the Physical, the Mathematical, and many other Societies were founded. And it was felt by those capable of forming a judgment that, as well expressed by Lord Playfair at Aberdeen in 1885, "Human progress is so identified with scientific thought, both in its conception and realisation, that it seems as if they were alternative terms in the history of civilisation." This is only an echo through the ages of an utterance of the great Englishman, Roger Bacon, who wrote in 1250 A.D.: "Experimental science has three great prerogatives over all other sciences: it verifies conclusions by direct experiment; it discovers truths which they could never reach; and it investigates the secrets of Nature, and opens to us a knowledge of the past and of the future."

The world has greatly changed since 1831; the spread of railways and the equipment of numerous lines of steamships have contributed to the peopling of countries at that time practically uninhabited. Moreover, not merely has travelling been made almost infinitely easier, but communication by post has been enormously expedited and cheapened; and the telegraph, the telephone, and wireless telegraphy have simplified as well as complicated human existence. Furthermore, the art of engineering has made such strides that the question "Can it be done?" hardly arises, but rather "Will it pay to do it?" In a word, the human race has been familiarised with the applications of science; and men are ready to believe almost anything if brought forward in its name.

Education, too, in the rudiments of science has been introduced into almost all schools; young children are taught the elements of physics and chemistry. The institution of a Section for Education in our Association (L) has had for its object the organising of such instruction, and much useful advice has been proffered. The problem is, indeed, largely an educational one; it is being solved abroad in various ways—in Germany and in most European States by elaborate Governmental schemes dealing with elementary and advanced instruction, literary, scientific, and technical; and in the United States and in Canada by the far-sightedness of the people: both employers and employees recognise the value of training and of originality, and on both sides sacrifices are made to ensure efficiency.

In England we have made technical education a local, not an Imperial, question; instead of half a dozen first-rate institutions of University rank, we have a hundred, in which the institutions are necessarily understaffed, in which the staffs are mostly overworked and underpaid; and the training given is that, not for captains of industry, but for workmen and foremen. "Efficient captains cannot be replaced by a large number of fairly good corporals." Moreover, to induce scholars to enter these institutions, they are bribed by scholarships, a form of pauperism practically unknown in every country but our own; and to crown the edifice, we test results by examinations of a kind not adapted to gauge originality and character (if, indeed, these can ever be tested by examination), instead of, as on the Continent and in America, trusting the teachers to form an honest estimate of the capacity and ability of each student, and awarding honours accordingly.

The remedy lies in our own hands. Let me suggest that we exact from all gainers of University scholarships an undertaking that, if and when circumstances permit, they will repay the sum which they have received as a scholarship, bursary, or fellowship. It would then be possible for an insurance company to advance a sum representing the capital value, viz. 7,464,931*l*., of the scholarships, reserving, say, twenty per cent. for non-payment, the result of mishap or death. In this way a sum of over six million pounds, of which the interest is now expended on scholarships, would be available for University purposes. This is about one-fourth of the sum of twenty-four millions stated by Sir Norman Lockyer at the Southport meeting as necessary to place our University education on a satisfactory basis. A large part of the income of this sum should be spent in increasing the emoluments of the chairs; for, unless the income of a professor is made in some degree commensurate with the earnings of a professional man who has succeeded in his profession, it is idle to suppose that the best brains will be attracted to the teaching profession. And it follows that unless the teachers occupy the first rank, the pupils will not be stimulated as they ought to be.

Again, having made the profession of a teacher so lucrative as to tempt the best intellects in the country to enter it, it is clear that such men are alone capable of testing their pupils. The modern system of "external examinations," known only in this country, and answerable for much of its lethargy, would disappear; schools of thought would arise in all subjects, and the intellectual as well as the industrial prosperity of our nation would be assured. As things are, can we wonder that as a nation we are not scientific? Let me recommend those of my hearers who are interested in the matter to read a recent report on Technical Education by the Science Guild.

I venture to think that, in spite of the remarkable progress of science and of its applications, there never was a time when missionary effort was more needed. Although most people have some knowledge of the results of scientific inquiry, few, very few, have entered into its spirit. We all live in hope that the world will grow better as the years roll on. Are we taking steps to secure the improvement of the race? I plead for recognition of the fact that progress in science does not only consist in accumulating information which may be put to practical use, but in developing a spirit of prevision, in taking thought for the morrow; in attempting to forecast the future, not by vague surmise, but by orderly marshalling of facts, and by deducing from them their logical outcome; and chiefly in endeavouring to control conditions which may be utilised for the lasting good of our people. We must cultivate a belief in the "application of trained intelligence to all forms of national activity."

The Council of the Association has had under consideration the formation of a Section of Agriculture. For some years this important branch of applied science, borrowing as it does from botany, from physics, from chemistry, and from economics, has in turn enjoyed the hospitality of each of these sections, itself having been made a sub-section of one of these more definite sciences. It is proposed this year to form an Agricultural Section. Here there is need of missionary effort; for our visits to our colonies have convinced many of us that much more is being done for the farmer in the newer parts of the British Empire than at home. Agriculture is, indeed, applied botany, chemistry, entomology, and economics, and has as much right to independent treatment as has engineering, which may be strictly regarded as applied physics.

The question has often been debated whether the present method of conducting our proceedings is the one best adapted to gain our ends. We exist professedly "to give a stronger impulse and a more systematic direction to scientific inquiry." The Council has had under consideration various plans framed with the object of facilitating our work, and the result of its deliberations will be brought under your attention at a later date. To my mind, the greatest benefit bestowed on science by our meetings is the opportunity which they offer for friendly and unrestrained intercourse, not merely between those following different branches of science, but also with persons who, though not following science professionally, are interested in its problems. Our meetings also afford an opportunity for younger men to make the acquaintance of older men. I am afraid that we who are no longer in the spring of our lifetime, perhaps from modesty, perhaps through carelessness, often do not sufficiently realise how stimulating to a young worker a little sympathy can be; a few words of encouragement go a long way. I have in my mind words which encouraged me as a young man, words spoken by the leaders of Associations now long past—by Playfair, by Williamson, by Frankland, by Kelvin, by Stokes, by Francis Galton, by Fitzgerald, and many others. Let me suggest to my older scientific colleagues that they should not let such pleasant opportunities slip.

Since our last meeting the Association has to mourn the loss by death of many distinguished members. Among these are:—

Dr. John Beddoe, who served on the Council from 1870 to 1875, has recently died at a ripe old age, after having achieved a world-wide reputation by his magnificent work in the domain of anthropology.

Sir Rubert Boyce, called away at a comparatively early age in the middle of his work, was for long a colleague of mine at University College, and was one of the staff of the Royal Commission on Sewage Disposal. The service he rendered science in combating tropical diseases is well known.

Sir Francis Galton died at the beginning of the year at the advanced age of eighty-nine. His influence on science has been characterised by Prof. Karl Pearson in his having maintained the idea that exact quantitative methods could —nay, must—be applied to many branches of science which had been held to be beyond the field of either mathematical or physical treatment. Sir Francis was General Secretary of this Association from 1863 to 1868; he was President of Section E in 1862, and again in 1872; he was President of Section H in 1885; but, although often asked to accept the office of President of the Association, his consent could never be obtained. Galton's name will always be associated with that of his friend and relative, Charles Darwin, as one of the most eminent and influential of English men of science.

Prof. Thomas Rupert Jones, also, like Galton, a member of this Association since 1860, and in 1891 President of the Geological Section, died in April last at the advanced age of ninety-one. Like Dr. Beddoe, he was a medical man with wide scientific interests. He became a distinguished geologist, and for many years edited the Quarterly Journal of the Geological Society.

Prof. Story Maskelyne, at one time a diligent frequenter of our meetings, and a member of the Council from 1874 to 1880, was a celebrated mineralogist and crystallographer. He died at the age of eighty-eight. The work which he did in the University of Oxford and at the British Museum is well known. In his later life he entered Parliament.

Dr. Johnstone Stoney, President of Section A in 1897, died on July 1, in his eighty-sixth year. He was one of the originators of the modern view of the nature of electricity, having given the name "electron" to its unit as far back as 1874. His investigations dealt with spectroscopy and allied subjects, and his philosophic mind led him to publish a scheme of ontology which, I venture to think, must be acknowledged to be the most important work which has ever been done on that difficult subject.

Among our corresponding members we have lost Prof. Bohr, of Copenhagen; Prof. Brühl, of Heidelberg; Hofrat Dr. Caro, of Berlin; Prof. Fittig, of Strassburg; and Prof. van 't Hoff, of Berlin. I cannot omit to mention that veteran of science Prof. Cannizzaro, of Rome, whose work in the middle of last century placed chemical science on the firm basis which it now occupies.

I knew all these men, some of them intimately; and, if I have not ventured on remarks as to their personal qualities, it is because it may be said of all of them that they fought a good fight and maintained the faith that only by patient and unceasing scientific work is human progress to be hoped for.

It has been the usual custom of my predecessors in office either to give a summary of the progress of science within the past year or to attempt to present in intelligible language some aspect of the science in which they have themselves been engaged. I possess no qualifications for the former course, and I therefore ask you to bear with me while I devote some minutes to the consideration of ancient and modern views regarding the chemical elements. To many in my audience part of my story will prove an oft-told tale; but I must ask those to excuse me, in order that it may be in some wise complete.

In the days of the early Greeks the word "element" was applied rather to denote a property of matter than one of its constituents. Thus, when a substance was said to contain fire, air, water, and earth (of which terms a childish game doubtless once played by all of us is a relic), it probably meant that they partook of the nature of the so-called elements. Inflammability showed the presence of concealed fire; the escape of "airs" when some substances are heated or when vegetable or animal matter is distilled no doubt led to the idea that these airs were imprisoned in the matters from which they escaped; hardness and permanence were ascribed to the presence of earth, while liquidity and fusibility were properties conveyed by the presence of concealed water. At a later date the "Spagyrics" added three "hypostatical principles" to the quadrilateral; these were "salt," "sulphur," and "mercury." The first conveyed solubility, and fixedness in fire; the second, inflammability; and the third, the power which some substances manifest of producing a liquid, generally termed "phlegm," on application of heat, or of themselves being converted into the liquid state by fusion.

It was Robert Boyle, in his "Skeptical Chymist," who first controverted these ancient and mediæval notions, and who gave to the word "element" the meaning that it now possesses—the constituent of a compound. But in the middle of the seventeenth century chemistry had not advanced far enough to make his definition useful, for he was unable to suggest any particular substance as elementary. And, indeed, the main tenet of the doctrine of "phlogiston," promulgated by Stahl in the eighteenth century, and widely accepted, was that all bodies capable of burning or of being converted into a "calx," or earthy powder, did so in virtue of the escape of a subtle fluid from their pores; this fluid could be restored to the "calces" by heating them with other substances rich in phlogiston, such as charcoal, oil, flour, and the like. Stahl, however false his theory, had at least the merit of having constructed a reversible chemical equation:—

$$\text{Metal} - \text{phlogiston} = \text{Calx}; \quad \text{Calx} + \text{phlogiston} = \text{Metal}.$$

It is difficult to say when the first element was known to be an element. After Lavoisier's overthrow of the phlogistic hypothesis, the part played by oxygen, then recently discovered by Priestley and Scheele, came prominently forward. Loss of phlogiston was identified with oxidation; gain of phlogiston with loss of oxygen. The scheme of nomenclature ("Méthode de Nomenclature chimique"), published by Lavoisier in conjunction with Guyton de Morveau, Berthollet, and Fourcroy, created a system of chemistry out of a wilderness of isolated facts and descriptions. Shortly after, in 1789, Lavoisier published his "Traité de Chimie," and in the preface the words occur: "If we mean by 'elements' the simple and indivisible molecules of which bodies consist, it is probable that we do not know them; if, on the other hand, we mean the last term in analysis, then every substance which we have not been able to decompose is for us an element; not that we can be certain that bodies which we regard as simple are not themselves composed of two or even a larger number of elements, but because these elements can never be separated, or rather, because we have no means of separating them, they act, so far as we can judge, as elements; and we cannot call them 'simple' until experiment and observation shall have furnished a proof that they are so."

The close connection between "crocus of Mars" and metallic iron, the former named by Lavoisier "oxyde de fer," and similar relations between metals and their oxides, made it likely that bodies which reacted as oxides in dissolving in acids and forming salts must also possess a metallic substratum. In October, 1807, Sir Humphry Davy proved the correctness of this view for soda and potash by his famous experiment of splitting these bodies by a powerful electric current into oxygen and hydrogen, on the one hand, and the metals sodium and potassium on the other. Calcium, barium, strontium, and magnesium were added to the list as constituents of the oxides, lime, barytes, strontia, and magnesia. Some years later Scheele's "dephlogisticated marine acid," obtained by heating pyrolusite with "spirit of salt," was identified by Davy as in all likelihood elementary. His words are: "All the conclusions which I have ventured to make respecting the undecompounded nature of oxymuriatic gas are, I conceive, entirely confirmed by these new facts." "It has been judged most proper to suggest a name founded upon one of its obvious and characteristic properties, its colour, and to call it chlorine." The subsequent discovery of iodine by Courtois in 1812, and of bromine by Balard in 1826, led to the inevitable conclusion that fluorine, if isolated, should resemble the other halogens in properties, and much later, in the able hands of Moissan, this was shown to be true.

The modern conception of the elements was much strengthened by Dalton's revival of the Greek hypothesis of the atomic constitution of matter, and the assigning to each atom a definite weight. This momentous step for the progress of chemistry was taken in 1803; the first account of the theory was given to the public, with Dalton's consent, in the third edition of Thomas Thomson's "System of Chemistry" in 1807; it was subsequently elaborated in the first volume of Dalton's own "System of Chemical Philosophy," published in 1808. The notion that compounds consisted of aggregations of atoms of elements united in definite or multiple proportions, familiarised the world with the conception of elements as the bricks of which the Universe is built. Yet the more daring spirits of that day were not without hope that the elements themselves might prove decomposable. Davy, indeed, went so far as to write in 1811: "It is the duty of the chemist to be bold in pursuit; he must recollect how contrary knowledge is to what appears to be experience. . . . To inquire whether the elements be capable of being composed and decomposed is a grand object of true philosophy." And Faraday, his great pupil and successor, at a later date, 1815, was not behind Davy in his aspirations when he wrote: "To decompose the metals, to re-form them, and to realise the once absurd notion of transformation—these are the problems now given to the chemist for solution."

Indeed, the ancient idea of the unitary nature of matter was in those days held to be highly probable. For attempts were soon made to demonstrate that the atomic weights were themselves multiples of that of one of the elements. At first the suggestion was that oxygen was the common basis; and later, when this supposition turned out to be untenable, the claims of hydrogen were brought forward by Prout. The hypothesis was revived in 1842, when Liebig and Redtenbacher, and subsequently Dumas, carried out a revision of the atomic weights of some of the commoner elements, and showed that Berzelius was in error in attributing to carbon the atomic weight 12·25 instead of 12·00. Of recent years a great advance in the accuracy of the determinations of atomic weights has been made, chiefly owing to the work of Richards and his pupils, of Gray, and of Guye and his collaborators, and every year an international committee publishes a table in which the most probable numbers are given on the basis of the atomic weight of oxygen being taken as sixteen. In the table for 1911, of eighty-one elements, no fewer than forty-three have recorded atomic weights within one-tenth of a unit above or below an integral number. My mathematical colleague, Karl Pearson, assures me that the probability against such a condition being fortuitous is 20,000 millions to one.

The relation between the elements has, however, been approached from another point of view. After preliminary suggestions by Döbereiner, Dumas, and others, John Newlands in 1862 and the following years arranged the elements in the numerical order of their atomic weights, and published in *The Chemical News* of 1863 what he termed his law of octaves—that every eighth element, like the octave of a musical note, is in some measure a repetition of its forerunner. Thus, just as C on the third space is the octave of C below the line, so potassium, in 1863 the eighth known element numerically above sodium, repeats the characters of sodium, not only in its physical properties—colour, softness, ductility, malleability, &c.—but also in the properties of its compounds, which, indeed, resemble each other very closely. The same fundamental notion was reproduced at a later date, and independently, by Lothar Meyer and Dmitri Mendeléeff; and to accentuate the recurrence of such similar elements in *periods*, the expression "the periodic system of arranging the elements" was applied to Newlands' arrangement in octaves. As everyone knows, by help of this arrangement Mendeléeff predicted the existence of then unknown elements, under the names of eka-boron, eka-aluminium, and eka-silicon, since named *scandium*, *gallium*, and *germanium*, by their discoverers, Cleve, Lecoq de Boisbaudran, and Winckler.

It might have been supposed that our knowledge of the elements was practically complete; that perhaps a few more might be discovered to fill the outstanding gaps in the periodic table. True, a puzzle existed, and still exists, in the classification of the "rare earths," oxides of metals occurring in certain minerals; these metals have atomic weights between 139 and 180, and their properties preclude their arrangement in the columns of the periodic table. Besides these, the discovery of the inert gases of the atmosphere, of the existence of which Johnstone Stoney's spiral curve, published in 1888, pointed a forecast, joined the elements like sodium and potassium, strongly electronegative, to those like fluorine and chlorine, highly electropositive, by a series of bodies electrically as well as chemically inert, and neon, argon, krypton, and xenon formed links between fluorine and sodium, chlorine and potassium, bromine and rubidium, and iodine and cæsium.

Including the inactive gases, and adding the more recently discovered elements of the rare earths, and radium, of which I shall have more to say presently, there are eighty-four definite elements, all of which find places in the periodic table if merely numerical values be considered. Between lanthanum, with atomic weight 139, and tantalum, 181, there are in the periodic table seventeen spaces; and although it is impossible to admit, on account of their properties, that the elements of the rare earths can be distributed in successive columns (for they all resemble lanthanum in properties), yet there are now fourteen such elements; and it is not improbable that other three will be separated from the complex mixture of their oxides by further work. Assuming that the metals of the rare earths fill these seventeen spaces, how many still remain to be filled? We will take for granted that the atomic weight of uranium, 238·5, which is the highest known, forms an upper limit not likely to be surpassed. It is easy to count the gaps; there are eleven.

But we are confronted by an *embarras de richesse*. The discovery of radio-activity by Henri Becquerel, of radium by the Curies, and the theory of the disintegration of the radio-active elements, which we owe to Rutherford and Soddy, have indicated the existence of no fewer than twenty-six elements hitherto unknown. To what places in the periodic table can they be assigned?

But what proof have we that these substances are elementary? Let us take them in order.

Beginning with radium, its salts were first studied by Madame Curie; they closely resemble those of barium—sulphate, carbonate, and chromate insoluble; chloride and bromide similar in crystalline form to chloride and bromide of barium; metal, recently prepared by Madame Curie, white, attacked by water, and evidently of the type of barium. The atomic weight, too, falls into its place; as determined by Madame Curie and by Thorpe, it is 89·5 units higher than that of barium; in short, there can be no doubt that radium fits the periodic table, with an atomic weight of about 226·5. It is an undoubted element.

But it is a very curious one. For it is *unstable*. Now, stability was believed to be the essential characteristic of an element. Radium, however, disintegrates—that is, changes into other bodies, and at a constant rate. If 1 gram of radium is kept for 1760 years, only half a gram will be left at the end of that time; half of it will have given other products. What are they? We can answer that question. Rutherford and Soddy found that it gives a condensable gas, which they named "radium emanation"; and Soddy and I, in 1903, discovered that, in addition, it evolves helium, one of the inactive series of gases, like argon. Helium is an undoubted element, with a well-defined spectrum; it belongs to a well-defined series. And radium emanation, which was shown by Rutherford and Soddy to be incapable of chemical union, has been liquefied and solidified in the laboratory of University College, London; its spectrum has been measured, and its density determined. From the density the atomic weight can be calculated, and it corresponds with that of a congener of argon, the whole series being: helium, 4; neon, 20; argon, 40; krypton, 83; xenon, 130; unknown, about 178; and niton (the name proposed for the emanation to recall its connection with its congeners and its phosphorescent properties), about 222·4. The formation of niton from radium would therefore be represented by the equation: radium (226·4) = helium (4) + niton (222·4).

Niton, in its turn, disintegrates, or decomposes, and at a rate much more rapid than the rate of radium; half of it has changed in about four days. Its investigation, therefore, had to be carried out very rapidly, in order that its decomposition might not be appreciable while its properties were being determined. Its product of change was named by Rutherford "radium A," and it is undoubtedly deposited from niton as a metal, with simultaneous evolution of helium; the equation would therefore be:

niton (222·4) = helium (4) + radium A (218·4).

But it is impossible to investigate radium A chemically, for in three minutes it has half changed into another solid substance, radium B, again giving off helium. This change would be represented by the equation:

radium A (218·4) = helium (4) + radium B (214·4).

Radium B, again, can hardly be examined chemically, for in twenty-seven minutes it has half changed into radium C^1. In this case, however, no helium is evolved; only atoms of negative electricity, to which the name "electrons" has been given by Dr. Stoney, and these have minute weight which, although approximately ascertainable, at present has defied direct measurement. Radium C^1 has a half-life of 19·5 minutes, too short, again, for chemical investigation; but it changes into radium C^2, and in doing so each atom parts with a helium atom, hence the equation:

radium C^1 (214·4) = helium (4) + radium C^2 (210·4).

In 2·5 minutes radium C^2 is half gone, parting with electrons, forming radium D. Radium D gives the chemist a chance, for its half-life is no less than sixteen and a half years. Without parting with anything detectable, radium D passes into radium E, of which the half-life period is five days; and, lastly, radium E changes spontaneously into radium F, the substance to which Madame Curie gave the name "polonium," in allusion to her native country, Poland. Polonium, in its turn, is half changed in 140 days, with loss of an atom of helium, into an unknown metal, supposed to be possibly lead. If that be the case, the equation would run:

polonium (210·4) = helium (4) + lead (206·4).

But the atomic weight of lead is 207·1, and not 206·4; however, it is possible that the atomic weight of radium is 227·1, and not 226·4.

We have another method of approaching the same subject. It is practically certain that the progenitor of radium is uranium, and that the transformation of uranium into radium involves the loss of three α particles, that is, of three atoms of helium. The atomic weight of helium may be taken as one of the most certain; it is 3·994, as determined by Mr. Watson in my laboratories. Three atoms would therefore weigh 11·98, practically 12. There is, however, still some uncertainty in the atomic weight of uranium; Richards and Merigold make it 239·4, but the general mean, calculated by Clarke, is 239·0. Subtracting 12 from these numbers, we have the values 227·0, and 227·4 for the atomic weight of radium. It is as yet impossible to draw any certain conclusion.

The importance of the work, which will enable a definite and sure conclusion to be drawn, is this: For the first time, we have accurate knowledge as to the descent of some of the elements. Supposing the atomic weight of uranium to be certainly 239, it may be taken as proved that, in losing three atoms of helium, radium is produced, and, if the change consists solely in the loss of the three atoms of helium, the atomic weight of radium must necessarily be 227. But it is known that β rays, or electrons, are also parted with during this change; and electrons have weight. How many electrons are lost is unknown; therefore, although the weight of an electron is approximately known, it is impossible to say how much to allow for in estimating the atomic weight of radium. But it is possible to solve this question indirectly by determining exactly the atomic weights of radium and of uranium; the difference between the atomic weight of radium *plus* 12, *i.e.* plus the weight of three atoms of helium, and that of uranium, will give the weight of the number of electrons which escape. Taking the most probable numbers available, viz. 239·4 for uranium and 226·8 for radium, and adding 12 to the latter, the weight of the escaping electrons would be 0·6.

The correct solution of this problem would in great measure clear up the mystery of the irregularities in the periodic table, and would account for the deviations from Prout's Law, that the atomic weights are multiples of some common factor or factors. I also venture to suggest that it would throw light on allotropy, which in some cases, at least, may very well be due to the loss or gain of electrons, accompanied by a positive or negative heat-change. Incidentally, this suggestion would afford places in the periodic table for the somewhat overwhelming number of pseudo-elements the existence of which is made practically certain by the disintegration hypothesis. Of the twenty-six elements derived from uranium, thorium, and actinium, ten, which are formed by the emission of electrons alone, may be regarded as allotropes or pseudo-elements; this leaves sixteen, for which sixteen or seventeen gaps would appear to be available in the periodic table, provided the reasonable supposition be made that a second change in the length of the periods has taken place. It is, above all things, certain that it would be a fatal mistake to regard the existence of such elements as irreconcilable with the periodic arrangement, which has rendered to systematic chemistry such signal service in the past.

Attention has repeatedly been drawn to the enormous quantity of energy stored up in radium and its descendants. That, in its emanation, niton is such that if what it parts with as heat during its disintegration were available, it would be equal to three and a half million times the energy available by the explosion of an equal volume of detonating gas—a mixture of one volume of oxygen with two volumes of hydrogen. The major part of this energy comes, apparently, from the expulsion of particles (that is, of atoms of helium) with enormous velocity. It is easy to convey an idea of this magnitude in a form more realisable by giving it a somewhat mechanical turn. Suppose that the energy in a ton of radium could be utilised in thirty years, instead of being evolved at its invariable slow rate of 1760 years for half-disintegration, it would suffice to propel a ship of 15,000 tons, with engines of 15,000 horse-power, at the rate of 15 knots an hour for thirty years—practically the lifetime of the ship. To do this actually requires a million and a half tons of coal.

It is easily seen that the virtue of the energy of the radium consists in the small weight in which it is contained; in other words, the radium-energy is in an enormously concentrated form. I have attempted to apply the energy contained in niton to various purposes; it decomposes water, ammonia, hydrogen chloride, and carbon dioxide each into its constituents; further experiments on its action on salts of copper appeared to show that the metal copper was converted partially into lithium, a metal of the sodium column; and similar experiments, of which there is not time to speak, indicate that thorium, zirconium, titanium, and silicon are degraded into carbon; for solutions of compounds of these, mixed with niton, invariably generated carbon dioxide, while cerium, silver, mercury, and some other metals gave none. One can imagine the very atoms themselves, exposed to bombardment by enormously quickly moving helium atoms, failing to withstand the impacts. Indeed, the argument *à priori* is a strong one; if we know for certain that radium and its descendants decompose spontaneously, evolving energy, why should not other more stable elements decompose when subjected to enormous strains?

This leads to the speculation whether, if elements are capable of disintegration, the world may not have at its disposal a hitherto unsuspected source of energy. If radium were to evolve its stored-up energy at the same rate that gun-cotton does, we should have an undreamt-of explosive; could we control the rate we should have a useful and potent source of energy, provided always that a sufficient supply of radium were forthcoming. But the supply is certainly a very limited one; and it can be safely affirmed that the production will never surpass half an ounce a year. If, however, the elements which we have been used to consider as permanent are capable of changing with evolution of energy, if some form of catalyser could be discovered which would usefully increase their almost inconceivably slow rate of change, then it is not too much to say that the whole future of our race would be altered.

The whole progress of the human race has indeed been due to individual members discovering means of concentrating energy and of transforming one form into another. The carnivorous animals strike with their paws and crush with their teeth; the first man who aided his arm with a stick in striking a blow discovered how to concentrate his small supply of kinetic energy; the first man who used a spear found that its sharp point in motion represented a still more concentrated form; the arrow was a further advance, for the spear was then propelled by mechanical means; the bolt of the crossbow, the bullet shot forth by compressed hot gas, first derived from black powder, later from high explosives, all these represent progress. To take another sequence: the preparation of oxygen by Priestley applied energy to oxide of mercury in the form of heat; Davy improved on this when he concentrated electrical energy into the tip of a thin wire by aid of a powerful battery, and isolated potassium and sodium.

Great progress has been made during the past century in effecting the conversion of one form of energy into others with as little useless expenditure as possible. Let me illustrate by examples: A good steam engine converts about one-eighth of the potential energy of the fuel into useful work; seven-eighths are lost as unused heat and useless friction. A good gas engine utilises more than one-third of the total energy in the gaseous fuel; two-thirds are uneconomically expended. This is a universal proposition; in order to effect the conversion from one form of energy into another, some energy must be expended uneconomically. If A is the total energy which it is required to convert, if B is the energy into which it is desired to convert A, then a certain amount of energy, C, must be expended to effect the conversion. In short, $A=B+C$. It is eminently desirable to keep C, the useless expenditure, as small as possible; it can never equal zero, but it can be made small. The ratio of C to B (the economic coefficient) should therefore be as large as is attainable.

The middle of the nineteenth century will always be noted as the beginning of the golden age of science, the epoch when great generalisations were made, of the highest importance on all sides, philosophical, economic, and scientific. Carnot, Clausius, Helmholtz, Julius Robert Mayer abroad, and the Thomsons, Lord Kelvin and his brother James, Rankine, Tait, Joule, Clerk Maxwell, and many others at home, laid the foundations on which the splendid structure has been erected. That the latent energy of fuel can be converted into energy of motion by means of the steam engine is what we owe to Newcomen and Watt; that the kinetic energy of the fly-wheel can be transformed into electrical energy was due to Faraday, and to him, too, we are indebted for the re-conversion of electrical energy into mechanical work; and it is this power of work which gives us leisure, and which enables a small country like ours to support the population which inhabits it.

I suppose that it will be generally granted that the Commonwealth of Athens attained a high-water mark in literature and thought which has never yet been surpassed. The reason is not difficult to find; a large proportion of its people had ample leisure, due to ample means; they had time to think and time to discuss what they thought. How was this achieved? The answer is simple: each Greek Freeman had, on an average, at least five helots who did his bidding, who worked his mines, looked after his farm, and, in short, saved him from manual labour. Now we in Britain are much better off; the population of the British Isles is in round numbers 45 millions; there are consumed in our factories at least 50 million tons of coal annually, and "it is generally agreed that the consumption of coal per indicated horse-power per hour is, on an average, about 5 lb." (Royal Commission on Coal Supplies, Part I.). This gives seven million horse-power per year. How many man-power are equal to a horse-power? I have arrived at an estimate thus: A Bhutanese can carry 230 lb. *plus* his own weight, in all 400 lb., up a hill 4000 feet high in eight hours; this is equivalent to about one twenty-fifth of a horse-power; seven million horse-power are therefore about 175 million man-power. Taking a family as consisting, on the average, of five persons, our 45 millions would represent nine million families, and dividing the total man-power by the number of families, we must conclude that each British family has, on the average, nearly twenty "helots" doing his bidding, instead of the five of the Athenian family. We do not appear, however, to have gained more leisure thereby; but it is this that makes it possible for the British Isles to support the population which it does.

We have in this world of ours only a limited supply of stored-up energy, in the British Isles a very limited one—namely, our coalfields. The rate at which this supply is being exhausted has been increasing very steadily for the last forty years, as anyone can prove by mapping the data given on p. 27, table D, of the General Report of the Royal Commission on Coal Supplies (1906). In 1870 110 million tons were mined in Great Britain, and ever since the amount has increased by three and a third million tons a year. The available quantity of coal in the proved coalfields is very nearly 100,000 million tons; it is easy to calculate that if the rate of working increases as it is doing, our coal will be completely exhausted in 175 years. But, it will be replied, the rate of increase will slow down. Why? It has shown no sign whatever of slackening during the last forty years. Later, of course, it must slow down, when coal grows dearer owing to approaching exhaustion. It may also be said that 175 years is a long time; why, I myself have seen a man whose father fought in the '45 on the Pretender's side, nearly 170 years ago! In the life of a nation 175 years is a span.

This consumption is still proceeding at an accelerated rate. Between 1905 and 1907 the amount of coal raised in the United Kingdom increased from 236 to 268 million tons, equal to six tons per head of the population, against three and a half tons in Belgium, two and a half tons in Germany, and one ton in France. Our commercial supremacy and our power of competing with other European nations are obviously governed, so far as we can see, by the relative price of coal; and when our prices rise, owing to the approaching exhaustion of our supplies, we may look forward to the near approach of famine and misery.

Having been struck some years ago with the optimism of my non-scientific friends as regards our future, I suggested that a committee of the British Science Guild should be formed to investigate our available sources of energy. This Guild is an organisation, founded by Sir Norman Lockyer after his tenure of the Presidency of this Association, for the purpose of endeavouring to impress on our people and their Government the necessity of viewing problems affecting the race and the State from the standpoint of science; and the definition of science in this, as in other connections, is simply the acquisition of knowledge, and orderly reasoning on experience already gained and on experiments capable of being carried out, so as to forecast and control the course of events, and, if possible, to apply this knowledge to the benefit of the human race.

The Science Guild has enlisted the services of a number of men, each eminent in his own department, and each has now reported on the particular source of energy of which he has special knowledge.

Besides considering the uses of coal and its products, and how they may be more economically employed, in which branches the Hon. Sir Charles Parsons, Mr. Dugald Clerk, Sir Boverton Redwood, Dr. Beilby, Dr. Hele-Shaw, Prof. Vivian Lewes and others have furnished reports, the following sources of energy have been brought under review: the possibility of utilising the tides; the internal heat of the earth; the winds; solar heat; water-power; the extension of forests, and the use of wood and peat as fuels; and, lastly, the possibility of controlling the undoubted, but almost infinitely slow, disintegration of the elements, with the view of utilising their stored-up energy.

However interesting a detailed discussion of these possible sources of energy might be, time prevents my dwelling on them. Suffice it to say that the Hon. R. J. Strutt has shown that in this country, at least, it would be impracticable to attempt to utilise terrestrial heat from bore-holes; others have deduced that from the tides, the winds, and water-power small supplies of energy are no doubt obtainable, but that, in comparison with that derived from the combustion of coal, they are negligible; nothing is to be hoped for from the direct utilisation of solar heat in this temperate and uncertain climate, and it would be folly to consider seriously a possible supply of energy in a conceivable acceleration of the liberation of energy by atomic change. It looks utterly improbable, too, that we shall ever be able to utilise the energy due to the revolution of the earth on her axis, or to her proper motion round the sun.

Attention should undoubtedly be paid to forestry and to the utilisation of our stores of peat. On the Continent, the forests are largely the property of the State; it is unreasonable, especially in these latter days of uncertain tenure of property, to expect any private owner of land to invest money in schemes which would at best only benefit his descendants, but which, under our present trend of legislation, do not promise even that remote return. Our neighbours and rivals, Germany and France, spend annually 2,200,000*l*. on the conservation and utilisation of their forests; the net return is 6,000,000*l*. There is no doubt that we could imitate them with advantage. Moreover, an increase in our forests would bring with it an increase in our water-power, for without forest land rain rapidly reaches the sea, instead of distributing itself so as to keep the supply of water regular, and so more easily utilised.

Various schemes have been proposed for utilising our deposits of peat: I believe that in Germany the peat industry is moderately profitable; but our humid climate does not lend itself to natural evaporation of most of the large amount of water contained in peat, without which processes of distillation prove barely remunerative.

We must therefore rely chiefly on our coal reserve for our supply of energy, and for the means of supporting our population; and it is to the more economical use of coal that we must look in order that our life as a nation may be prolonged. We can economise in many ways: By the substitution of turbine engines for reciprocating engines, thereby reducing the coal required per horse-power from 4 to 5 lb. to 1½ or 2 lb.; by the further replacement of turbines by gas engines, raising the economy to 30 per cent. of the total energy available in the coal, that is, lowering the coal consumption per horse-power to 1 or 1¼ lb.; by creating the power at the pit-mouth, and distributing it electrically, as is already done in the Tyne district. Economy can also be effected in replacing "beehive" coke ovens by recovery ovens; this is rapidly being done; and Dr. Beilby calculates that in 1909 nearly six million tons of coal, out of a total of sixteen to eighteen millions, were coked in recovery ovens, thus effecting a saving of two to three million tons of fuel annually. Progress is also being made in substituting gas for coal or coke in metallurgical, chemical, and other works. But it must be remembered that for economic use gaseous fuel must not be charged with the heavy costs of piping and distribution.

The domestic fire problem is also one which claims our instant attention. It is best grappled with from the point of view of smoke. Although the actual loss of thermal energy in the form of smoke is small—at most less than a half per cent. of the fuel consumed—still the presence of smoke is a sign of waste of fuel and careless stoking. In works, mechanical stokers, which ensure regularity of firing and complete combustion of fuel, are more and more widely replacing hand-firing. But we are still utterly wasteful in our consumption of fuel in domestic fires. There is probably no single remedy applicable; but the introduction of central heating, of gas fires, and of grates which permit of better utilisation of fuel will all play a part in economising our coal. It is open to argument whether it might not be wise to hasten the time when smoke is no more by imposing a sixpenny fine for each offence; an instantaneous photograph could easily prove the offence to have been committed, and the imposition of the fine might be delayed until three warnings had been given by the police.

Now I think that what I wish to convey will be best expressed by an allegory. A man of mature years, who has surmounted the troubles of childhood and adolescence without much disturbance to his physical and mental state, gradually becomes aware that he is suffering from loss of blood; his system is being drained of this essential to life and strength. What does he do? If he is sensible he calls in a doctor, or perhaps several, in consultation; they ascertain the seat of the disease, and diagnose the cause. They point out that while consumption of blood is necessary for healthy life, it will lead to a premature end if the constantly increasing drain is not stopped. They suggest certain precautionary measures; and if he adopts them he has a good chance of living at least as long as his contemporaries; if he neglects them his days are numbered.

That is our condition as a nation. We have had our consultation in 1903; the doctors were the members of the Coal Commission. They showed the gravity of our case, but we have turned a deaf ear.

It is true that the self-interest of coal consumers is slowly leading them to adopt more economical means of turning coal into energy. But I have noticed, and frequently publicly announced, a fact which cannot but strike even the most unobservant. It is this: When trade is good, as it appears to be at present, manufacturers are making money; they are overwhelmed with orders, and have no inclination to adopt economies which do not appear to them to be essential, and the introduction of which would take thought and time, and which would withdraw the attention of their employees from the chief object of the business—how to make the most of the present opportunities. Hence improvements are postponed. When bad times come, then there is no money to spend on improvements; they are again postponed until better times arrive.

What can be done?

I would answer: Do as other nations have done and are doing; take stock annually. The Americans have a permanent Commission initiated by Mr. Roosevelt, consisting of three representatives from each State, the sole object of which is to keep abreast with the diminution of the stores of natural energy, and to take steps to lessen its rate. This is a non-political undertaking, and one worthy of being initiated by the ruler of a great country. If the example is followed here the question will become a national one.

Two courses are open to us: first, the *laissez-faire* plan of leaving to self-interested competition the combating of waste; or second, initiating legislation which, in the interest of the whole nation, will endeavour to lessen the squandering of our national resources. This legislation may be of two kinds; penal, that is, imposing a penalty on wasteful expenditure of energy supplies; and helpful, that is, imparting information as to what can be done, advancing loans at an easy rate of interest to enable reforms to be carried out, and insisting on the greater prosperity which would result from the use of more efficient appliances.

This is not the place, nor is there the time, to enter into detail; the subject is a complicated one, and it will demand the combined efforts of experts and legislators for a generation; but if it be not considered with the definite intention of immediate action, we shall be held up to the deserved execration of our not very remote descendants.

The two great principles which I have alluded to in an earlier part of this address must not, however, be lost sight of; they should guide all our efforts to use energy economically. Concentration of energy in the form of electric current at high potential makes it possible to convey it for long distances through thin, and therefore comparatively inexpensive, wires; and the economic coefficient of the conversion of mechanical into electrical, and of electrical into mechanical, energy is a high one; the useless expenditure does not much exceed one-twentieth part of the energy which can be utilised. These considerations would point to the conversion at the pit-mouth of the energy of the fuel into electrical energy, using as an intermediary turbines, or preferably gas engines, and distributing the electrical energy to where it is wanted. The use of gas engines may, if desired, be accompanied by the production of half-distilled coal, a fuel which burns nearly without smoke, and one which is suitable for domestic fires, if it is found too difficult to displace them and to induce our population to adopt the more efficient and economical systems of domestic heating which are used in America and on the Continent. The increasing use of gas for factory, metallurgical, and chemical purposes points to the gradual concentration of works near the coal mines in order that the laying-down of expensive piping may be avoided.

An invention which would enable us to convert the energy of coal directly into electrical energy would revolutionise our ideas and methods, yet it is not unthinkable. The nearest practical approach to this is the Mond gas-battery, which, however, has not succeeded, owing to the imperfection of the machine.

In conclusion, I would put in a plea for the study of pure science, without regard to its applications. The discovery of radium and similar radio-active substances has widened the bounds of thought. While themselves, in all probability, incapable of industrial application, save in the domain of medicine, their study has shown us to what enormous advances in the concentration of energy it is permissible to look forward, with the hope of applying the knowledge thereby gained to the betterment of the whole human race. As charity begins at home, however, and as I am speaking to the *British* Association for the Advancement of Science, I would urge that our first duty is to strive for all which makes for the permanence of the British Commonweal, and which will enable us to transmit to our posterity a heritage not unworthy to be added to that which we have received from those who have gone before.

SECTION A.

MATHEMATICS AND PHYSICS.

OPENING ADDRESS BY PROF. H. H. TURNER, D.Sc., D.C.L., F.R.S., PRESIDENT OF THE SECTION.

The Characteristics of the Observational Sciences.

IT will doubtless startle my audience to hear that this Section has only once in its history been addressed by an astronomical President upon an astronomical topic. I hasten to admit that I am not using the term astronomical in its widest sense. Huxley once declared that there were only two sciences, Astronomy and Biology, and it is recorded that "the company" (which happened to be that of the Royal Astronomical Society Club) "agreed with him." One may agree with the company in assenting to the proposition in the sense in which it is obviously intended without losing the right to use the name astronomy in a more restricted sense when necessary; and at present I use it in its classical sense. At Brighton, in 1872, Dr. De La Rue addressed Section A on Astronomical Photography in words which are still worthy of attention, though they are all but forty years old; and this is the only instance I can find in the annals of the Section. There have, of course, been occasional astronomical Presidents such as Airy, Lord Rosse, and Dr. Robinson, but these presided in early days before the Address existed, or when it was brief and formal; and the only allusions to astronomical matters were the statements, by Robinson and Airy, of what the Association had done in subsidising the reduction of Lalande's observations and the Greenwich lunar observations. In 1887 Sir Robert Ball occupied this chair, but he selected from his ample scientific wardrobe the costume of a geometer, and left his astronomical dress at home. A great man whose death was announced almost as I was writing these words, Dr. Johnstone Stoney, spoke (in 1879 at Sheffield) of the valuable training afforded by the study of mechanics and of chemistry, with that keen insight which made him so valuable a member of our Section. Other Presidents whom we have been glad to welcome as astronomers at certain times and seasons did not choose the occasion of their presidency for any very definite manifestation of astronomical sympathy.

The Addresses of Sir George Darwin (in 1886) and of Prof. Love (in 1907) on the past history of our earth certainly have an astronomical bearing, but if we distinguish between the classical astronomy and its modern expansions they would be assigned to the latter rather than to the former; and so do the few astronomical allusions in Prof. Schuster's Address at Edinburgh in 1892. Even if we include, instead of excluding, all doubtful cases, there will still appear a curious neglect of astronomy by Section A in the last half-century, all the more curious when it is remarked that the neglect does not extend to the Association itself, seeing that there have been three Astronomical Presidents of the Association who had not been previously chosen to fill this chair. The neglect is not confined to astronomy, but extends, as some of us recently pointed out, to the other sciences of observation; and we thought that, as a corollary, it would be better for the Section to divide, in order that these sciences might not continue the struggle for existence in an atmosphere to which they were apparently ill-suited. But the Section decided against the suggestion, and I have no intention of appealing against the decision. This explicit statement will, I trust, suffice to prevent misunderstanding if I proceed to examine the possible causes of neglect—for I cannot but regard the record as significant of some cause which it will be well to recognise even if we cannot remove it. Personally I think the cause is not far to seek, and my hope is to make it manifest; but as the statement of it involves something in the nature of an accusation, I will beg leave to make it as gently as possible by using the words of others, especially of those against whom the mild accusation is to be made.

Let me begin by quoting from the admirable Address—none the less admirable because it was only one-quarter of the length to which we have become accustomed—delivered by my late Oxford colleague, the Rev. Bartholomew Price, at Oxford in 1860, wherein he referred to the constitution of this Section as follows:—

"The area of scientific research which this Section covers is very large, larger perhaps than that of any other; and its subjects vary so much that while to some of those who frequent this room certain papers may appear dull, yet to others they will be full of interest. Some of them possess, probably in the highest degree attainable by the human intellect, the characteristics of perfect and necessary science; while others are at present little more than a conglomeration of observations, made indeed with infinite skill and perseverance, and of the greatest value: capable probably in time of greater perfection, nay, perhaps of the most perfect forms, but as yet in their infancy, scarcely indicating the process by which that maturity will be arrived at and containing hardly the barest outline of their ultimate laws."

A little later in the Address Prof. Price made it quite clear which were the sciences "in their infancy."

"And finally we come to the facts of meteorology and its kindred subjects, many of which are scarcely yet brought within any law at all."

There is here much that will command ready and universal assent; but is there not also a rather unnecessary social scale? The science of planetary movement had not yet been "brought within any law at all" (as we now use the term) in Tycho Brahé's time; but was the astronomy of Tycho Brahé socially inferior to that of Kepler? It is difficult to fix the eye on such a question without its being caught by the splendour of Newton towering so near; and the idea of a scale descending from that great height is almost irresistibly suggested. But in spite of this grave difficulty, I ask whether there is of necessity any drop whatever from the plane of Kepler, who realised the laws, to that of Tycho, who never reached any suspicion of the true laws, but had nevertheless such faith in their existence that he cheerfully devoted his life to labours of which he never reaped the fruits? Is it not a dangerous doctrine that the work done previous to the formulation of a law is in any way inferior? Take the case of a man like Stephen Groombridge, who made thousands of accurate observations of stars in the early part of last century. Fifty years later something of the value of his work began to emerge from a comparison with later observations which showed what stars had moved and how; but it was not until nearly a century had elapsed that something about the laws of stellar movement was extracted from his patient work, combined with a repetition of similar works at Greenwich. *Then*, with the skilful assistance of Mr. Dyson and Mr. Eddington, Groombridge at last came into the fruits of his labours; but had he been asked during his lifetime for credentials in the shape of laws, on pain of being classed as an inferior in the social scientific scale, he would have been lamentably unprepared. Or consider the case of M. Teisserenc de Bort, when he began sending up his balloons. "Show me your laws," cries the mathematician. "But they are just what I hope to find," replies M. de Bort. "Yes, but surely you have formulated some law you wish to test?" pursues the invigilator. "How am I to give you proper scientific rank unless you can produce at least a tentative law?" "On the other hand I wish to keep a perfectly open mind," maintains M. de Bort. "Then I fear I cannot admit you to our class at present; you must join the infants' class, and I can only give you my best wishes that you may reach maturity some day." Unperturbed, M. de Bort continues to send up his balloons, and almost immediately discovers the great fact about the isothermal region which will be a permanent factor in the meteorology of the future. The mathematician is now ready to admit him, as a worthy person who has found a law about the constitution of the atmosphere. But was not the merit in sending up the balloons, whatever came of it? Is it not sometimes more courageous to take risks of failure? The mathematician, safe in his stronghold which possesses "probably in the highest degree attainable by the human intellect the characteristics of perfect and necessary science," is like a man who has inherited a good old-established business, and he has a distaste for the methods of those who have to try new ventures. No doubt many who make such trials fail; but, on the other hand, great fortunes have been made in that way.

It may seem, however, that too much is being deduced from a single quoted opinion, which may easily have been personal and not representative. Let me, therefore, take another which presents a different aspect of the same matter. I take the opening words of Sir G. H. Darwin's Address to this Section at Birmingham in 1886.

"A mere catalogue of facts, however well arranged, has never led to any important scientific generalisation. For in any subjects the facts are so numerous and many-sided that they only lead us to a conclusion when they are marshalled by the light of some leading idea. A theory is then a necessity for the advance of science, and we may regard it as the branch of a living tree, of which facts are the nourishment."

Those who have read the letters of Charles Darwin will recognise that this opinion was also held by the father, and may have been adopted by the son. It is no part of my purpose to raise any question of originality: I mention the point merely to take the opportunity it gives me of showing that I do not approach lightly an opinion held by two such men. With the utmost respect, I wish to question whether the criterion indicated goes deep enough. Often have we had ocular demonstration of the value of a theory in stimulating the advance of science; but is advance wholly dependent on the existence of a theory? I have tried to indicate already a deeper motive power by such instances as the work of Tycho, who had no theory, but who perceived the need of observation. And I will now definitely formulate the view that the perception of the need for observations, the faith that something will come of them, and the skill and energy to act on that faith—that these qualities, all of which are possessed by any observer worthy the name, have at least as much to do with the advance of Science as the formulation of a theory, even of a correct theory. The work of the observer is often forgotten—it lies at the root of the plant; it is easier to notice the theories which blossom and ultimately produce the fruit. But without the patient work of the observer underground there would be neither blossom nor fruit. It is also easy to fix attention on the mechanical nature of much observation; but this is not the principal feature of observing any more than is numerical computation of mathematics. There are men like Adams who perform gigantic numerical computations faultlessly, but there are others who would take equal rank as mathematicians who cannot do three additions correctly; and, again, others who could compute well and quickly, but prefer to hand over that part of their work to someone else. Similarly some great observers themselves look through the telescope, and some merely direct others how to do so; the spark of divine fire is not dependent on this detail, but on the possession of the qualities above mentioned—perception, faith, skill, and energy.

By way of bringing out more fully the nature of the assertion made by Sir George Darwin, let me beg your attention to a striking incident in recent astronomical history. We all know how the great astronomer we lost last year, Sir William Huggins (one of those already mentioned as having occupied the presidential chair of the Association without having filled that of Section A), initiated the determination of velocities of the heavenly bodies in the line of sight by means of the spectroscope. We know, further, how the accuracy of these determinations was improved by the application of photography, so that it has recently become possible to measure the velocity of the earth in its orbit (as it alternately approaches and recedes from a given star) with a precision which matches that of other known methods. Now Mr. W. W. Campbell, on his appointment as Director of the Lick Observatory in 1900, perceived the desirability of observing the line-of-sight velocities of as many stars as possible, believed that that outcome would be in some way for the advancement of science, and resolutely acted on that belief, so that for many years the resources of his great establishment have been devoted to this work. He has not turned aside from it even to publish provisional results, and has thereby incurred some adverse criticism. But, having now accumulated a large mass of observation, he is proceeding to let them tell their own tale, and a wonderful story it is. We have, unfortunately, not time to listen to more than a fraction of it at the moment; but that fraction is well worthy of our attention. When the stars are grouped in classes according to their spectral type, their average velocities differ; and if the spectral types are arranged in that particular order which for quite independent reasons we believe to be that of development of the stars, there is a steady increase in the velocities. To put the matter in a nutshell, the older a star is the quicker it moves. There are no doubt several assumptions made in reducing the matter to this simple statement, but I venture to think that they do not affect the point I now wish to make, which is as follows. There is no doubt whatever that the catalogue of facts accumulated by Mr. Campbell, when arranged in an obvious order, has led to a most important scientific generalisation—a direct negative at this date of Sir George Darwin's opening sentence, however true it may have been when he wrote it. If we read on, his next sentence doubtless entitles him to say that it was the marshalling of the facts which led to the conclusion. It is not altogether clear to me in what way this marshalling differs from the permitted "arrangement" of the catalogue; but the third sentence seems to imply that the distinction lies in the existence of a theory. But certainly Mr. Campbell had no theory; so far is he from having had a theory that he finds it extremely difficult, if not at present actually impossible, to formulate one which will satisfactorily account for the extraordinary fact brought to light by the simple arrangement of his catalogue.

Witness his words in Lick Observatory "Bulletin," No. 196, dated April 20 last:—

"The correct interpretation of the observed facts referred to in this 'Bulletin' seems not easy of accomplishment, and the brief comments which follow make no pretensions to the status of a solution.

"That stellar velocities should be functions of spectral types is one of the surprising results of recent studies in stellar motions, for we naturally think of all matter as equally old gravitationally. Why should not the materials composing a nebula or a Class B star have been acted upon as long and as effectively as the materials in a Class M star? . . . The established fact of increasing stellar velocities with increasing ages suggest the questions: Are stellar materials in the ante-stellar state subject to Newton's law of gravitation? Do these materials exist in forms so finely divided that repulsion under radiation pressure more or less closely balances gravitational attraction? Does gravity become effective only after the processes of combination are well under way?"

Mr. Campbell is far from being helpless in the situation he has created; he is ready with suggestions, though he modestly puts them as questions; but they are obviously consequent, and not antecedent, to the advance which he has made. Even if the like has never happened before, *this* scientific advance is at any rate due to little more than the accumulation of facts which arranged themselves, as Bacon hoped would naturally happen. But does it detract from the merits of this fine piece of observational work that it was suggested by no leading theory? And I will ask even further: Would its merits have been less if no such immediate induction had presented itself? To this second question I can scarcely expect a general answer in the affirmative; it is so natural to judge by results, and so difficult to look beyond them to the merits of the work itself, that I shall not easily carry others with me in claiming that the merits of the observer shall be assessed independently of his results. And yet I affirm unhesitatingly that until this attitude is reached, we cannot do justice to the observer. I believe it will be reached in the future, and I shall endeavour to give reasons for this forecast; but I admit frankly that our habit of judging by results will be hard to break. It extends even to the observer himself, and leads to the withholding of his observations from publication, so that he may himself extract the results from them. In the pure interests of the advance of knowledge, it would be far better to publish the material, so that many brains rather than one might work upon it. But the observer knows that by this course he risks losing almost the whole value of his patient work, which would pass as unearned increment to the particular person who was lucky enough to make the induction. Hence arise quarrels such as those between Flamsteed and Newton; the former refusing to publish his observations until he had himself had an opportunity of discussing them, while Newton and Halley exerted their powerful influence in the contrary sense. This situation by no means belongs to a bygone age; it may and does arise to-day, and will continue to arise so long as the recognition of the observer's work is inadequate. It was mentioned a few minutes ago that Mr. Campbell had incurred adverse criticism by accumulating a considerable mass of unpublished observations. Let me be careful not to suggest that his primary motive was the desire to have the first use of them, for I happen to know that there was at least one other good and sufficient reason for his action in the difficulty of finding funds for publication, a difficulty with which observers are only too familiar. But, whatever the reason, there were those who regretted the delay in publication as hindering the advance of science. The whole question is a delicate one, and might have been better left unraised at the moment but for a most curious sequel, which puts clearly in evidence the importance of the observer and the desirability of allowing him to discuss his own work. To make this clear, a small digression is necessary.

During the last half-dozen years astronomers have been startled on several occasions by pieces of news of a particular kind, indicating the association of large, widely scattered groups of stars in a common movement. The discussion of these movements is to occupy the special attention of this Section at one of our meetings, which is an additional reason for brevity in the present allusion. Possibly, also, most members of the Section have already heard of Prof. Kapteyn's division of the great mass of bright stars into two distinct groups flying one through the other; and, again, of the discovery by Prof. Boss of a special cluster of stars in the constellation Taurus, moving in parallel lines like a flock of migrating birds. The fascination of this latter discovery, and of one or two others like it, is that when the information supplied by the spectroscope is combined with that furnished by the long watching of patient observers, we can determine the distance of the cluster and its shape and dimensions. We realise, for instance, that there is a large flat cluster migrating just over our heads, so that one member of it (Sirius) is close to our Sun—that is to say, only three or four light-years from him. "Close" is a relative term; and the distance travelled by light in three years is from some standpoints by no means despicable. But it is small in comparison with the dimensions of the cluster, which is about one hundred light-years from end to end. The study of these clusters will doubtless occupy our close attention in the immediate future; and it is very natural that the discovery of one should lead to the search for others. Accordingly, we heard last autumn with the deepest interest, but with modified surprise, the announcement of common movement in a class of stars of a particular spectral type. The announcement rested to some extent on the work done at the Lick Observatory, much of which has been published in an abbreviated form. But Mr. Campbell, in the Lick Observatory "Bulletin" already quoted, gives reasons why he cannot accept the conclusion, which is vitiated, in his opinion, by the existence of a systematic error in the observations. Now on such a point as this the observer himself is at any rate entitled to a hearing, and is often the best judge. To take proper precautions against systematic errors is the business of the observer, and his efficiency may very well be estimated by his success in this direction—this would be a far safer guide than to judge by results. But sometimes such errors, which are very elusive, do not suggest themselves until the observations have been completed, and must be detected from the observations themselves. This, again, is rightly the business of the observer, and the desire to free his observations from such error is a perfectly sound and scientific reason for withholding publication. In the present instance the error is a peculiarly insidious one; and, indeed, we are not even certain that it is an error. It is a possible alternative interpretation of the facts that the stars with Class B spectrum are in general moving outwards from the Sun, and the additional fact that there is a comparatively large volume of space round the Sun at present empty of B stars would seem to favour this alternative. But, as already mentioned, the observer himself prefers rather to credit his observations with systematic error, which gives a spurious velocity of 5 km. per second to stars of this type. Now it will readily be understood how an error of this kind may appear doubled: two vehicles travelling in opposite directions approach or recede from one another with double the speed of either, and if one were erroneously supposed to be at rest, the other would be judged to travel twice as fast. In this way the B stars in a particular portion of the sky were judged to be travelling with a common motion of 10 km. per second, which would have been a discovery of far-reaching importance if true, but which the observer relegates to the category of systematic errors.

The illustration will suffice to remind us that the work of the observer is far from being merely mechanical: it demands also skill and judgment—skill in defeating systematic error, and a fine judgment, born of experience, of the success attained. All this is independent of the generalisations which may or may not be arrived at. Bradley's skill as an observer enabled him to discover the Aberration of Light and the Nutation of the Earth's Axis; it was enhanced rather than lessened when he went on to make further observations which, had he lived, would have conducted him to the discovery of the Variation of Latitude. After his death the world waited more than a century for this discovery to be made; but Mr. Chandler, who played a leading part in it, has declared that Bradley was almost certainly on its track. It would almost seem that an observer is only properly appreciated by another observer. There are doubtless many who, assisted by the knowledge that Bradley's skill had twice previously conducted him to a discovery, would be ready to admit the value of his later work, although he did not live to crown it; but how many of these could properly appreciate Bradley without such assistance?

I venture to think that the great brilliance of Newton has dazzled our vision so that we do not see some things quite clearly.

"Had it not been for Newton," writes De Morgan in his "Budget of Paradoxes," p. 56, "the whole dynasty of Greenwich astronomers, from Flamsteed of happy memory, to Airy, whom Heaven preserve, might have worked away at nightly observation and daily reduction without any remarkable result: looking forward, as to a millennium, to the time when any man of moderate intelligence was to see the whole explanation. What are large collections of facts for? To make theories *from*, says Bacon; to try ready-made theories *by*, says the history of discovery; it's all the same, says the idolater; nonsense, say we!"

But nothing of this will fit in with what we know of

Bradley's work; he discovered aberration, not by any help from Newton, but by accumulating a mass of observations. He had no ready-made hypothesis, or rather he had a wrong one, viz. that the stars would show displacement due to parallax; and after this was proved wrong, as it was at the very outset, he had nothing in the way of a theory to guide him, and found great difficulty in devising one *after* he had collected his facts, which spoke for themselves so far as to reveal plainly the essential features of the phenomenon in question.

"Modern discoveries" (on the preceding page of the "B. of P.") "have not been made by large collections of facts, with subsequent discussion, separation, and resulting deduction of a truth thus rendered perceptible."

To this I venture to oppose not only such work as that of Bradley, but much in the recent history of astronomy; the discoveries about systematic proper motions, about moving clusters, about the growth of velocity with life-history, and so forth.

"There is an attempt at induction going on, which has yielded little or no fruit, the observations made in the meteorological observatories. The attempt is carried on in a manner which would have caused Bacon to dance for joy. . . . And what has come of it? Nothing, says M. Biot, and nothing will ever come of it: the veteran mathematician and experimental philosopher declares, as does Mr. Ellis, that no single branch of science has ever been fruitfully explored in this way."

De Morgan was a mathematician, and I have noticed that mathematicians are apt to be crisp in their statements: but he is a bold man who says "nothing will ever come of it." Perhaps an equally crisp statement on the other side may be pardoned. I adventure the remark that if nothing has hitherto come of such observations, it is because observers have been misled by the very teaching of De Morgan and others who share his views: they have been told that they will do no good without a theory until they have come to believe it; whereas the truth probably lies in a quite different direction. To present my reasons for this proposition I must ask you first to consider in some detail the method of discussing meteorological observations suggested some years ago by Prof. Schuster. He gave an account of it to the Department of Cosmical Physics over which he presided in 1902, so that I must face some repetition of what he said; but the matter is so important that I trust this may be pardoned.

Let us compare the records produced on a gramophone disc by the playing of a single instrument and by that of an orchestra. The first will be comparatively simple, and when suitably magnified will show a series of waves which in certain parts of the record form sequences of great regularity. These represent occasions when the single instrument played a long sustained note, the pitch of which is indicated by the frequency of the wave. If the instrument plays more loudly, while still keeping to the same note, the heights of the waves will increase, though their frequency will not be altered. The exact shape of each wave will represent the quality of tone which characterises the instrument: and if another instrument were to play the same note it would be different. But so long as we keep to the same instrument, whenever the same note recurred we should find, generally speaking, the same shape of wave: and we could resolve it into its constituents, one being the main wave and others harmonics of different intensities. The analysis of such a record would thus be a comparatively simple matter, on which we need scarcely dwell further. Very different is the case of the orchestral record. There are numerous instruments, playing notes of different pitch, intensity, and character, each of which, if playing alone, would produce its own peculiar record. But when they play together the records are all combined into one. The needle can only make one record, but it is a true sum of all the individuals; for when the instrument is set to reproduce the playing of the orchestra, a trained ear can perceive the playing of the separate instruments—when the strings are playing alone, and when the wind joins them: when the horn comes in, and whether there are two players or only one: nay, even that one of the second violins is playing somewhat flat! This could not happen unless the individual performances were essentially and truly existent in the combined record; and yet this consists of only one single wavy line. The waves are, however, now of great complexity, and it seems at first sight hopeless to analyse them. The mathematician knows, however, that such analysis is possible, and is quite simple in conception, though it may be laborious in execution. Selecting a note of any given pitch, a simple calculation devised by Fourier will reveal when and how loudly that particular note was being played. This being so, it is only necessary to repeat the process for notes of different pitch. But though this can be stated so simply, the carrying out in practice may involve immense labour, by reason of the number of separate notes to be investigated. It is not merely that these will extend from low growls by the double bass to high squeaks by the fiddles, but that their variety within these wide limits will be so great. The series is really infinite. We might, indeed, prescribe a certain scale of finite intervals for the main notes, as in a piano: but the harmonics of the main tones would refuse to obey this artificial arrangement, and would form intermediate pitches, which must be properly investigated if our analysis is to be complete. Moreover, the orchestral instruments will not keep to any such prescribed intervals, but will insist on departing from them more or less, according to the skill of the performer. There is a story told of an accompanist who vainly tried to adjust the key of his accompaniment to the erratic voice of a singer. At length, in exasperation, he addressed him as follows: "Sir, I have tried you on the white notes, and I have tried you on the black notes, and I have tried you on white and black mixed: you are singing on the cracks!" Some instruments will almost certainly "sing on the cracks," so that we shall not easily escape from the examination of a very large number of possibilities indeed—we may well call them *all* the possibilities within the limits of audibility. The illustration is already sufficiently developed for provisional use. My suggestion is that science has only dealt so far with the easy records, and that the genuine hard work is to come. If we can imagine a number of deaf persons turned loose among a miscellaneous collection of gramophone records, with instructions to make what they could of them, we can readily imagine that they would pick out those of single instruments first. We must make the researchers deaf, so that they may not use the beautiful mechanism of the human ear, which has as yet no analogue in scientific work. Possibly something corresponding to this wonderful and still mysterious mechanism may ultimately be devised, and then the course of scientific research may be fundamentally altered: but for the present we must regard ourselves as deaf, and as condemned to work by patient analysis of the records. It is perfectly natural, and even desirable, to begin with the easy ones; and the finding of an easy one would no doubt in our hypothetical case be a sensational event, reflecting credit on the lucky discoverer, who would be hailed as having detected a new law, *i.e.* a new simple case. But sooner or later these will be used up, and we must attack the more complex orchestral records in earnest. Shall we find that the best music is still to come, as our illustration suggests?

But we must return to Prof. Schuster's suggested plan of work. It is closely similar to that already sketched for dealing with a complex gramophone record. Let us consider the record of any meteorological element, such as temperature or rainfall. When these records are put in the form of a diagram in the familiar way we get a wavy line, which has much in common with that traced by a gramophone needle on a smaller scale. The sight of the complexities is almost paralysing, especially when those who would otherwise attack the problem are deterred by the emphatic assertion that it is useless to do so without the equipment of some guiding hypothesis. Most of the obvious hypotheses have, of course, already been tried, and the majority of them have failed. It is to Prof. Schuster that we owe the vitally important advice to disregard hypotheses and make a complete analysis of the record. Of course the labour is great, but the genuine observer is not afraid of labour: he has a right to ask, of course, that it shall not be interminable; and when we are told that we must examine an almost infinite series of possibilities, there would seem to be some danger of this. But in practice the work always resolves itself into a series of finite steps, owing to the finite extent of the observations. A definite illustration will make this clear. Suppose we have ninety years of rainfall, and we test the record for a frequency of nine years, which would run through its period ten times; we must certainly test independently for a frequency of ten years, which would only run through its period nine times, and thus lose one whole period on the former wave; and so, also, for a possible frequency of nine years and a half, and of nine years and a quarter. But a frequency of nine years and one day would not be distinguishable from that of nine years, for the phase would only change 1° in the whole available period of observation. Indeed, the same might be said of all frequencies between nine years and nine years and one month: for the extreme difference of phase would not exceed 40°. But in course of time, when the series of ninety years' observations become 900 years, the differences of phase will approach or exceed a complete cycle, and we must accordingly narrow the intervals between frequencies chosen for examination.

The length of the series of observations is thus an important factor in our procedure, for which Prof. Schuster has indicated a beautiful analogy. Our illustrations hitherto have been provided by the science of sound, but we may also gather them from that of optics. Testing a series of rainfall observations for a periodicity is like examining a source of light for a definite bright line. The process of computation indicated by Fourier gives us what corresponds to the measured brilliance of the bright line, and the complete process of analysis corresponds to the determination of the complete spectrum of the source of light, which may consist of bright lines superimposed on a continuous spectrum. And the length of the series of observations corresponds simply to the resolving power of the optical apparatus. The only point in which the analogy breaks down is unfortunately that of ease and simplicity. In the optical analogy, an optical instrument performs for us with completeness and despatch the analysis, which in its counterpart must be performed by ourselves with much numerical labour.

Let us consider how we should most conveniently proceed to the complete delineation of a spectrum. We should ultimately need an apparatus of the greatest possible resolving power, but it might not be advisable to begin with it; on the contrary, a small instrument which enabled us to glance through the whole spectrum might save much time. Suppose, for instance, that there was a bright line in the yellow; our small instrument might suffice to show us that it was due either to sodium or helium, but no more: the decision between these alternatives must be reserved for the larger instrument. On the other hand, if no line is seen in the yellow at all, we have ruled out both possibilities at once, and so economised labour. Hence it is natural to use first an instrument of low resolving power, and afterwards one of higher.

Now in the work for which this serves as an analogy this procedure is actually imposed upon us by the march of events. It has been pointed out that the resolving power of the optical apparatus corresponds exactly to the length of our series of observations. Hence our resolving power is continually increasing. Quite naturally we begin with a short series of observations, which shows us our lines blurred and confused: to define and resolve them we have but one resource—"wait and see"; wait and accumulate more observations, to lengthen the series. But the lengthening must be in geometrical progression; we must double our series to increase the resolving power in a definite ratio, and double it again. We begin to get a glimpse of the important part to be played by the observer in the future, and of his increase in numbers.

Let us glance at a few illustrations of the use of this method. Prof. Schuster has applied it, for instance, to the observations of sun-spots. Now it may fairly be said that the general law of sun-spots was thought to be known; the variation in a cycle of about $11\frac{1}{3}$ years has long been considered to represent the facts: it catches the eye at once in a diagram, and though there are also obvious anomalies, they had not been deemed worthy of any particular attention (with one exception presently to be mentioned) until Prof. Schuster undertook his analysis. To his surprise, when he calculated the periodogram of sun-spots, he found two entirely new facts:—

Firstly, that there were other distinct periodicities, notably of about four, eight, and fourteen years.

Secondly, that the eleven-year cycle had not been continuously in action, but that during the eighteenth century it had been much less marked than the eight-year and fourteen-year cycles.

A further most interesting fact seems to emerge, viz. that several of the periodicities are harmonics of a major period of some thirty-three years or more, and it seems just possible that a connection may ultimately be established with the Leonid meteor-swarm, which revolves in this period. But it would take us too far from our main point to follow these most interesting corollaries; the point well worthy of our special attention is this, that we have here an undoubted advance in knowledge resulting, not from observations made with regard to any particular theory, but from the simple collection of facts and the arrangement of them in all possible ways, the very method which has been despised and condemned. Let us contrast with this the method hitherto adopted, which has been to hunt for some particular possible cause which will give the eleven-year period. Thus Prof. E. W. Brown suggested[1] in 1900 that the eleven-year cycle was due to the tidal action of Jupiter, altered periodically by two causes:—

	Period	Mag. of force
By Jupiter's eccentricity ..	11·86 years ...	0·33
By the motion of Saturn ...	9·93 ,, ...	0·11

and he suggests his contention by an ingenious and striking diagram, which seems to explain not only the main cycle, but its anomalies. (This Paper is, in fact, the exception above referred to.) But if his contention is correct, the periodogram should show bright lines at 11·86 and 9·93 years, which it does not. This is worth noting, since it is sometimes said that there is nothing new in Prof. Schuster's method, which is true enough in one sense, since it is simply the analysis of Fourier. The novelty consists, *firstly*, in calling attention to the necessity of applying the analysis in all cases, a necessity which I venture to think was overlooked in this instance by so able a mathematician as Prof. Brown; and, *secondly*, in the insistence on the examination of *all* periods, irrespective of any particular theory or preconception. And in this second character the method seems to me to cut at the root of the canons of procedure which have found favour hitherto.

As a second instance I present with much more diffidence a few results which seem to emerge from a very laborious analysis of the rainfall at three or four stations, for which Prof. Schuster and myself are jointly responsible. There is some evidence for a cycle of 600 days in the Greenwich rainfall, to which a further cycle in the quarter period (150 days) lends support. On analysing the Padua records it is found that these cycles do not exist; but it seems quite possible that there are cycles of rather shorter period, viz. 594 days and $148\frac{1}{2}$ days, the relation of four to one being maintained. The separate links in this chain are none of them very strong, but they seem to hang together, and there is certainly a case for further investigation. But would this case have been likely to present itself in any other way than by the examination of the whole periodogram? I find it very difficult to think, even now the periods are suggested, of any theoretical cause; to let the facts speak for themselves took much time and labour, but I venture to think that we might have waited far longer, and cudgelled our brains much more, before we got the clue by formulating hypotheses of causation.

A new method is not adopted widely all at once. Prof. Whittaker has, I am glad to say, begun to apply the method to variable star observations, and is already hopeful of having obtained valuable information in the case of the star SS Cygni. Possibly we may hear something from him at this meeting. Meanwhile, I take the opportunity to remark that the history of variable star observation affords us many lessons as to the desirability of simply accumulating observations and letting them speak for themselves, instead of being guided by a theory on hypothesis. Let me give an instance. One of the fathers

[1] Monthly Notices R.A.S., lx., p. 600.

of variable star-observing, the late N. R. Pogson, made a series of excellent observations of the star R Ursæ Majoris in the years 1853 to 1860. He then seems to have formulated a particularly unfortunate hypothesis, viz. that he knew all about the variation; and he accordingly only made sporadic observations in succeeding years. Now this star, along with many others, varies in a manner which may be illustrated from the occurrence of sunrise. The average interval between two sunrises is exactly twenty-four hours; but this is only the average. In March the sun is rising two minutes earlier every day, and the interval is therefore two minutes short of twenty-four hours; as the year advances the daily gain slackens, and at midsummer the interval is exactly twenty-four hours; then the sun begins to rise *later* each day, and the interval exceeds twenty-four hours, and so on, so that there is a regular yearly swing backwards and forwards through a mean value, and, as in the case of all such swings, there is a sensible halt at the extreme values. Now when Pogson made his observations of R Ursæ Majoris in 1853–60 it was time of halt at an extreme; the period remained stationary, and the variation repeated itself eleven times in closely similar fashion, so that Pogson concluded it would continue in the same way. How many instances suffice for an induction? Many inductions have been based on fewer than eleven. Unfortunately, the period was just beginning to change sensibly, and we lost much valuable information, for no one else repaired Pogson's neglect adequately; and the whole swing of period occupies about forty years, so that the opportunity of studying the changes he missed has only quite recently returned. We are thus reminded how disastrous may be a break in the record. It should be one of the articles of faith with an observer that the record is sacred, and must not be broken. Most of them, indeed, act on that principle already; but there are heretics, and it pained us to find even Prof. Schuster himself tinged with heresy. On the very occasion when he did so much for the observer by presenting his beautiful method, he suggested that it might even be advisable to drop observing for a time in order to apply the method to accumulated observations. He may possibly be right, but the observer had better believe him wrong. There ought to be an "observer's promise," like the promise of the boy scout; and one part of it should be not to interrupt the record, and another should be to publish the observations regularly, and never to let them accumulate beyond five years.

The method of Prof. Schuster is not the only one that has been recently proposed for dealing with large masses of observations. We have also the methods of Prof. Karl Pearson. These have been far more widely adopted for use than the periodogram, and they have also been more adversely criticised. As regards criticism, I think it is fair to say that it has chiefly been directed towards the nature of the material on which Prof. Pearson has used his process than on the process itself, and at present we need not be concerned with it. The processes themselves are sound enough; one of them, for instance, is much the same as the old method of least squares in a simple form. But if the same criticism is made as has been made on the method of the periodogram, viz. that it is not new, we can reply in almost the same words in the two cases: the mathematical calculus may not be new; the novelty is the insistence on the application of it, and the application to all possible cases. Prof. Pearson ceases to look for one principal factor only, and examines all possible factors, just as Prof. Schuster examines all possible frequencies. Let us recur for a moment to the words of Sir George Darwin previously quoted.

"A mere catalogue of facts, however well arranged, has never led to any important scientific generalisation. For in any subject the facts are so numerous and many-sided that they only lead us to a conclusion when they are marshalled by the light of some leading idea."

Let us take, for instance, a catalogue of variable stars such as those of Mr. Chandler. Particulars for each star are given in separate columns, exclusive of the name and number. We might wait long for a leading idea to guide us in marshalling the facts, and, so far as I know, we have waited till now without any such idea occurring to anyone. But Prof. Pearson insists on the plain duty of determining the correlation between each and every pair of these columns, and any others we may be able to add. Anybody could have made the suggestion, and there was plenty of elementary mathematical machinery in existence for carrying it out; but, so far as I know, nobody did, any more than the critics of Columbus suggested how to stand up an egg. But the suggestion having been made by Prof. Pearson, it was so clearly sound that I did what lay in my power to follow it up, with the result that certain correlations were at once indicated which at least pave the way for further inquiry. If we cannot say more than this, it is simply because the catalogue of facts was not large enough. So far from the observers having wasted their energies by observing without any theory to guide them, more work of the same kind would have been welcome, for it would have reduced the probable error of the correlations indicated. As an example, I may quote the following. It has already been mentioned that a variable star maximum, though it may recur after a more or less definite period, on the average, is subject to a swing to and fro like the time of sunrise. Let us call the average interval *the day* of the star and the period of swing *the year*, without implying anything more by these names than appears in the analogy. Then I found[1] that the day and the year were correlated, the value of the coefficient being

$$r = 0{\cdot}56 \pm 0{\cdot}08.$$

Having obtained this clue, it was interesting to use it for the elucidation of individual problems. The *days* of many stars are by this time pretty well known, but their *years* are very uncertain. In nine or ten cases the assessment of the vaguely known *year* was under revision, and in all, without exception, the revised assessment tended in the direction of the formula. In one case (S Serpentis) the formula suggested the solution of a long-standing puzzle.[2] Finally, the inquiry is suggested whether our own sun may be treated as a variable star with a period or *day* of eleven years, in which case its time of swing a *year* should be about seventy-five years if the formula is strictly linear. There are found to be indications of a swing of this order of magnitude, though the time given by the periodogram method is fifty-four years.[3] If the relation between *year* and *day* is not strictly linear, these figures could easily be reconciled for a case lying so far outside the limits within which the formula was deduced. But the ultimate successful establishment of the connection is of less importance for our present purpose than to notice the fruitfulness of the method of suggestion, which is as mechanical as Bacon himself could have wished.

Let us admit frankly that there is an appearance of brutality about such methods. Is our method of search to be merely the old and prosaic one of leaving no stone unturned? We have been led to believe that there should be more of inspiration in it; that a true man of science should have some of the qualities of that fascinating hero of fiction, Mr. Sherlock Holmes, who picks up his clue and follows it unerringly to the triumphant conclusion. Such qualities will do the man of science no possible harm: indeed, they will be of the utmost value to him. The point to which I am now calling attention is the change in nature of the opportunities for using them, which are becoming every day more confused. Sir Conan Doyle, in the exercise of his art, keeps our attention fixed on a single trail: he conceals from us by mere omission the numerous trails which cross it. We admire the skill of the Indian who pursues an enemy through the trackless forest; but his success depends on the simplicity brought by this very tracklessness, and would be imperilled if there were numerous tracks. It may be remarked, however, that there is a still higher sagacity—that of the hound who, even among a number of tracks, can pick out the right one by scent. Let us imagine for a moment that the scientific man can be endowed in the future, by training or by some new invention, with a faculty of this kind, so that he may unerringly pursue a single trail even when it is crossed and recrossed by others. Then, in the terms of this metaphor, I draw attention to the fact that he has still to determine which is the right trail, and that in general he can only do so by pursuing each in turn to

[1] Monthly Notices R.A.S., lxviii., p. 544. [2] *Ibid.*, p. 156. [3] *Ibid.*, p. 659

the end. To take an example from recent scientific anecdote: I relate the story as I was told it, and, even if incorrect in detail, it will serve its purpose as a parable. The Röntgen rays were discovered originally by their photographic action, but afterwards it was found that they would render a screen of calcium tungstate phosphorescent. I was told that this discovery had been made in this wise: Mr. Edison had a large collection of different chemicals and a number of assistants; he set his assistants busily to work to try each substance in turn until the right one was found. Now this is not only a genuine scientific process, but it is *the fundamental process*. Let it be frankly admitted that our instincts are against it. We should much prefer to hear that some *hypothesis* had pointed the way, even a false hypothesis such as actually led to the discovery of the possibility of achromatism in lenses. Or if *memory* had played a part: The other day Prof. Fowler identified the spectrum of a comet's tail with one taken in his laboratory, of which he had some recollection, and our human sympathies fasten at once on this idea of recollection as a praiseworthy element in the discovery. Nay, even mere *accident* appeals to us more than brutal industry; if Mr. Edison had wandered into his laboratory, picked up a bottle at random, and found it answer his purpose, I venture to say that we should have instinctively awarded him more merit; there would have been just a chance that he was inspired. Let us by all means welcome hypothesis, memory, inspiration, and accident whenever and wherever they will help us; but they may fail, and then our only resource is to help ourselves by the unfailing method of examining all possibilities. The aid of the others is adventitious, and comes, like that of the gods, most readily to those who help themselves.

The maxim of "leaving no stone unturned" was enunciated from a rather different point of view some dozen years ago by an American geologist, Prof. T. C. Chamberlin, of Chicago, in a short paper for students entitled "The Method of Multiple Working Hypotheses."[1] After recalling how much the march of science in early days was retarded by the tyranny of a theory formulated too hastily, and how in later times attempts have been made to remedy this evil by holding the theory, provisionally only, as a working hypothesis, Prof. Chamberlin points out that even the working hypothesis has serious disadvantages:—

"Instinctively there is a special searching-out of phenomena that support it, for the mind is led by its desires. . . . From an unduly favoured child it readily grows to be a master and leads its author whithersoever it will. . . . Unless the theory happens perchance to be the true one, all hope of the best results is gone. To be sure truth may be brought forth by an investigator dominated by a false ruling idea. His very errors may indeed stimulate investigation on the part of others. But the condition is scarcely the less unfortunate.

. . . .

"To avoid this grave danger the method of multiple working hypotheses is urged. It differs from the simple working hypothesis in that it distributes the effort and divides the affections. . . . In developing the multiple hypotheses, the effort is to bring up into view every rational explanation of the phenomenon in hand and to develop every tenable hypothesis as to its nature, cause or origin, and to give all of these as impartially as possible a working form and a due place in the investigation. The investigator thus becomes the parent of a family of hypotheses: and by his parental relations to all is morally forbidden to fasten his affections unduly upon any one. In the very nature of the case, the chief danger that springs from affection is counteracted."

For the further elucidation of Prof. Chamberlin's proposals I must refer my audience to his original paper, which is well worthy of careful attention. He does not shirk consideration of the drawbacks—"No good thing is without its drawbacks," he writes. And it may be added that no good thing is entirely new or entirely old. Perhaps it is better to say that it is generally both new and old. The Method of Multiple Hypotheses is new because it is still necessary to remind scientific workers of all kinds that, so long as they restrict themselves to the examination of one hypothesis only, they can never reach complete logical proof: they can only attain a high measure of probability. What is often called verification[1] is not complete proof, but only increase in probability; for complete proof it is necessary to show that no other hypothesis will suit the facts equally well, and thus we are bound to consider other possible hypotheses even in the direct establishment of one.

[1] University of Chicago Press. 1897.

But the method is also old in that it has long been adopted in practice, however partially and unconsciously, by scientific workers of all kinds. When, as a boy at school, I began to make physical measurements under Mr. J. G. MacGregor (now Professor of Physics at Edinburgh), I learnt from him one golden rule: "Reverse everything that can be reversed." The crisp form of the rule may be new to many who have long used it in their work: and its use is simply that of "multiple hypotheses." For when the current in a wire is reversed, the hypothesis is tacitly made that the effect observed may be due to the direction of the current: and when a measured spectrum photograph is turned round and remeasured, it is an admission of the hypothesis that the direction of measurement may be partly responsible for the observed displacements of the spectrum lines. By the various reversals we endeavour, in Prof. Chamberlin's words, "to bring up into view every rational explanation of the phenomenon in hand" which can be brought up into view in this way. But truly "no good thing is without its drawbacks," and one drawback to the recognition of this principle is that, by a process of mental confusion, it seems sometimes to be regarded as a distinct merit in a piece of apparatus that it can be reversed in a large number of ways. It must be remembered that the hypotheses thus examined and ruled out are chiefly instrumental ones superadded to those of Nature: and the latter are already sufficiently numerous, without our ingenious additions.

The view which I have endeavoured to put before you of the inevitable course of scientific work is that it will depend more and more on the patient process of "leaving no stone unturned." It may not be an inspiring view, but it should be at least encouraging, for it follows that no good honest work is thrown away. And it is just this encouragement of which the observer, as opposed to the worker in the laboratory and the mathematician, stands sometimes in sore need. The worker in the laboratory can often clear away his hypothesis on the spot: he can reverse his current then and there; but this is often impossible for the observer, who can and does reverse his spectrum plate for measurement, but to reverse the motion of the earth which affected the lines must wait six months, and to reverse also the motion of the star may have to wait six years, or sixty, or sixty thousand. In many cases he must leave the reversal to others, and thus not only can he not test all his hypotheses, but he may not even be able to formulate them. His aim cannot therefore be to establish within his lifetime some new law, and his work is not therefore to be appreciated or condemned by his success or failure in this respect. There are truer aims and surer methods of judgment. Something is inevitably lost when we endeavour to express these aims in the concrete; but, for the sake of illustration, we may say that the true observer is always endeavouring to reach the next decimal place, and is ever on the alert for some new event. Of the pursuit of the next decimal place it is needless to say more: the aim is as familiar in the labora-

[1] To show that the facts agree with the consequences of our hypothesis is not to prove it true. To show that is often called *verification*: and to mistake verification for proof is to commit the fallacy of the consequent, the fallacy of thinking that, because the hypothesis were true, certain facts would follow, therefore, since those facts are found, the hypothesis is true. . . . A theory whose consequences conflict with the facts cannot be true: but so long as there may be more than one giving the same consequences, the agreement of the facts with one of them furnishes no ground for choosing between it and the others. Nevertheless, in practice, we often have to be content with verification; or to take our inability to find any other equally satisfactory theory as equivalent to there being none other. In such matters we must consider what is called the weight of the evidence for a theory which is not rigorously proved. But no one has shown how weight of evidence can be mechanically estimated; the wisest men, and best acquainted with the matter in hand, are oftenest right.—"An Introduction to Logic," by H. W. B. Joseph, Fellow and Tutor of New College, Oxford, Clarendon Press, 1906, p. 486.

tory as in the observatory. But I often think that the recognition of new events is scarcely given its proper place in the annals of science if we have due regard to the consequences. I have protested that in much of his work the observer cannot be judged by the fruits of his labour, though there is an instinctive tendency to judge in this way; but here is a case where he might well be content to be so judged, and yet the consistent award is withheld. Think for a moment of the very considerable additions to our knowledge which have accrued from the discovery by Prof. W. H. Pickering of an Eighth Satellite to Saturn. The discovery led directly to the recognition of the retrograde motion; and to explain this we were led to revise completely our views of the past history of the Solar system. Incidentally, it stimulated the search for other new satellites, resulting in the discovery of a curious pair to Jupiter, and next of the extraordinary Eighth Satellite; while it was the investigation of the orbit of this curiosity which suggested an eminently successful method of work on Cometary orbits. If we judge scientific work by its results, we must take into account all this subsequent history in our appreciation of Prof. Pickering's achievement. But whether we do so or not is probably a matter of indifference to him, for the true observer is, above all things, an amateur, using the word in that splendid sense to which Prof. Hale recently introduced us. There have been many attempts to define an amateur. One was given by Prof. Schuster in his eloquent address to this Section at Edinburgh in 1892:—

"We may perhaps best define an amateur as one who learns his science as he wants it and when he wants it. I should call Faraday an amateur."

We need not quarrel with his definition, and certainly not with the noble instance with which he points it. But after all I prefer the definition of Prof. Hale[1]:—

"According to my view, the amateur is the man who works in astronomy because he cannot help it, because he would rather do such work than anything else in the world, and who therefore cares little for hampering traditions or for difficulties of any kind."

The wholly satisfactory nature of this view is that it provides not only a definition, but an ambition and a criterion. We feel at once the ambition to become amateurs, for I deny stoutly that the distinction is conferred at birth: it comes with work of the right kind. And we may know what is work of the right kind by this, if by nothing else: that by diligently performing it we shall become amateurs who find it impossible to stop: "who work in astronomy because we cannot help it." Before an army of such men even the vast hordes of dusky possibilities of which we are beginning to catch glimpses must yield. The fight may seem, and no doubt is, without end; and the opportunities for glorious deeds by which outlying whole troops of the enemy are demolished at once are becoming rarer. We are confronted with the necessity of attacking each possibility singly which threatens the stopping of the conflict through sheer weariness. Clearly the army of amateurs is the right one for the work; weariness cannot touch them: they will go on fighting automatically because "they cannot help it."

SECTION B.

CHEMISTRY.

OPENING ADDRESS BY PROF. J. WALKER, D.Sc., F.R.S., PRESIDENT OF THE SECTION.

Theories of Solutions.

TWENTY-ONE years ago the Chemistry Section of the British Association at its meeting in Leeds was the scene of a great discussion on the nature of solutions. It was my first experience of a British Association meeting, and I well remember the stimulating effect of the lively discussion on all who took part in it. To-day, speaking from the honourable position of President of the Section, I conceive I can do no better than indicate the position of the question at the present time. And this appears to me the more appropriate as our science has had this year to mourn the departure of van 't Hoff, the founder of the modern theory of solution, whose name will remain one of the greatest in theoretical chemistry—in time to come, it will, I think, be considered almost the greatest. He had expressed the hope that he might attend this meeting as he did that twenty-one years ago. The hope is not fulfilled: his activity is merged in the final equilibrium of death. But his ideas are part and parcel of the chemical equipment of every one of us, and we know that whatever form the fundamental conceptions of chemistry may assume, the quantitative idea of osmotic pressure will be to the theory of solution what the quantitative idea of the atom is to chemical composition and properties. For I must emphasise the fact that chemistry is essentially a quantitative science, and no chemical theory, no partial chemical theory even, can be successful unless its character is quantitative. To quote the words of Lord Kelvin: "I often say that when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely in your thoughts advanced to the stage of science."

A general theory of solutions must be applicable to all solutions—to those in which solvent and solute exist in practically mere intermixture, as well as to those in which solute and solvent are bound together in what we cannot sharply distinguish from ordinary chemical union. Between these extremes all grades of binding between solvent and solute exist, and it may be well to give a few examples illustrating the various types of solution.

Where no affinity exists between solvent and solute, the solution is practically of the same type as a mixture of two gases which are without chemical action on each other. The solute is merely diluted by the solvent and retains its properties unchanged. An example of this type of solution may be found in the solution of one saturated hydrocarbon in another, say of pentane in hexane. On mixing the two liquids there is no evidence of union between them, the volume of the mixture is practically the sum of the volume of the components, the heat of solution is practically *nil*, the vapour pressure of each constituent is reduced merely as if by dilution with the other constituent, and so on. That there is some action between the two components even in this extreme case must be admitted, but it may be referred entirely to action of a physical kind, such as one finds on mixing one gas with another at considerable pressures. Action of a chemical nature is absent. If it be said that even saturated hydrocarbons have some chemical affinity for each other, recourse may still be had for examples to mixtures of two inactive elements, say liquid argon and liquid krypton, where chemical affinity is non-existent.

At the other extreme we have such solutions as those of sulphuric acid and water. Here there is every physical evidence of chemical union. The volume of the mixture is by no means the sum of the volumes of the components, the amount of heat evolved on mixing is very great, the separate liquids, which are practically non-conductors, yield on mixing a solution which is a good conductor, and so on. There is obviously here a great influence of the solvent water on the solute sulphuric acid, and this influence we can only account for by assuming that it is essentially chemical in character.

As the influence in such a case is necessarily reciprocal, then if even one of the constituents of the solution is inactive chemically there can plainly be no action of a chemical nature on mixing. Thus, no matter what solvent we take, it can exercise no action other than that of a physical kind on argon, say, which has been dissolved in it; and, again, if liquid argon is chosen as solvent no substance dissolved in it can be affected by it chemically, and we thus obtain only the properties of a physical mixture. It is convenient therefore to classify liquid solvents according to their chemical activity. The saturated hydrocarbons, which are chemically very inert, and, as their name paraffin implies, little disposed to chemical action of any kind, may be taken as typically inactive solvents, analogous to liquid argon. Water, on the other hand, as its numerous compounds (hydrates) with all kinds of substances testify, may be taken

[1] Monthly Notices R.A.S., lxviii., p. 64.

as a typically active solvent. The ordinary organic solvents exhibit intermediate degrees of activity.

For the purpose of illustrating the effect of solvents on a dissolved substance one may conveniently take a coloured substance in a series of colourless solvents. If the substance is unaffected by the solvent, we might reasonably expect the colour of the solution to be the same as the colour of the vapour of the substance at equal concentration. Iodine, for instance, gives rise to the familiar violet vapour. Its solution in carbon disulphide has a colour practically similar, but its solution in alcohol or water is of a brown tint quite different from the other. In the indifferent hydrocarbons and in chloroform the colour is like that in carbon disulphide, in methyl or ethyl alcohol it is brown. We conclude therefore roughly that iodine dissolved in saturated hydrocarbons, in chloroform, carbon tetrachloride and carbon disulphide is little affected by the solvent, whereas in water and the alcohols it is greatly affected, probably by way of combination, since in all the solvents two atoms of iodine seem to be associated in the molecule. That combination between the iodine and the active solvents has really occurred receives confirmation from the behaviour of iodine in dilute solution in glacial acetic acid. If the colour of this solution is observed in the cold it is seen to be brown, resembling in colour the aqueous solution. If the solution be now heated to the boiling-point, the colour changes to pink, which may be taken to indicate that the compound of iodine and acetic acid which is stable at the ordinary temperature becomes to a large extent dissociated at 100°.

Now, as I have said, a general theory of solution must be applicable to all classes of solution, and herein lies the importance of van 't Hoff's osmotic pressure theory. It applies equally to mixtures of gases, to mixtures of inert liquids, and to mixtures such as those of sulphuric acid and water; and it has the further advantage that so long as the solutions considered are dilute there are simple relations connecting the osmotic pressure with other easily measurable properties of the solutions. It has been unfortunately the custom to oppose the osmotic pressure theory of solution to the hydrate, or more generally the solvate, theory, in which combination between solute and solvent is assumed. The solvate theory is, in the first place, not a general theory, and in the second place it is perfectly compatible with the osmotic pressure theory. It is in fact with regard to a general theory of solutions on the same plane as the electrolytic dissociation theory of Arrhenius. This theory of ionisation applies to a certain class of solutions, those, namely, which conduct electricity, and is a welcome and necessary adjunct in accounting for the numerical values of the osmotic pressure found in such solutions. Similarly the hydrate, or more generally the solvate, theory is applicable only to those solutions in which combination between solvent and solute occurs, and will no doubt in time afford valuable information with regard to the osmotic pressure, especially of concentrated solutions in which the affinity between solvent and solute is most evident. It can tell us nothing about solutions in which one, or both, components is inactive, just as the electrolytic dissociation theory can tell us nothing about solutions which do not conduct electricity.

The great practical advantage bequeathed to chemists by the genius of van 't Hoff is the assimilation of substances in dilute solution to substances in the gaseous state. Here all substances obey the same physical laws, and a secure basis is offered for calculation connecting measurable physical magnitudes, irrespective of the chemical nature of the substances and of the solvents in which they are dissolved, provided only that the solutions are non-electrolytes. If the solutions are electrolytes, the dissociation theory of Arrhenius, developed independently of the osmotic pressure theory of van 't Hoff, gives the necessary complement, and for aqueous solutions offers a simple basis for calculation. Van 't Hoff has given to science the numerically definable conception of osmotic pressure; Arrhenius has contributed the numerically definable conception of coefficient of activity of electrolytes in aqueous solution, or what is now called the degree of ionisation.

Of late there has been a tendency in some thermodynamical quarters to belittle the importance of the conception of osmotic pressure. It is quite true that from the mathematical thermodynamical point of view it may be relegated to a second place, and even dispensed with altogether, for it is thermodynamically related to other magnitudes which can be substituted for it. But it may be questioned if without the conception the cultivators of the thermodynamic method would ever have arrived at the results obtained by van 't Hoff through osmotic pressure. Van 't Hoff was only an amateur of thermodynamics, but the results achieved by him in that field are of lasting importance, and his work and the conception of osmotic pressure have given a great stimulus to the cultivation of thermodynamics to chemistry.

And here we trench on a question on which a certain confusion of thought often exists. To the investigator it is open to choose that one of several equivalent methods or conceptions which best suits his personal idiosyncrasy. To the teacher such a choice is not open. He must choose the method or conception which is most clearly intelligible to students, and is at the same time least likely to lead to misconception. Osmotic pressure is a conception which the chemical student of mediocre mathematical attainments can grasp, and it is not difficult to teach the general elementary theory of dilute solutions by means of it and of reversible cycles without liability to radical error or misconception. I should be sorry on the other hand to try to teach the theory of solutions to ordinary chemical students by means of any thermodynamic function. The two methods are thermodynamically equivalent, and the second is mathematically more elegant and in a way simpler, but it affords less opportunity than the first for the student to submit his methods to any practical check or test, and in nine cases out of ten would lead to error and confusion. The difficulty of the student is not the mathematical one; with the excellent teaching of mathematics now afforded to students of physics and chemistry the mathematical difficulty has practically disappeared—the difficulty lies in critically scrutinising the conditions under which each equation used is applicable.

Of the mechanism of osmotic pressure we still know nothing, but with the practical measurement of osmotic pressure great advances have been made in recent years. In particular the admirable work of Morse and Frazer is of the first importance in establishing for solutions up to normal concentration the relationship between osmotic pressure and composition, and its variation with the temperature. Much may be anticipated from the continuation of these accurate and valuable researches, the experimental difficulties of which are enormous.

We are indebted to America not only for these researches, and for the voluminous material of H. C. Jones and his collaborators dealing with hydrates in solution, but also to A. A. Noyes and his school for accurate experimental work and for systematic treatment of solutions on the theoretical side. They, and also van Laar, have shown how solutions not coming within the ordinary range of dilute solutions to which van 't Hoff's simple law is applicable, may in some cases at least be made amenable to mathematical treatment. Van 't Hoff chose one simplification of the general theory by considering only very dilute solutions, for which very simple laws hold good, just as they do for dilute gases. Even a single gas in the concentrated or compressed form diverges widely from the simple gas laws; much more then may concentrated solutions diverge from the simple osmotic pressure law. The other simplification is to consider solutions of which the components are miscible in all proportions and are without action on each other; and this method has been developed with marked success from the point of view of osmotic pressure and other colligative properties.

The outstanding practical problem in the domain of electrolytic solutions is to show why the strong electrolytes are not subservient to the same laws as govern weak electrolytes. If we apply the general mass-action law of chemistry to the electrically active and inactive parts of a dissolved substance (the ions and un-ionised molecules) as deduced from the conductivities by the rule of Arrhenius, we find that for a binary substance a certain formula connecting concentration and ionisation should be followed, a formula which we know by the name of Ostwald's dilution law. This law seems to be strictly applicable to solutions of feeble electrolytes, but to solutions of strong electrolytes it is altogether without application. Wherein lies the fundamental difference between these two classes of solutions? Two kinds of explanation may be put forward. First, the ionised proportion may not be given accurately for strong electrolytes by the rule of Arrhenius; or second, the strong electrolytes do not obey the otherwise general law of active mass, which states that the activity of a substance is proportional to its concentration. The first mode of explanation has been practically abandoned, for other methods of determining ionisation give values for strong electrolytes in sufficient agreement with the values obtained by the method of Arrhenius. The other explanation is that for some reason the law of active mass is, apparently or in reality, not obeyed by some or all of the substances in a solution of a strong electrolyte. An apparent disobedience to the law of mass-action would, for example, be caused by the formation of complexes such as Na_2Cl_2, or Na_2Cl^+ or $NaCl_2^-$ in a solution of sodium chloride. Mere hydration, *e.g.* the formation of a complex $NaCl_1\ 2H_2O$, would not affect the mass-action law in dilute solution, and the electrolyte would obey the dilution law in solutions of the concentration usually considered. A somewhat similar explanation, which takes into account the properties of the solvent, is that the ionising power of the solvent water undergoes a noticeable change when the concentration of the ions in it increases beyond a certain limit.

I should wish now to draw attention to a point of view which has not, so far as I am aware, been fully considered. To begin with we may put to ourselves the question: Is it the ions in the solution which are abnormal or is it the non-ionised substance? A simple consideration would point at once to it being the non-ionised portion. We have, for example, in acetic acid a substance which behaves normally, so that the ions H^+ and Ac^- as well as the undissociated molecule HAc are normal. Similarly in ammonium hydroxide the ions NH_4^+ and OH^- as well as the non-ionised NH_3 and $NH_4\ OH$ all behave normally. When we mix the two solutions there is produced a substance, ammonium acetate, which behaves abnormally. Now, on the assumption that the equilibrium we are now dealing with is

$$NH_4^+ + Ac^- \rightleftharpoons NH_4Ac,$$

which of these molecular species is abnormal in the relation between its concentration and its activity? Probably not the ions NH_4^+ and Ac^-, because these were found to act normally in the solutions of acetic acid and ammonia. The presumption is rather that the abnormal substance is the undissociated ammonium acetate, for this occurs only in the abnormal acetate solution, and not in the normal acetic acid and ammonia. This view, that it is the non-ionised portion of the electrolyte which exhibits abnormal behaviour, and not the ions, has been reached on other grounds by Noyes and others, and I hope in what follows to deduce reasons in its support.

One is apt, because the ions are in general the active constituents of an electrolyte, to lay too much stress on their behaviour in considering the equilibrium in an electrolytic solution. We are justified in attributing the fact that acetic acid is a weak acid, whilst trichloracetic acid is a powerful one, rather to the properties of the un-ionised substances than to the properties of the ions. The divergence of trichloracetic acid from the simple dilution law may similarly be due to an inherent property of the un-ionised acid, a single cause being not improbably at the bottom of both the great tendency to split into ions in water and also the abnormal behaviour towards dilution.

However that may be, I think the following reasoning goes far to show that the non-ionised portion of the electrolyte is that which is primarily abnormal in its behaviour, the ions acting in every way as normal. The dilution formulæ of Ostwald or of van 't Hoff is essentially equilibrium formulæ. One side of the equilibrium represents the interaction of the ions to form the non-ionised substance, the other side represents the splitting up of the non-ionised substance into ions. In order to fix our ideas, we may consider a salt which obeys the empirical dilution-formula of van 't Hoff. If c_u represents the molar concentration of the un-ionised portion, and c_i the molar concentration of each ion, then according to van 't Hoff's empirical formula,

$$\frac{c_i^3}{c_u^2} = \text{const.}$$

If the law of mass-action were obeyed we should have, on the other hand, Ostwald's dilution formula,

$$\frac{c_i^2}{c_u} = \text{const.}$$

According to this last formula, the activity of each substance concerned varies directly as its molar concentration, and a normal result is obtained on dilution. According to van 't Hoff's formula as stated above, the activity of none of the substances concerned varies directly as its concentration; but since the constancy of the expression is the only test of its accuracy, there are obviously other methods of stating the relation which will throw the abnormal behaviour either on the ions or on the non-ionised substance. Thus, if we write the equivalent form

$$\sqrt{\frac{c_i^3}{c_u^2}} = \text{const., or } \frac{c_i^{1.5}}{c_u} = \text{const},$$

the un-ionised substance is here represented as behaving normally, and the ions abnormally; whilst if we write the formula in the form

$$\frac{c_i^2}{c_u^{1.33}} = \text{const.}$$

the ions are represented as behaving normally, and the non-ionised substance abnormally. Now it is very important that a choice should be made amongst these three expressions, all equivalent amongst themselves so far as the mere constancy of the expression is concerned, as tested by measurements of electrolytic conductivity. Looked at from the kinetic point of view we have in the first form,

$$\frac{dx}{dt} = kc_i^3$$

$$-\frac{dx}{dt} = k'c_u^2,$$

both direct and reverse actions abnormal. In the second form, we have

$$\frac{dx}{dt} = kc_i^{1.5}$$

$$-\frac{dx}{dt} = k'c_u,$$

the ionisation being normal, the recombination abnormal. And in the third form we have

$$\frac{dx}{dt} = kc_i^2$$

$$-\frac{dx}{dt} = k'c_u^{1.33},$$

the ionisation being abnormal and the recombination normal.

Now, if it were possible to measure directly the velocity of either ionisation or recombination, we should at once be able to select the equilibrium formula which was really applicable. Unfortunately such velocities are so high as to be beyond our powers of measurement. Yet it seems possible to seek and obtain an answer from reaction velocities which are measurable. One assumption must be made, but it seems to me so inherently probable that few will hesitate to make it. It is this, if a substance in a given solution has normal activity with respect to one reaction, it has normal activity with respect to all reactions in which it can take part in that given solution. Similarly, if a substance in a given solution exhibits abnormal activity with respect to one reaction, it will exhibit abnormal activity with respect to all.

Granting this assumption, we have then to find a reaction in which either the ionised or un-ionised portion of an abnormal electrolyte is converted into a third substance with measurable velocity. Such a reaction exists in the transformation of ammonium cyanate into urea in aqueous and aqueous-alcoholic solutions, which was investigated some years ago by myself and my collaborators, and found to proceed at rates which could easily be followed experimentally. First of all comes the question: Is the urea formed directly from the ions or from the un-ionised cyanate? As Wegscheider pointed out, it is impossible from reaction-velocity alone to determine which portion passes directly into urea, if the velocities of ionisation and recombination are infinitely greater than that of the urea-formation, as is undoubtedly the case. Other circumstances make it highly probable that the ions are the active participants in the transformation, but we may leave the question open, and discuss the results on both assumptions.

Suppose, first, that the un-ionised cyanate is transformed directly into urea. Then we have the successive reactions

$$NH_4^{\cdot} + CNO' \rightleftharpoons NH_4CNO \rightarrow CO(NH_2)_2.$$

The slight reverse transformation of urea into cyanate may for the present purpose be neglected, as it in no way influences the reasoning to be employed.

If the un-ionised substance behaves normally, then the conversion of the ammonium cyanate into urea, when referred to the un-ionised substance, will appear unimolecular and obey the law of mass-action: when referred to the ionised substance it will not appear to be bimolecular and will not obey the law of mass-action.

Suppose, now, that the direct formation of the urea is from the ions. Then we are dealing with the actions

$$NH_4CNO \rightleftharpoons NH_4^{\cdot} + CNO' \rightarrow CO(NH_2)_2.$$

Again, let us assume the un-ionised substance to be normal. Once more, if the transformation is referred to the non-ionised substance it will appear as monomolecular; when referred to the ionised substance it will not appear as bimolecular, as it should if the mass-action law were obeyed.

It is a matter of indifference, then, so far as the point with which we are dealing is concerned, whether the ionised or the non-ionised cyanate is transformed directly into urea. If the non-ionised cyanate behaves normally the action when referred to it will in either case appear to be strictly monomolecular.

If the ionised cyanate, on the other hand, behaves normally, the reaction when referred to it will be bimolecular and normal; when referred to the non-ionised cyanate it will not be monomolecular, and therefore will be abnormal.

The actual experiments show that whether water or a mixture of water and alcohol be taken as solvent, the reaction when referred to the ions is strictly bimolecular; when referred to the non-ionised substance it is not monomolecular, *i.e.*, proportional to c_u, but rather proportional to a power of c_u other than the first, namely, $c_u^{-1 \cdot 4}$.

This is, to my mind, a very strong piece of evidence that in the case of the abnormal electrolyte, ammonium cyanate, the abnormality of the ionisation equilibrium is to be attributed entirely to the non-ionised portion. But ammonium cyanate differs in no respect, with regard to its electrolytic conductivity, from the hundreds of other abnormal binary electrolytes with univalent ions; and I am therefore disposed to conclude that it is to the non-ionised portion in general of these electrolytes that the abnormality is to be attributed.

As I have already indicated, this conclusion is not altogether novel, but in my opinion it has not been sufficiently emphasised. Even in discussions where it is formally admitted that the divergence from the dilution law may be due to the non-ionised portion, yet the argument is almost invariably conducted so as to throw the whole responsibility on the ions. The point which ought to be made clear is whether the constant k of the equation

$$\frac{dx}{dt} = kc_i^2,$$

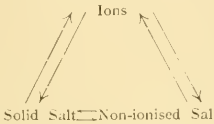
or the constant k' of the reverse equation

$$-\frac{dx}{dt} = k'c_u,$$

is really constant. If the former, then the ions are truly normal, and primary explanations of the abnormality of the strong electrolytes can scarcely be sought in high total ionic concentrations and the like, though a connection between the two no doubt exists, both being determined by the same cause.

In my illustration I have assumed that there holds good a dilution law of the kind given by Storch, of which van 't Hoff's dilution law is a particular case. Here the active mass is represented as a power of the concentration other than the first power. The argument I have used is altogether independent of this special assumption; the active mass of the abnormal substance may be any function of its concentration, and the same conclusion will be reached.

Nernst's principle of the constant ionic solubility product affords additional evidence that the ions act normally in solution. In deducing this principle it is generally assumed that it is the constant solubility of the non-ionised salt that determines the final equilibrium. This assumption, though convenient, is not necessary. The equilibrium is a closed one, thus:—



The solid is not only in equilibrium with the non-ionised salt but also with the ions. Now, in the deduction of the change of solubility caused by the addition of a substance having one ion in common with the original electrolyte the mass-action law for ionisation is assumed. This is of course justified when we deal with feeble electrolytes, but in the case of salts and strong acids which do not follow the mass-action law the experiments are found still to be in harmony with the theoretical deductions. This is not only so when the two substances in solution are both abnormal, but also when one is abnormal and the other normal, no matter which is used to produce the saturated solution. In fact, the principle of the constant ionic solubility product may be employed with equal success to calculate the effect on the solubility of one electrolyte of the addition of another electrolyte with a common ion, whether both electrolytes are normal, both abnormal, or whether one is normal and the other abnormal. At first sight, this apparent obedience of abnormal electrolytes to the mass-action law seems strange, but a little consideration shows that if it is only the non-ionised portion of a salt that is truly abnormal, the theoretical result is to be expected. Suppose that the ions do behave normally in the ionisation, then they must also act with normal active mass with reference to the solid, with which they may be regarded as in direct equilibrium according to the closed scheme referred to above. A change, then, in the concentration of any one of the ions, brought about by the addition of a foreign salt with that ion, will necessarily bring about the change in solubility of the salt calculated from the mass-action law, so far at least as experiment can tell us, for any variation from theory is caused by the change in the nature of the solvent due to the addition of the foreign substance. We ought, then, on the assumption that the ions behave normally, to expect that the principle of the constant solubility product would yield results of the same degree of accuracy in dilute solutions whether the electrolytes considered were normal or abnormal. This, as I have said, is actually the case.

To put the whole matter briefly, in the equilibrium between electrolytes agreement will be obtained between theory and experiment whether we use the mass-action law, or an empirical law such as van 't Hoff's dilution formula, provided only that we attribute the abnormality to the non-ionised portion of the electrolyte. Thus we can deduce the ordinary formulæ for hydrolysis or for isohydric solutions as readily for abnormal as for normal electrolytes, and find the most satisfactory agreement with experiment in both cases.

By this one simple assumption, then, for which I have offered some direct justification, it is possible to find a basis for calculation with abnormal electrolytes. The problem of *why* certain electrolytes should be normal and others abnormal is, of course, in no way touched by this assumption. That is a matter for further investigation and research.

Another great desideratum of the theory of solutions is to find a general basis for the calculation of hydrates. The present position of the theory of hydrates in solution may perhaps most aptly be compared to the theory of electrolytic dissociation for solvents other than water. That hydrates exist in some aqueous solutions is undoubted, but no general rule or method exists for determining what the hydrates are and in what proportions they exist. Similarly the theory of electrolytic dissociation applied to other than aqueous solutions affords no general means of determining what the ions are and how great is the degree of ionisation. It is only for aqueous solutions that Arrhenius was able to give a practically realisable definition of degree of ionisation, and it is on this definition that the whole effective work on aqueous electrolytes is based; and until some general practically applicable principle of a similar character is attained for hydrates, the work done on that subject, however interesting and important it may be in itself, must necessarily be of an isolated character.

Arrhenius did not originate the doctrine of electrolytic dissociation or free ions: that was enunciated in 1857 by Clausius, and remained relatively barren. What he did was to introduce measurable quantities into the doctrine, and to show its simple quantitative applicability to aqueous solutions; immediately it became fertile. And as soon as a simple quantitative principle is developed for hydrates in solution, that doctrine will become fertile also.

It is surely now time that all the irrelevant and intemperate things that have been said and written by supporters of the osmotic pressure and electrolytic dissociation theories on the one hand, and by those of the hydrate theory on the other, should be forgotten. Far from being irreconcilable, the theories are complementary, and workers may, each according to his proclivity, pursue a useful course in following either. One type of mind finds satisfaction in using a handy tool to obtain practical results; another delights only in probing the ultimate nature of the material with which he works. For the progress of science both types are necessary—the man who determines exact atomic weights as well as the man who speculates upon the nature of the atoms. That the want of knowledge as to what the exact nature and mechanism of osmotic pressure is, should prevent accurate experimental work being done on it, or interfere with its use in theoretical reasoning, is equally ridiculous with the proposition that because in the theory of osmotic pressure we have a good quantitative tool for the investigation of solutions, therefore we should abandon altogether the problem of its nature.

The fundamental ideas of a science are the gift to that science of the few great masters; the many journeymen investigators may be trusted to utilise them according to their abilities. Having once given his great principles to the world, van 't Hoff remained practically a spectator of their development; but by his single act he provided generations of chemists with useful and profitable fields for their labour.

NOTES.

SIR ARCHIBALD GEIKIE, K.C.B., president of the Royal Society, Prof. Svante A. Arrhenius, and Prof. Elias Metchnikoff have been elected honorary members of the Vienna Academy of Sciences.

WE regret to announce the death, on August 23, at sixty-three years of age, of the Rev. F. J. Jervis-Smith, F.R.S., late university lecturer in mechanics and Millard lecturer in experimental mechanics and engineering, Trinity College, Oxford.

THE death is announced, at the age of eighty-two years, of Dr. G. F. Blandford. Dr. Blandford early devoted himself to the study of insanity, and was for many years lecturer on psychological medicine at St. George's Hospital. His chief work, "Insanity and its Treatment," was published first in 1871, and passed through several editions. In 1895 he delivered the Lumleian lectures on "The Diagnosis, Prognosis, and Prophylaxis of Insanity" before the Royal College of Physicians. In 1877 he was president of the Medico-psychological Association, and his address for the year was on "Lunacy Legislation." In 1887 he delivered an address before the International Congress of Medicine at Washington on "The Treatment of Recent Cases of Insanity in Private and in Asylums."

THE death is announced of Prof. Georges Dieulafoy, in his seventy-second year. Prof. Dieulafoy was well known in French medical circles, and was professor of clinics in the Necker Hospital, succeeding Prof. Trousseau in 1896. He was known as an author by the six volumes of his "Leçons cliniques de l'Hôtel-Dieu" and his "Manuel de pathologie interne," which has reached a seventeenth edition. He was a member of the Paris Academy of Medicine and a Commander of the Legion of Honour.

WE regret to record the death of Mr. J. R. Mortimer, of Driffield, on August 20, in his eighty-seventh year. Mr. Mortimer was one of the few remaining antiquaries of the old type, and during the past half-century he thoroughly investigated the archæological treasures of the East Riding of Yorkshire, in an area adjoining the field of Canon Greenwell's investigations. Mr. Mortimer excavated more than 300 Bronze-age burial mounds, and a number of Anglo-Saxon cemeteries, and also carefully mapped the elaborate series of prehistoric earthworks which occur on the Yorkshire Wolds in all directions. To a smaller extent he excavated Roman and later sites, and also made extensive collections from the chalk and other secondary formations in his district. These he transferred to a special building at Driffield, which has long been the rendezvous of antiquaries and geologists interested in East Yorkshire. This museum also contains a very large collection of stone and bronze axes, flint arrows, spears, &c., which number tens of thousands, all of which have been obtained in the vicinity. Mr. Mortimer was the author of numerous papers and memoirs, a complete list of which will be found in *The Naturalist* for May last. His principal work, however, is the massive volume "Forty Years' Researches in the British and Saxon Burial Mounds of East Yorkshire," which was published a few years ago by Browns. Besides elaborate tables of measurements of crania, &c., and hundreds of plans and sections of the barrows and earthworks, this volume has illustrations of more than a thousand Bronze-age drinking cups, food vessels, cinerary urns, and bronze and stone implements, from beautiful drawings made by his daughter, Miss Agnes Mortimer. This book, and his magnificent museum, will ever remain monuments to his memory.

THE death is announced of Mr. John Griffiths, the well-known fossil collector of Folkestone. He rendered important service to Mr. F. H. Hilton Price and Mr. J. Starkie Gardner in their researches on the Gault and associated formations, and he discovered a large proportion of the most important Gault fossils now in the British Museum and the Museum of Practical Geology.

THE Scunthorpe Urban District Council has appointed Mr. T. Sheppard, of the Hull Municipal Museums, as expert adviser to the new public museum at Scunthorpe.

IT is announced that on Saturday, September 9, an aërial postal service will be started between Hendon and Windsor. This scheme, which has the sanction of the Postmaster-General, was conceived by Mr. D. Lewis Poole and Captain W. G. Windham, and a contract has now been made with the Grahame-White Company for the carriage of mails by suitable pilots. Post-cards and envelopes, bearing a design of Windsor Castle, have been prepared, and will be on sale, at the price of 6½*d.* and 1*s.* 1*d.* respectively, in the establishments of a number of large firms in London. The letters must be posted in special boxes provided in these establishments, from which they will be collected and conveyed daily to Hendon by motor-van. The mail-bags will be also flown daily, weather permitting, to Windsor from the Hendon ground, and the correspondence distributed from there through the ordinary postal channels. All proceeds from the sale of the postcards and envelopes will be devoted to charity. Captain Windham, the most active mover in the present scheme, inaugurated the first aërial post in India last February.

A SEISMOGRAPH has recently been installed in the Tunnel Colliery, Nuneaton, the object being to ascertain if the apparently inexplicable falls of coal and roof in mines have any relation with the occurrence of earthquakes. Whether or no the problem admits of solution in this direction, there can be no doubt that the comparison of earthquake records obtained on the surface and in mines will lead to interesting results.

IN the July number of *The Cairo Scientific Journal*, Mr. J. Craig discusses some results derived from the anthropometrical material which he had previously investigated and published in *Biometrika*. The measurements dealt with 9000 prisoners of Egyptian nationality, and were taken by the Anthropometric Bureau of the Ministry of the Interior from about 1902 to 1908. The relations of the Copts to the Moslem population, of the urban to the rural population, and of the people of Lower Nubia to the rest of Egypt, were studied, and though the data were not sufficient to support definite conclusions, indications were found of a differentiation into eastern, centre, and western delta districts; Girga and Qena provinces stood apart from Lower Nubia and Aswan on one hand, and from the rest of Upper Egypt on the other. The recent census is utilised to show the amount of migration of males from one province to another.

IT is satisfactory to learn from the report of the Maidstone Museum, Library, and Art Gallery for the period comprised between November, 1908, and October, 1910, that investigations have been undertaken in relation to the origin and purpose of the megalithic monuments of the district, more especially the one at Coldrum. Excavations undertaken beneath the dolmen occupying the centre of the stone circle at that spot revealed evidence of human interments, but nothing indicative of systematic burial or of the date when the interments were made. The skulls have been submitted to an expert, whose opinion as to their age and race had not been received when the report went to press. A model of the Coldrum structures has been presented to the museum by Mr. F. J. Bennett.

A FINE skull of the horned Dinosaur, *Triceratops prorsus*, has just been added to the gallery of fossil reptiles in the British Museum (Natural History). The specimen was discovered in the Laramie formation (Upper Cretaceous) of Wyoming, U.S.A., by Mr. Charles H. Sternberg, who undertook a special expedition for the purpose of making this addition to the museum collection. It is nearly complete, only the middle of the occipital crest, the left horn-core, and the left quadrate bone being restored in plaster. The skull proper measures $3\frac{1}{2}$ feet in length, while the crest extends backwards for another 3 feet, and rises above the level of the tips of the horns. The brain-cavity has been carefully cleaned by the preparator, Mr. Frank O. Barlow, and a cast has been made in plaster. The total length of the cavity is only 10 inches, and its extreme width across the cerebral hemispheres is $2\frac{1}{2}$ inches. For some time the museum has possessed a plaster copy of the restored skeleton of Triceratops as mounted in the National Museum at Washington, but the new specimen is the first actual skull of this remarkable reptile which has been exhibited in Europe. Portions of two skulls of the same genus, also discovered by Mr. Sternberg, have lately been acquired by the Senckenberg Museum, Frankfurt, where they are now being prepared.

The Times of August 28 gives an interesting and very graphic account of a remarkable hailstorm in the Pyrenees on August 16. The narrative of the storm is written by Mr. D. W. Wheeler, who, with his wife and Mr. O. P. Tidman, were encamped in the valley of Arayas, by the side of the Ordesa River. The valley lies on the Spanish side of the Pyrenees, in the Provincia de Huesca, five or six miles directly south of the Cirque of Gavarnie, and has an altitude of 4400 feet. Two storms were experienced, the first shortly after 11 a.m., and this was preceded by a clouding in of the sky and darkness. Mr. Wheeler says that midway in the darkness was the clear-cut straight line of cloud which invariably tells of hail. At first a few isolated hailstones were experienced, but soon the air suddenly became full of hailstones, and in a few minutes the storm had passed. The average size of the hailstones in the first storm is described as that of a marble, but mixed with these was a scattering of much larger stones, almost as large as golf-balls. Another storm, which followed fairly quickly on the first, was more severe. At first marble-sized hail fell and lightning blazed. Suddenly the whole land was bombarded by great hailstones as large as lawn-tennis balls. The violence of the hail is described as surpassing anything that had been previously heard of. All the mountains around were white with the covering of stones, which lay over everything like a sheet, so that in an hour summer had become winter. The smaller branches of trees had fallen as if they had been clipped by hedgers. The open grassland is described as pitted with holes, some of them a couple of inches in depth, and of about the same diameter. Testing the weight of the stones in two instances, in one six stones went to the kilogram, in the other five, which gives 5 and 7 ounces respectively. The size was that of a tennis-ball, and almost uniform. The storm wrought much destruction in the Pyrenean valleys. Seventy sheep were said to have been killed on the heights immediately above the position occupied by the writer of the narrative. Above the village of El Plan, thirty-five cows and some mules were killed. The size of the hailstones is said to have varied in different parts, according to different peasants' accounts, from "hen's eggs" to that of the closed fist. The Paris *Bulletin International* gives no indication of any atmospheric disturbance over the Spanish Peninsula. Mr. Wheeler directs attention to a hailstorm which occurred in Moravia in 1889, which is described in "Chambers's Encyclopædia," where the hailstones are said to be the size of a man's fist, and weighing 3 lb. Mr. Wheeler suggests that this should be three to the lb. The Hon. Rollo Russell, in his work on "Hail," describes a storm in the Orkneys in October, 1890, in which stones fell the size of a goose's egg, and the weight of the largest stones was estimated at 8 oz., and some penetrated the ground to the depth of 4 inches, whilst the depth of the hail in the open fields was 9 inches.

THE drought of July in this country and the serious drought in India are referred to in *Symons's Meteorological Magazine* for August. A map shows the parts of the United Kingdom in which more than ten consecutive days without rain occurred; in some districts in England, Wales, and the south of Ireland the rainfall was under 5 per cent. of the average, but was rather above the average in the west of Scotland. The duration of twenty-five days of drought was general to the west of a line drawn from the Solent to Dunstable (Bedfordshire); several places had no rain for the whole month, and the same district suffered droughts in May and June, and again in August. In India the feebleness of the south-west monsoon has caused great anxiety. Reports in *The Times* and other papers showed that up to July 28 the area most affected was west of a line drawn from Bombay through Jubbulpore to Darbhanga: nearly half of the whole country. A report dated August 21 showed, however, that conditions had greatly improved in several provinces, although famine appears to be certain in Kathiawar and Gujarat. In parts of the United Provinces and the Punjab the canals and rivers were also well supplied with water from the melting of the snow of last spring in the Himalayas.

THE Australian Monthly Weather Report for July, 1910 (lately received), contains an interesting article by Mr. E. T. Quayle on the amount of dust suspended in the atmosphere at Melbourne. One of Dr. Aitken's dust counters was in regular use at the Weather Bureau from March to July, 1909; one observation was usually made in the morning and another in the afternoon of each day. The average number of particles per cubic inch during this period was 674,000; the number steadily increased from an average of 460,000 during the first fortnight to 909,000 in the last, indicating a tendency to a winter maximum. This increase appeared to be seasonal, probably due to the diminished power of the sun in causing convectional movements of the air, and to greater relative humidity, rather than to smoke from chimneys. Taking only those days on which the wind direction remained the same, the morning observations gave an average of 638,000, and the afternoon 536,000. Wind direction had a considerable effect, the north wind being least dusty, and the north-east the most so, calms being by far the most dusty. The fact that the northerly winds in Melbourne are the least dusty is entirely contrary to the general impression on this subject. The greatest number of dust particles obtained in any one observation was 1,902,000 on a calm morning during a dense fog; the lowest recorded was 128,000, on a wet day.

IN conformity with the new regulations introduced by the Indian Museum Act of 1910, the report of the superintendent of the zoological and anthropological section of the museum at Calcutta for 1910–11 is issued in two divisions, one dealing with the progress and general condition of the establishment as a whole, and the other with the aforesaid section. In the former, after reference to the complete reorganisation of the various sections of the museum and the progress on a new wing, it is stated that the most unsatisfactory feature is the relatively small number of Europeans by whom the galleries are visited, the ratio being 15,485 Europeans to 786,519 natives. In the sectional portion of the report it is mentioned that the augmentation of the scientific staff has rendered it possible to provide instruction in the methods of zoological research, and likewise to institute inquiries relating to the fishing industries of the country. The report also contains two letters relating to the volumes on invertebrates in the "Fauna of British India," with reference to the advisability of engaging for this work the services of naturalists personally acquainted with India, and also whether the work could be best done in Calcutta or London.

IN the Transactions of the Lincolnshire Naturalists' Union for 1910 attention is directed by the president to the excellent manner in which the Lincoln Museum is discharging its proper and legitimate function as an exposition of everything connected with the natural history and antiquities of the county, strictly limiting its scope to the productions of that area. To this issue Mr. G. W. Mason contributes the fourth part of his catalogue of Lincolnshire Lepidoptera.

IN *The Field* of August 19 Mr. Pocock expresses the opinion that the animal commonly known in this country as the chita (*Cynaelurus jubatus*) is closely allied to the more typical cats, the puma, and the lynx, whereas lions, tigers, leopards, and jaguars are as markedly different. This conclusion is largely based on the fact that in the former group the hyoid apparatus is intimately connected with the skull, and that these animals purr instead of roaring. In the second group, on the contrary, the hyoid is suspended to the skull by means of a pair of long elastic cartilages, this structure being apparently connected with the power of roaring. The partial retractility of the claws of the chita is regarded as an adaptive feature connected with speed, for which this animal is specially built. It may be mentioned that in India the name chita (meaning spotted) is applied indifferently to the leopard and to *Cynaelurus jubatus*, for which reason "hunting leopard" is a preferable designation for the latter.

IN *The Zoologist* for August Captain Stanley Flower records his impressions of zoological gardens, museums, and aquariums in various parts of Europe visited by himself during the last three years, these including Birmingham, Brighton, Brunn-am-Gebirge (Austria), Cologne, Halifax, Lyons, Marseilles, Munich, Naples, Paris, Southampton, Stuttgart, and Vienna.

THE first of a series of "Behaviour Monographs" (New York: Hy. Holt and Co., 1911) in connection with *The Journal of Animal Behaviour* is by Mr. F. S. Breed, and deals with the development of certain instincts and habits in chicks. The results of a great number of experiments are tabulated and plotted. The author considers that the initial accuracy of the instinctive pecking has been exaggerated, and regards the improvement observed in the early days of life as due rather to the maturing of the organic mechanism than to the effects of habit. The efficiency of pecking has reached nearly 60 per cent. of accuracy by the beginning of the third day, about 80 per cent. on the eleventh day, after which it rises to a limit of about 85 per cent. The experiments on the rate of learning to respond differentially to objects of different brightness, colour, and size are carefully devised. The results of tests with differences of form were, however, negative. There was no conclusive evidence that the previous establishment of differential response to different colours facilitated that of responding to different sizes.

IN a paper on the birds inhabiting the bush (forest) districts of New Zealand, published in *The Emu* for July, Mr. J. C. M'Lean states that the number of such species is much less than in Australia. Originally there were only about a score of birds with strictly arboreal habits to be found in the whole of the North Island, and of these many which were once common are now rare, while one or two may possibly be extinct. An impression has, indeed, prevailed among ornithologists that nearly all the New Zealand bush-birds are *in extremis*; but this, it is satisfactory to learn, is not shared by Mr. M'Lean, who is of opinion that, although many are retreating before the axe and forest-fires, yet they are still to be met with in considerable numbers in the higher and more remote bush-country, where, it may be hoped, steps will be taken for their preservation.

IN vol. lvi., No. 21, of the Smithsonian Miscellaneous Collections Mr. E. W. Nelson describes a humming-bird from an elevation of about 3000 feet on Cerro Azul, in the Chepo district of Panama, which is referred to a new genus and species, *Goldmania violiceps*. The new bird is allied to the members of the large genus Saucerottea, but distinguished by certain peculiarities of the under tail-coverts and primary quills, and the short feathers of the tarsus, which leave the outer side of that segment exposed.

With the exception of the crown, forehead, and lores, which are iridescent violet, the general colour of the upper parts is metallic-green.

Paramaecium aurelia and *P. caudatum* are the subject of several observations by L. Woodruff (*Journ. of Morphol.*, June; *Journ. Exper. Zoology*, July; Proc. Soc. Exper. Biology, viii.). He finds that these protozoa grow well in a medium of beef extract, that the rate of reproduction in hay infusion is influenced by the volume of the culture medium, and that the organisms excrete substances which are toxic to themselves. The great majority of individuals of *aurelia* and *caudatum* can be distinguished both by shape and by size, but the power of reproduction of the two is practically identical. The macronucleus is subject to such variation that it affords no diagnostic feature; the micronuclear apparatus, on the other hand, affords crucial diagnostic characters.

A COLLECTION of six short papers is published in vol. xiii., part x., of the Contributions from the United States National Herbarium. A lichen contribution by Mr. A. W. C. Herre deals with the family Gyrophoraceæ in California; the single species *Umbilicaria semitensis*, and twelve species of Gyrophora, are described. Some interesting facts are noted by Mr. W. H. Brown as the result of observations upon plant life in four shallow lakes in North Carolina. Lake Ellis, the most fertile, is three miles long with a maximum depth of 2 to 3 feet. Three zones of vegetation are clearly distinguishable, dependent primarily on substratum, not on depth of water, which is fairly uniform. The central zone, underlaid by sand, carries a sparse growth of *Eriocaulon compressum* mingled with Eleocharis in shallower spots. The substratum becomes muddier in the intermediate zone, where *Philotria minor*, *Panicum hemitomon*, and *Eleocharis interstincta* are conspicuous, and in the thicker sediment of the marginal zone *Eleocharis mutata*, *Castalia odorata*, grasses, and sedges are the most prominent plants.

As the conditions of the various regions of the United States cause marked vegetation differences, there is a corresponding variety about the problems attacked by the various agricultural experiment stations. Both at the Connecticut and Wisconsin stations, as well as elsewhere in the old settled regions, the problem is to restore the lost fertility of the soil consequent on many years of pioneer agriculture. Especially are some of the Wisconsin clay soils deficient in phosphates, so that small dressings of rock phosphate are producing unexpectedly large returns. The management of sandy soils and of peat soils is also receiving attention, and under Prof. Whitson's direction some very useful work on soil improvement is being carried out. Another direction is given to the work at Connecticut. Considerable attention is being paid to dairying and fruit-growing, both of which systems tend to make the most of the soil and at the same time maintain its fertility. A batch of bulletins is recently to hand dealing with the renovation of old orchards and the planting of new ones, and with various dairy problems of practical importance.

THE July number of *The Cairo Scientific Journal* contains a preliminary note by Dr. W. Bean on the soils of the Gezira. A large tract on the left bank of the Blue Nile from Wad Medani to Kamlin is to be irrigated, and very wisely a thorough examination of the soil has been undertaken, samples being collected down to a depth of more than a metre along several lines across the area included in the scheme. The soils, both the more and the less fertile as the natives classify them, are well supplied with potash and phosphates, but, like most Egyptian and Sudan soils, are markedly deficient in organic matter and nitrogen, so that the results which may be obtained from their cultivation will largely depend on their treatment with respect to this deficiency. Rotation with a leguminous crop has not been used on most Sudan soils, but the experiment when made on a small scale near Khartoum gave results exceeding all expectations.

THE report of the Chemical Laboratories of the Survey Department of Egypt is this year published separately. Mr. A. Lucas, in discussing the work for 1910, reviews the various stages by which the work has developed since its commencement in 1899. Almost all the work is done for Government departments, and as approximately 40 per cent. of the materials offered or delivered are found to be adulterated or of very inferior quality, the laboratories furnish a valuable safeguard on expenditure made. In spite of this the importance of systematic analysis of supplies and accurately drawn up specifications is only being slowly realised, and the samples of material examined still bear but a small proportion to the number which would represent an adequate control of the supplies purchased.

IN continuation of an earlier contribution dealing with the Allioniaceæ of the United States, Mr. P. C. Standley has prepared a synopsis of the Mexican and Central American species of the family ordinarily known as the Nyctaginaceæ, that is published in the Contributions from the United States National Herbarium (vol. xiii., part xi.). Twenty-two genera are differentiated, but some of these are changes of name that are not sufficiently explained. Among the new species are additions to Allionia, Boerhaavia, Neea, and Pisonia. An interesting ubiquitous species is *Pisonia aculeata*, that owes its distribution to the viscid glands on the fruit.

THE prospects of viticulture in Rio Grande do Sul, the southernmost State of Brazil, are discussed by Senor A. de Azambuja in a pamphlet reprinted from articles in the *Gazeta do Commercio*, published at Porto Allegre. The first vine, introduced about sixty years ago, was the American variety Isabella. Other American and some European varieties were tried later, and the cultivation was taken up by Italian colonists. Different varieties have been grown with the object of discovering those suitable for producing table fruit, wine, and currant grapes. In recommending the Isabella and other American varieties of the *labrusca* species, the author claims that first-class wines can be produced when the details of manufacture are improved.

A SUMMARY of Dr. Kienitz's important investigations into the shapes and types of *Pinus sylvestris* is provided by Mr. B. Ribbentrop in the Transactions of the Royal Scottish Arboricultural Society (vol. xxiv., part ii.). The two extreme types are represented by the strong-branched, broad-crowned tree common in Scotland, and the slender pyramidal shape characteristic of the Baltic pine. The chief result of Dr. Kienitz's researches and experiments has been to demonstrate the heredity of special forms or races, even when transferred to different conditions of climate and soil, and thereby to prove the necessity for getting the best and most suitable seed. It is noted that the much-branched tree is better fitted to hold its own in the struggle for light, and is the prevailing form in milder localities, whereas the slender form is developed under more rigorous conditions, where heavy snowfalls constitute a primary source of danger.

The volume of *Mitteilungen* of the Berne Scientific Society for 1910 contains an interesting attempt by P. Gruner to render the principle of relativity intelligible to the less mathematical reader. The twenty-one pages of "elementary" presentation still offer a formidable array of complex arguments, many of which are by no means easy to follow. Gruner imagines the inhabitants of earth and Mars as engaged in an attempt to unify and connect their respective time and space scales without the aid of astronomical observations of any other bodies, but with the free use of wireless telegraphy for mutual communications. He shows how, owing to relative motion, the scales must differ, and deduces Einstein's transforming equations in a simple manner. The scheme and argument could, no doubt, be still further simplified, and the simpler the better. Even this simplification tends to bring out the essential weakness of the theory, which assumes that successive light waves from a moving source are not concentric, and at the same time postulates, on the basis of Michelson's experiment, that this eccentricity cannot be discovered. Everything would be so much simpler if the speed of the body were added to the speed of the light it emitted, a supposition which, indeed, does not appear to contradict any astronomical observations.

Although the "exploring electrode" method of determining the distribution of electrical potential in the kathode dark space of a vacuum tube through which an electric discharge is passing has been suspected for some time, and has recently been superseded by the measurement of the deflection of a beam of kathode rays shot transversely through the discharge, it is important that the reason for the divergent results obtained by the former method should be ascertained. Prof. Wehnelt shows in a paper in the *Verhandlungen der Deutschen Physikalischen Geselischaft* for July 30 that any small obstruction placed in the kathode dark space acquires a positive charge, and its potential is therefore higher than that of the point at which it is placed. Between the kathode and the obstruction the rise of potential is linear, but between the obstruction and the kathode glow it is curved, showing that electric charges are present in this portion of the discharge.

OUR ASTRONOMICAL COLUMN.

Astronomical Occurrences for September:—

Sept. 2. 22h. 0m. Saturn stationary.
4. 4h. 37m. Uranus in conjunction with the Moon (Uranus 4° 35′ N.).
9. 3h. 0m. Mercury in inferior conjunction with the Sun.
13. 1h. 48m. Saturn in conjunction with the Moon (Saturn 4° 22′ S.).
14. 0h. 39m. Mars in conjunction with the Moon (Mars 4° 32′ S.).
15. 0h. 0m. Venus in inferior conjunction with the Sun.
17. 9h. 28m. Neptune in conjunction with the Moon (Neptune 5° 46′ S.).
20. 23h. 11m. Venus in conjunction with the Moon (Venus 13° 14′ S.).
23. 16h. 18m. Sun enters sign of Libra.
25. 2h. 0m. Mercury at greatest elongation W. of the Sun (17° 52′).
,, 12h. 0m. Mercury in perihelion.
,, 16h. 5m. Jupiter in conjunction with the Moon (Jupiter 2° 11′ N.).

Brooks's Comet, 1911*c*.—During several of the clear evenings which obtained at the latter end of last week, Brooks's comet was faintly visible to the naked eye of an observer who knew where to look for it. Ordinary opera-glasses showed it as a distinct nebulosity, and in the field of a 3½-inch refractor it was a really brilliant object, some 5′ or 6′ in diameter, having a distinct nucleus. On Sunday night, at Gunnersbury, Mr. W. E. Rolston found the comet, as seen with opera-glasses, to be no less conspicuous than ω^1 Cygni (mag. 5·6), which it immediately preceded.

Encke's Comet, 1911*d*.—Observations of Encke's comet, made by Dr. Gonnessiat at the Algiers Observatory, are recorded in No. 4518 of the *Astronomische Nachrichten*. On August 1, under excellent atmospheric conditions, the comet was seen before ninth-magnitude stars which were rising at the same time, and if seen in a dark sky would probably have equalled in brightness stars of the seventh or eighth magnitude.

Dr. Backlund briefly discusses the recent observations, and gives an ephemeris extending to September 21. At present the comet is apparently about 2° south-east of ν Leonis, and is travelling south of, and almost parallel to, the ecliptic, down through Virgo towards Libra; on September 14 it will be some 5° south of Spica.

The Aspect of Nova Lacertæ.—On a photograph taken with fifty minutes' exposure on August 11, Herr Kostinsky found that the image of Nova Lacertæ was surrounded by a well-defined luminous aureole (black on the negative) similar to that which surrounded the images of Nova Persei in 1901. This aureole is not to be seen on similar negatives secured in January and February; therefore Herr Kostinsky deduces it may be taken as an indication that the nova has now become a gaseous nebula in the spectrum of which only bright radiations of hydrogen and the nebula lines are represented. The photographic magnitude of the nova on August 11 was about 10·5 (*Astronomische Nachrichten*, No. 4518).

Kiess's Comet, 1911*b*.—An improved set of elements and an ephemeris are given for comet 1911*b*, by Dr. Kobold, in No. 4518 of the *Astronomische Nachrichten*. The comet reached its most southerly point on August 24, and is now travelling northwards slowly. For the next fortnight its apparent path lies through the constellation Telescopium. This comet was discovered independently by Herr Raimond Moravansky in Moravia on August 5, and the observation sent to Kiel; but this was nearly a month later than the discovery by Mr. Kiess.

The Early Visibility of the New Moon.—From calculations based on the data given by Mr. Horner for his remarkably early detection of the new moon, on February 10, 1910, Mr. Whitmell finds, after correcting for parallax, &c., that the difference in altitude between sun and moon at the moment of observation was only 3° 16′, the moon being 1° 46′ above, and the sun 1° 30′ below, the horizon. The corrected azimuth difference was only 9° 8′, and the moon's age sixteen hours, so that this observation is probably unique in its detection of the crescent so soon after "new moon" (*The Observatory*, No. 438).

Variable Stars.—Observers of variable stars will find part ii., vol. lv., of the Annals of the Harvard College Observatory, prepared by Miss Cannon, useful. It contains a table in which are set out the maxima and minima of a large number of variable stars. For each variable the elements and the dates of observed maxima and minima are tabulated, with a special column showing the differences between the observed and calculated dates.

In No. 4515 of the *Astronomische Nachrichten* Herr Max Mündler publishes the results of a number of observations of variable stars made by him, with a 6-inch comet seeker, at Mundenheim during 1909–10.

WATER SUPPLY IN THE UNITED STATES.

To its excellent series of pamphlets on water supply the United States Geological Survey has just added three papers, one (No. 270) descriptive of the hydrographical features of the Great Basin, an immense tract of country 208,000 square miles in area (just as large as Germany), and extending over parts of the States of Utah, Nevada, Idaho, Oregon, and California; the other two, practical manuals entitled, respectively, "Underground Waters" (Paper No. 258) and "Well-Drilling Methods" (Paper No. 257).

Of the first pamphlet, it is only necessary to remark that it follows on the same lines as those adopted for similar reports, recently reviewed in these columns, on other of the dozen districts into which the United States has been divided by the Geological Survey for the purpose of hydrographical research, and that it is equally excellent in compilation and treatment.

The two papers on well waters contain much useful information on the means of finding and securing for domestic consumption a satisfactory supply of water from underground sources. The pamphlet on well-drilling is especially practical in its description of the outfit and appliances required for the purpose, and of the methods to be followed according to the exigencies of particular localities, exigencies which, it is to be observed, are frequently of an exceptional nature. The literature on the subject of well-sinking is by no means extensive, and Mr. Bowman has exploited a field of his own, comprising those features of American practice which are associated with pioneer work in districts where many of the ordinary resources of highly developed communities are not readily available. The scope of the manual is not limited to water wells—all classes of borings for oil, gas, and water are treated, though naturally the hydraulic aspect of the subject is that which receives most prominent consideration. The interaction of borings undertaken for different ends is noted, and the flooding of oil wells by carelessly constructed and abandoned water shafts is made the subject of very necessary advice and caution. The text is freely, yet judiciously, illustrated by diagrams and photographs; and though one of the former, otherwise complete, rather amusingly indicates a platform carrying a couple of men in mid-air without any visible means of support, yet where misconception is unlikely it would be ungracious to cavil at so slight a defect. The manual is one deserving of cordial commendation.

MAGNETIC OBSERVATIONS.

The magnetic observations made during 1910 at the Khedivial Observatory, Helwan, are included in a small pamphlet of seven pages, which gives for each month and the year the mean values of the magnetic elements, the diurnal variations in declination, horizontal force and vertical force, and particulars of the ranges of these elements on the eight most disturbed days of the year. In the diurnal variation tables values are given for both midnights, the aperiodic element not being eliminated. This is rather unusual. These tables go to 0·1′ in declination and to 1γ (1×10^{-5} C.G.S.) in the force components. As the days tabulated in the month average twenty-eight, the expediency of going to 0·01′ and to $0{\cdot}1\gamma$ seems worthy of consideration, especially as the diurnal ranges are small. Disturbances at Helwan, at least in 1910, seem to rule small. The largest ranges in the selected disturbed days were only 13′ in declination, 187γ in horizontal force, and 58γ in vertical force. So far as internal evidence enables one to judge, its magnetic work does increasing credit to the Egyptian Survey Department, and it is to be hoped that it will continue to be prosecuted under favourable conditions.

In Blatt 3 of the Royal Observatory of Wilhelmshaven the assistant director, Prof. Bidlingmaier, continues the discussion of the magnetic disturbance character of the year 1910, initiated in Blatt 1 and 2, already noticed (March 16, p. 90). His method, it will be remembered, extends to individual hours the international scheme which assigns a magnetic character to individual days. Dr. Bidlingmaier's original view seems to have been that the disturbance character of a magnetic element might be based on the extent of its departure at the hour concerned from the corresponding mean monthly value on quiet days. He now regards this view as unsatisfactory, owing to its disregarding the influence of previous disturbance and making no allowance for Chree's discovery that the regular diurnal inequality varies according to the magnetic character of the day. His present estimate of hourly disturbance character seems based on the size of the maximum departure of the element during the hour from its mean value for the hour. He arrives at a numerical estimate of what he terms "Erdmagnetische Aktivitat" for the months of 1910, and compares it with Wolfer's sun-spot frequency. The hourly character of the first six months of 1911 is shown graphically in the manner applied in Blatt 1 and 2 to 1910.

The results of observations made at the U.S. Coast and Geodetic Survey's magnetic observatories at Cheltenham (Maryland), Sitka (Alaska), and Honolulu during 1907 and 1908 are published in volumes similar to those of previous biennial periods. Besides hourly readings and diurnal inequalities for the two years in question, the Cheltenham volume gives particulars of the mean annual values of the elements since the observatory began operations in 1901. A list is given of the fifty-eight principal magnetic disturbances of 1907 and 1908, with the times of their beginning and ending, and the curves obtained on nineteen of these occasions are reproduced, the times shown being G.M.T. The time scale adopted, 15 mm. to the hour, is more open than in previous years. The largest storms of the period were those of September 11 and 28, 1908. A list of earthquakes recorded by a Bosch-Omori seismograph is also given. The Sitka volume contains the usual tables of hourly readings and diurnal inequalities, and mean monthly values for the two years. A list is given of the sixty-two principal magnetic storms of the period, and the curves for sixteen of these are reproduced on a scale of 15 mm. to the hour. Sitka is a highly disturbed station, and during the principal storms there is at times considerable loss of trace; also the traces from the several elements being on one sheet—the usual practice with Eschenhagen magnetographs—there is a good deal of intercrossing of the traces. During the early part of 1908 there was also some loss of trace owing to defects in the driving clock, and a new one had to be substituted. Particulars are also given of the earthquake records obtained with a Bosch-Omori seismograph. Besides the ordinary tables of hourly readings, diurnal inequalities, &c., the Honolulu volume contains a list of the principal magnetic storms of the two years, and reproduces the curves for a number of these. Honolulu is a relatively quiet station, and loss of trace seems rare. The volume also contains a register of earthquakes recorded by a Milne seismograph.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

The death is announced of Prof. J. P. Schweitzer, professor of chemistry in the University of Missouri from 1872 until 1910, when he became professor emeritus. Prof. Schweitzer was born in Berlin in 1840, and went to the United States in 1865. He was known for his work in analytical and agricultural chemistry.

Mr. F. Pullinger, chief inspector of the Technological Branch of the Board of Education; Mr. W. R. Davies, assistant secretary of the Technological Branch of the Board of Education; Prof. John Perry, F.R.S., professor of mechanics and mathematics in the Imperial College of Science and Technology; and Mr. W. Gannon, principal of the Woolwich Polytechnic, have been appointed members, for a period of three years, of the Examinations Board of its Department of Technology by the City and Guilds of London Institute. They succeed Mr. C. A. Buckmaster, Prof. W. Gowland, F.R.S., Mr. J. H. Reynolds, and Prof. W. Ripper, whose terms of office have expired.

It is announced in *The Pioneer Mail* of August 4 that Rao Saheb Vasanji Trikamji has generously placed at the disposal of the Governor of Bombay a sum of two and a quarter lakhs of rupees for the foundation of a scientific library in connection with the institute of science now being erected in Bombay. The conditions attached to this donation are that the science institute library shall be called Vasanaji Trikamji Mulji Library. A marble bust of Vasanji Trikamji Mulji and two marble tablets mentioning the amount of the donation and other particulars are to be placed in suitable positions. The Governor has publicly thanked Rao Saheb Vasanji Trikamji for his benefaction, which will enable provision to be made for the formation of an adequate scientific library in Bombay in connection with the institute of science.

With the adoption of the Budget for 1909–10, a system of automatic increases in salaries was inaugurated at the University of California. We learn from *Science* that an instructor's salary is to be increased automatically 20*l.* per year from 200*l.* to 300*l.*, and the salaries of assistant professors 20*l.* a year from 320*l.* up to 400*l.* The automatic increases are not to apply to members of the faculty below the rank of instructor, nor above the rank of assistant professor, and there is to be no automatic increase after instructors have arrived at a salary of 300*l*., and after assistant professors have arrived at a salary of 400*l*. Increases are not automatic in salaries of members of the faculty who are on part time only, nor in the case of instructors and assistant professors for a year of absence on leave. Increases of salary may, of course, be given in the cases cited above, in which no automatic increase is due as of right. Larger increases than of 20*l*. are sometimes made at the discretion of the president, with the approval of the regents.

The calendar for the session 1911–12 of the Glasgow and West of Scotland Technical College shows that the whole building now comprises more than seven acres of floor space. To quote the calendar, it "forms the largest structure in Great Britain devoted to education." It has cost, with the equipment, about 400,000*l*. The plan of confining each department to one floor has been followed in nearly every case, with the result that the internal arrangements generally are well adapted to promote efficiency in working. County secondary education committees in Scotland are authorised by the Education (Scotland) Act of 1908 to grant bursaries tenable at this college to students resident within their districts. It may be noticed, too, that a large number of firms in the area in which the college is situated have expressed their willingness to allow a selected number of their apprentices facilities for carrying out a scheme of college study conjoined with practical work. The courses of study in engineering are held during the winter session of the college, and thus student-apprentices are left free to spend the intervening summers in works. Some of these firms are willing to recognise, wholly or partially, the time spent in college as part of the apprenticeship period, but such recognition will be contingent upon satisfactory reports being received from the college in each case.

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, August 21.—M. Armand Gautier in the chair.—The president announced the death of Albert Ladenburg, correspondant in the section of chemistry, and gave a short account of his work.—H. **Deslandres** and L. **d'Azambuja**: The velocities of rotation of the black filaments (flocculi) in the upper layer of the solar atmosphere. A historical sketch of the work done on the dark flocculi since their discovery by Hale and Ellermann in 1903, with special reference to the work done at the Meudon Observatory since 1908. Five diagrams are given showing successive positions of a filament on different dates, and four tables analysing various negatives.—J. **Boussinesq**: The spontaneous vibrations of a free bar, cooling by contact at its extremities and by radiation or convection at its lateral surface.—Kr. **Birkeland**: The sun and its spots. A description of experiments made with a magnetic globe as a kathode in a large discharging vessel, and a discussion of the possible bearing of these experiments on the theory of the sun. Seven photographs of the luminous phenomena observed are reproduced, and the author concludes that in the evolution of the solar system, electrical and magnetic forces must be regarded as playing a part comparable with gravitation.—A. de la Baume **Pluvinel** and F. **Baldet**: The spectrum of the Kiess comet (1911*b*). The Kiess comet was sufficiently bright during the second fortnight in July to allow of the photography of its spectrum by the prism-objective method. The wave-lengths and aspect of the bands measured are given in a table. The comet gave no continuous spectrum. Portions of the Swan spectrum and cyanogen spectrum are identified, and comparisons are made with the Johannesburg (1910*a*) and Morehouse (1908*c*) comets.—Michel **Fekete**: Some generalisations of a theorem of Weierstrass.—Georges **de Bothezat**: A method for the experimental study of the deadening of the oscillations of certain systems in motion in a fluid.—Em. **Bourquelot**: The glucoside from the leaves of the pear tree, its presence in the leaves of several varieties, its presence in the trunk and root. The existence of a true arbutine in the leaves, branches, and roots of the pear has been proved.—E. L. **Trouessart** and E. G. **Dehaut**: The wild and domesticated pigs of Sardinia and Corsica.—Édouard **Chatton**: Some parasites of marine copepods observed by M. Apstein.—E. **Roubaud**: New biological researches on the solitary wasps of Africa; evolution, variations, disturbances of the maternal instinct under the influence of hunger.—C. **Schlegel**: The development of *Maia squinado*.—Maurice **Arthus**: The intoxications produced by snake venom.—J. **Basset**: The determining cause of "typhoid fever of the horse" (influenza, grippe, pasteurellosis, pferdestaupe, pink eye).—Maurice **Piettre**: A mode of resorption of fatty reserves.

FORTHCOMING CONGRESSES.

August 31–September 6.—British Association. Portsmouth. President: Sir William Ramsay, K.C.B., F.R.S. Address for inquiries: General Secretaries, Burlington House, W.

September 4–6.—Centenary of the University of Christiania. President of Festival Committee: Prof. Brögger.

September 9–20.—International Congress of the Applications of Electricity. Turin. President of the Committee of Honour: H.R.H. the Duke of the Abruzzi. Honorary Secretary of the Committee: Signor Guido Semenza, Via S. Paolo 10, Milano. International Secretary: Col. R. E. Crompton, C.B., R.E., Crompton Laboratory, Kensington Court, W.

September 12–15.—Celebration of the Five-hundredth Anniversary of the University of St. Andrews.

September 18–23.—International Conference of Genetics. Paris. President: Dr. Viger. Secretary: M. Philippe de Vilmorin.

September 25–29.—German Naturalists and Physicians, Karlsruhe.

October 2–7.—Third International Congress of Hygiene. Dresden. General Secretary: Dr. Hopf, Reichsstrasse 4, Dresden.

October 12–18.—Italian Society for the Advancement of Science. Rome. President: Prof. G. Ciamician. General Secretary: Prof. V. Reina, Via del Collegio Romano 26, Roma.

October 15–22.—Tenth International Geographical Congress. Rome. President: Marquis Raffaele Cappelli. General Secretary: Commander Giovanni Roncagli, Italian Geographical Society, Rome.

December 27.—American Association for the Advancement of Science. President: Dr. C. E. Bessey, University of Nebraska. Permanent Secretary: Dr. L. O. Howard, Smithsonian Institution, Washington, D.C.

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THURSDAY, SEPTEMBER 7, 1911.

THE PARSONS STEAM TURBINE.

The Evolution of the Parsons Steam Turbine. By Alex. Richardson. Pp. xix+264+173 plates in the text. (London: Offices of *Engineering*, 1911.) Price 21s.

IN this volume there is contained an authentic record of steps taken in the development of a great invention. Lord Kelvin once described the work done by the Hon. Sir Charles Parsons in connection with the steam turbine as ranking in importance with the work of James Watt. The council of the Royal Society of Arts in awarding the Albert medal for 1911 to Sir Charles Parsons, for his experimental researches into the laws governing the efficient action of steam in engines of the turbine type, and for his invention of the reaction type of turbine, stated that by means of its practical applications the production of mechanical power had been cheapened, economy of fuel and higher speeds had been obtained in steamships, and the problem of rotary engines, which long had baffled many other inventors, had been solved. This expression of opinion by a council which includes many eminent engineers and physicists will command universal assent: it also emphasises the value attaching to the record of research and achievement which has been undertaken and completed by the author of this book. The principal facts were already available, having been published from time to time in the Proceedings of engineering societies and in engineering journals. But it is equally true that by collecting and arranging such materials the author has done a useful piece of work, and done it well. Not merely has he told the story in an interesting way, but he has secured the aid of Sir Charles Parsons and several of his colleagues, and has thus made the reeord complete, adding many new facts. One characteristic of the book deserves special mention: its style and method will enable readers to master the main steps in the development of the steam turbine, even though their knowledge of engineering is small. On the other hand, skilled mechanical engineers can find therein a wealth of illustration and a mass of valuable data obtained by Sir Charles Parsons and his assistants in their long and varied experimental researches.

It scarcely seems credible, but it is the fact, that so lately as 1884 Sir Charles Parsons began work on his first steam turbines, or that it was ten years later before trials were made with the first steamship driven by turbine machinery. During the earlier period progress was naturally slow: many difficulties had to be overcome, and outside or accidental causes of delay occurred. The inventor was not daunted by these difficulties, and he fortunately obtained support from friends who had confidence in his ability to face and solve problems which had baffled previous investigators. Sir Charles Parsons, like many other inventors, discovered that although many previous attempts had been made to construct steam turbines, little exact or trustworthy data had been put on record by his predecessors. Consequently it became necessary for him to arrange and undertake further and costly experiments. The system which had previously found most favour with his predecessors was that known as the "impulse type" of turbine, in which rotary motion was produced by the impact of steam jets on suitably shaped cavities situated at the periphery of revolving wheels, or by the reaction of steam-jets issuing into the atmosphere. Sir Charles Parsons originated the idea of splitting up the fall in steam pressure, by employing a great number of wheels or turbines placed in series. To quote Mr. Richardson's words, Sir Charles Parsons made "the assumption that in each turbine the action would approximate to that in a turbine using an incompressible fluid such as water, and that the aggregate of such simple turbines, which together constituted the complete machine, would give an efficiency approximating to that obtained in water turbines."

This fundamental assumption proved to be accurate; but when the fact had been established its embodiment in successful machines which were individually of large power demanded great skill and patient experiment. Unfortunately, after the first reaction turbines had been made and proved successful, difficulties of a business nature interfered for some time with the development of the system. Sir Charles Parsons then introduced turbines of the "radial flow" type instead of the longitudinal flow type with which his name will ever be associated. The first turbine was produced in 1884 and was applied to the generation of electricity, the design of the dynamo being modified by the inventor so that it might be suitable for association with turbines running at very high rates of revolution. These early turbo-generators were of comparatively small power and were relatively wasteful in steam consumption, although in their mechanical details they were the pioneers of the enormously powerful machines now in use on land in electro-generating stations. In 1885 a turbo-generator of four-kilowatts power required 200 lb. of steam per kilowatt-hour. In 1910 turbo-generators of 5000 kilowatts were produced by Sir Charles Parsons, and the steam consumption per kilowatt-hour was but little more than 13 lb. Limits of space prevent any detailed explanation being given of the successive improvements which have led to this remarkable economy in steam consumption; but readers desirous of tracing these steps will find every information in the pages of the volume under review.

In the application of the Parsons steam turbine to ship propulsion even more remarkable progress has been made. The first vessel (the famous *Turbinia*), completed in 1897, was a hundred feet long and weighed about forty-four tons; her engines developed 2300 horse-power, and her speed was $32\frac{3}{4}$ knots for runs of short duration. Ten years later the great Cunard trans-Atlantic steamships *Mauretania* and *Lusitania* were driven by turbine machinery developing 74,000 horse-power, the length of the vessels being about 785 feet, their weight 40,000 tons; and the mean speed on their fastest trans-Atlantic voyages 26 knots. The latest armoured cruisers of the *Lion* class in the Royal Navy furnish the most notable illustrations of the application of the Parsons steam turbine to warships: their engines will develop more than 70,000 horse-power, and are estimated to drive vessels weighing 26,400 tons at speeds approaching 30 knots per hour for short periods and from 26 to 27 knots for great distances. A table in the book shows that on June 30, 1910, the Parsons type of turbine had been applied to 333 steamships, and that their aggregate horse-power exceeded 4,700,000. The first order for a turbine destroyer was given by the British Admiralty in 1899; the first merchant steamer fitted with turbine machinery was built by Messrs. Denny in 1901; and this simple statement of facts indicates the unprecedented progress which has been made by the new type of marine steam engine. That progress proceeds at an accelerated rate; and in July, 1911, 378 steam vessels, with an aggregate of more than 5,800,000 horse-power in Parsons turbines, had been built or were building.

As time has passed and experience has been gained modifications and improvements have naturally been made by the inventor. It becomes obvious from the story told by Mr. Richardson that from first to last broad views, original research, and readiness to test the relative merits of alternative arrangements, have marked the work done by Sir Charles Parsons. The mechanical ingenuity which has been displayed by him in the details of designs for steam turbines is illustrated in many ways, and no one can fail to be impressed by the mastery of fundamental principles affecting the economic use of steam in engines of the turbine type displayed by him, and the skill shown in the design of mechanical engineering details, as well as processes of manufacture, which have been no less essential to the success of the new invention. In the marine steam turbine the principles upon which economy and efficiency depend are, of course, identical with those which hold good in steam turbines applied for land purposes; but in connection with ship propulsion the designer has not only to take into account the efficient use of steam in turbines, but the general propulsive efficiency secured by the combination of efficient turbines with suitable screw propellers driven by the turbines. In marine steam turbines it is consequently found necessary to accept lower rates of revolution than can be applied with advantage in land turbines because a very rapid rate of rotation tends to diminished propeller-efficiency. This was one of the most serious problems which had to be faced in the design and construction of the *Turbinia*; its solution occupied a long period, and led to many modifications in that remarkable vessel before success was finally achieved and the revolution in marine steam engines above described was made possible.

Great differences exist in the conditions of service of various classes of ships, and demand different designs of propelling machinery. Hitherto the turbine has been used almost entirely in vessels of high speed, but its use in vessels of moderate or low speed is now being considered. There also Sir Charles Parsons has done pioneer work and has taken the lead in producing practical examples. A cargo steamer of good type (the *Vespasian*) has been purchased, her reciprocating engine has been removed, and geared turbines have been fitted instead. These turbines run much faster than the propeller shafts, so that both the turbines and the screw propellers can be given high efficiency. A long period of working in actual service, as well as measured mile trials, have shown a considerable gain in economy and cargo capacity which was well worth having in cargo vessels even of low speed. Another arrangement suitable for vessels of the "intermediate" type—in which large passenger accommodation is combined with a great capacity for carrying cargo and moderate speed—is known as the "combination system." Low-pressure turbines are associated with reciprocating engines in such vessels, and the expansion of the steam can thus be carried much further than in engines of the reciprocating type. In the *Olympic* and *Titanic*, the largest vessels at present afloat in the mercantile marine, this combination system has been applied, and it had previously proved completely successful in vessels trading to Australia and Canada. These are but a few of the examples of the variety of the applications of the steam turbine in marine propulsion which are illustrated in this book; and other applications to mine ventilation, blast furnace operations, and other services are also described. The volume is handsomely produced and beautifully illustrated.

W. H. W.

SYSTEMATIC BOTANY.

Handbuch der systematischen Botanik. By Prof. R. R. v. Wettstein. Zweite Auflage. 1 Hälfte. Pp. 424. Price 20 marks. 2 Hälfte. Pp. viii+425–915. Price 24 marks. (Leipzig und Wien: F. Deuticke, 1910–11.)

THE first edition of this work appeared in 1901, and during the decade that has elapsed since, important advances have been made in the investigation of many groups in the vegetable kingdom, more especially in the Schizophyta and the Gymnospermæ. The first part comprises the Cryptogams and Gymnosperms, preceded by a general introduction of some fifty pages, in which the more recent discoveries and theories are discussed, explained, or mentioned. As the title indicates, the work is entirely devoted to systematic botany, and it may be added that it is not intended for the beginner, but for students already fairly well versed in the rudiments of the science.

The main object has been to construct, or rather to improve, a classification on phylogenetic principles. It is now generally admitted that it is impossible to give expression to this in a linear arrangement, especially as a monophyletic development can no longer be sustained. On this point Dr. Wettstein is very decided. He accepts it as probable, however, that the more highly organised plants—the Cormophytes—are of monophyletic descent, though it cannot be claimed that this point has been settled. On the other hand, he considers that it is beyond doubt that the so-called Thallophytes include types of very different origin. Consistent with these views, Wettstein discriminates seven "Stämme," or lines of development, namely, (i) Myxophyta; (ii) Schizophyta; (iii) Zygophyta; (iv) Phæophyta; (v) Rhodophyta; (vi) Euthallophyta; and (vii) Cormophyta; and he thinks it very probable that the Cormophytes may have been derived from one or the other of these stems, most probably from the Euthallophyta. The designation of these stems are mostly sufficiently descriptive to be intelligible; but one is naturally curious as to what the Euthallophyta include, as they are here placed next to the Cormophyta, on account "of possible genetic connections." Wettstein's brief diagnosis of this group runs:—

"One-celled or many-celled. Cells of the vegetative stages of development, clothed by a membrane, which is not composed of shell-like segments. Autotrophic (self-nourishing) or (in derived series of forms) heterotrophic. The autotrophic forms always furnished with chlorophyll in the assimilating cells. Simpler forms propagated vegetatively only; those of higher organisation sexually as well. Autotrophic forms (with isolated exceptions) adapted to the development of their reproductive organs in water. Not differentiated into root, stem, and leaf."

It is not assumed that the above characteristics (all or any one of them) are peculiar to the group; but as thus broadly defined, the Euthallophyta include two classes, the Chlorophyceæ and the Fungi. To the first belong the orders Volvoceæ, Ulothricaceæ, Siphoneæ, and the Characeæ. The Fungi are divided into parasitic and saprophytic Fungi, including those symbiotic with Cormophytes (Mycorrhiza, &c.), and Fungi symbiotic with Algæ, otherwise Lichens. The Myxophyta, formerly associated with Fungi, and now placed in the lowest series of vegetable organisms, are characterised thus:—

"One-celled or many-celled. Vegetative stages of development composed entirely of membraneless cells. Nourishment never autotropic. Sexual reproduction altogether wanting."

We have not space to enlarge on the treatment of the different groups of organisms; but it may be mentioned that the Schizomycetes (bacteria) are described and illustrated in some detail, though the figures are practically all copied from Migula, Meyer, and other writers on the subject, and are much the same as in the first edition.

It may be interesting to mention that the cells of some of the Schizomycetes are the smallest hitherto measured; those of *Spirillum parvum* being from 0·1 to 0·3 μ in thickness, whilst those of the organism causing lung-disease in cattle are described as even smaller.

Turning to the Gymnospermæ. It seems a pity that the term "flower" should still be employed to designate the organs of reproduction, with or without envelopes or appendages, especially as the interpretations of authors are so divergent; some viewing the female cone of an Abies, for example, as an inflorescence, others as a flower. Much confusion has arisen from this cause in the nomenclature of the components of a cone. Wettstein defines the flowers, "characteristic of all Anthophytes," as shoots, or parts of shoots, which bear the leaves on which the sexual organs of reproduction are formed. And he adds that accepting this definition, Selaginella is the only other genus among recent plants that has flowers In this connection it may be added that the fossil Bennettitinæ present some of the most singular of the "flowers" of Gymnosperms. They are either unisexual or bisexual. Those of *Cycadeoidea ingens* are interpreted as having a perianth of numerous plumose segments; twelve pinnate stamens, involute in æstivation, with very numerous anther-cells, and a solitary central gynæceum or ovule, whereas *C. Wielandii* has female "flowers" with a plumose perianth and numerous separate ovules, or gynæcia, looking much more like pistils.

Tumboa (Welwitschia) is mentioned as the only living gymnosperm in which the pollen is conveyed by insects to the ovules.

The foregoing was written before the second part of the work was received. This has undergone less modification than the first, and we must dismiss it with a few words. We note that the proposed new Order or Family, the Julianiaceæ, has been accepted and placed in the Juglandales, though Hallier had previously reduced it to the Terebinthaceæ. The entire work has undergone an enlargement from 778 pages to 914, with 571 additional figures. Most of the figures are exceedingly good, but unfortunately many of them have lost much of their beauty through being printed too black. Of course, in a comprehensive work like the present, a large proportion of the figures must be borrowed; but here the source of every one is indicated. It may be added that Dr. Wettstein writes a simple, clear German which is easily construed.

W. B. H.

PHOTOMICROGRAPHY.

Practical Photomicrography. By J. E. Barnard. Pp. xii + 322 + 10 plates. (London: Edward Arnold, 1911.) Price 15*s.* net.

KING SOLOMON'S remark that "of making books there is no end," applies to the subject of Photomicrography nowadays, as well as to any subject in his time, for many indeed are the books, both large and small, that are now available. Yet the author of "Practical Photomicrography" has had the courage to publish a handsome volume of some 300 pages which we think fills a unique place. Our reason for saying so is because we should call this book a dictionary upon the subject rather than a practical guide, and there is no such work as that in existence. For example, if we require an illuminant suitable for some special class of work, we have only to turn to our dictionary, open the chapter devoted to "sources of illumination," and there we find an epitome of all that is known upon the subject. So, too, with cameras for all classes of work, photographic stands, and, indeed, every other thing connected with photomicrography. But if we look for practical hints or useful "dodges," such as the author must know in abundance, we can find—if, indeed, any at all—only a very meagre supply. There is no taking the beginner by the hand when attempting his first photograph, and telling him how to proceed to obtain a uniform background, and how to adapt and regulate his screen or filter so as to increase or diminish contrast; no explaining to him such things as how to distinguish between the use of an ordinary inch on his microscope, and the employment of a planar or such-like combination of the same magnifying power; no helping him to make progress from low-power work to high-power magnifications, and the pointing out to him the many pitfalls he may expect in this section of the work. Nothing, or very little indeed of this nature is given; anyhow, in a collective and succinct form.

Proceeding seriatim through the book, the introduction over, the reader is told first about the microscope and general equipment, not so much in particular for any special type of work—such as high, low, or medium magnifications, but in a general way; and tables of magnification, cuts of different eye-pieces and such-like, occupy several pages. It must not be omitted to mention some good photographs of Abbe's test-plate, but we question the expediency of comparing the photographic performance of achromats with that of apochromats, unless the former are used in conjunction with a suitable screen to cut off the secondary spectrum, which we are unable to find was done in this instance. A student upon seeing these comparisons might be led to think that the achromat was of no service at all, whereas the image in the preferred colour with most of the newer form of modern achromats is of the finest description, and almost rivals that produced by the apochromat: but a screen *must* be used.

Whilst referring to the resolution possessed by combinations of different numerical aperture, an error has crept in on p. 60. The 80,000 should be 40,000, as a solid direct cone is being spoken about, and not oblique light. Abbe's law of *doubling* the number of waves to the inch of the light employed refers only to the use of oblique pencils, and not to direct illumination at all. Passing over this slip in the reading of the proofs, we come to the consideration of collecting systems, and here again we find a most comprehensive chapter full of interest and information; but we must remind the reader that the Köhler lenses are not of the simple kind that the author leads one to believe. A careful examination of their curves reveals at once that they are of what may be called the distorted type. Their originality and usefulness has led the makers to call them after their inventor's name.

The sources of illumination, as we have already said, are fully discussed in the chapter devoted to this branch of the subject, and the dark-room and photographic methods, with all connected with the production of the negative and positive, whether on glass or paper, carefully gone into. The master mind is here very much in evidence, although he offers but scanty information how to distinguish a slightly over-exposed from a slightly under-exposed plate; his opinions would have been welcome we feel sure, even to the experienced hand, for at times it is extremely difficult to decide.

Several methods of reducing vibration with apparatus located in other places than the basement are mentioned, but we did not notice the method of using several layers of carpet-felt under each leg of the apparatus. We have been told—and it is common knowledge—that several workers in busy streets employ this method which was suggested by Mr. Norman—with much satisfaction.

A chapter is written upon the manipulation of the apparatus in general, but it is of a scattered nature and not collected under specific heads, so that the reader is left to ferret out what he wants for any special kind of work. The information may be there, but not easy to find.

The use of filters and screens is dealt with, and, so far as it goes, is of great value and information; but it is to be regretted more particular mention is not made of the uses of the box of "gelatines" sold by Messrs. Wratten and Wainwright, of Croydon. In the booklet accompanying the arrangement opposite to the name of most dyes used for microscopy, is placed the number of the screen to be used to increase contrast if required, whilst, in addition, besides showing how to reduce contrast, a table is given showing how by the assembling of certain of the same films together, monochromatic light of given wave-length can be obtained at almost any part of the visible spectrum. It is obvious of what service this little "box" is to the practical man at work, and ought to be always named as part of the equipment.

The description of several special processes, stereoscopic photography, the photographing of culture tubes and cultures, are followed by some important remarks concerning the use of ultra-violet rays; and then comes a very comprehensive index and the plates.

We are bound to express our disappointment at the appearance presented by plate i. Everyone knows it is not altogether easy to obtain a uniformly and pleasantly tinted background, but in this instance the blocks have been cut away up to the very margin of the object, and even that is sliced up into moieties! Surely a student who looks for guidance wants an ideal to live up to, a standard at which to aim? If the teacher be guilty of exhibiting work of this description, how will he teach the tyro to do better? The author's strong point is certainly not that of photographing diatoms, but is rather that dealing with bacteriological specimens and such like. Take, for example, the photograph of *Trypanosoma gambiense*, or that of *Bacillus typhosus*, in plate vii.: we doubt if it be possible to find two more magnificent illustrations in any book upon the subject. So too with the Podura scales in plate viii. The manner in which the constriction around the head of the so-called "comma" or "note" is shown is beyond all praise, and so too is the delicate tapering off to a point of its extreme end: it is perfection. We wonder what the promoters of the new idea that this focus is not the correct one, and that they have found another two or three (according to how they misarrange their adjustments), will say to this magnificent work? Taking "Practical Photomicrography" as a whole, we cordially recommend it, and congratulate the writer; but the reader must approach it as a dictionary full of answers to questions he may desire to put, rather than as a guide, philosopher, and friend, for that it is not.

MODERN ELECTROMAGNETIC THEORY.

Outlines of the Theory of Electromagnetism: a Series of Lectures delivered before the Calcutta University. By Dr. G. T. Walker, F.R.S. Pp. viii+52. (Cambridge: University Press, 1910.) Price 3*s*. net.

THESE lectures were intended to present some of the more important developments of electromagnetic theory in a connected and convenient form for the use of advanced students in the University of Calcutta and of the lecturers in outlying colleges. Following the example of Abraham and Föppl's excellent treatise, the author prefixes a chapter on the notation and methods of vector analysis, employing clarendon type for vector quantities. These are adhered to closely throughout the book, with the slight excursions into Cartesian method which seem to be inevitable. The second chapter consists of some illustrations of the application of these methods to the magnetostatic field. This is followed by an account of the Hertzian form of the equations of the electromagnetic field both for stationary and for moving bodies, with an indication of instances in which they fail to agree with experiment, and, finally, the electron theory of Lorentz is expounded so far as the general equations of the field are concerned.

The book is welcome as partly supplying the great need of an English text-book setting forth clearly the present state of electromagnetic theory, which seems in the last few years to have emerged a little from the purely tentative stage. The accumulated evidence against the possibility of the determination of a unique velocity of matter relative to the æther is giving physicists a prepossession in favour of the Lorentz field-equations. The present work seems to be directed mainly towards familiarising a larger public with the theory on which these equations are based, as contrasted with the earlier theory of Hertz. The account given is concise and free from digressions, and well adapted to the author's purpose.

In one respect the book might have been improved, and have assisted more materially than it does in establishing a uniform usage among English writers on electromagnetism. The author speaks of the *polarisation of the aether, polarisation of the matter, and of total polarisation.* Now that the theory of the stagnant æther is generally accepted, the time would seem ripe for confining the term *polarisation* to the second of these quantities, even if the unsatisfactory term *displacement* has to be retained for the last, as is done by Lorentz in his "Theory of Electrons" (Leipzig, 1909). It would be a great advantage to students beginning to read the subject if English-speaking physicists would adopt a terminology analogous to that used in recent German accounts of the subject (*e.g.* Lorentz, "Enzyk der Math. Wiss."; Abraham, "Theorie der Elektrizität," Bd. 2), where the term *Erregung* is used for both displacement (electric) and induction (magnetic).

The author is slightly confusing in his use of symbols, making an otherwise very clear exposition more difficult to follow. Without warning, the notation for the magnetic induction is changed from $\mathbf{B}$ to $\mathbf{H}$, a new symbol, $\mathbf{H}_1$, being introduced for the magnetic force, and an equally novel one, $\mathbf{G}^1$, for the magnetisation. Closely following one another we find the three equations, $\text{div}\, e=\rho$, $\text{div}\,\mathbf{D}^1=-\rho$, $\text{div}(\mathbf{E}+\mathbf{D}^1)=\rho$, in each of which ρ has a different significance. An apparent desire for brevity has caused the omission of explanation which was probably present in the spoken lectures and would make the book much easier to read for one to whom the subject was unfamiliar. The process of finding the average electric force over a small element of volume, so fundamental to the Lorentz theory, would with advantage have received fuller explanation, if only by a bare definition of the averaged vectors.

Save for the few exceptions referred to, the book marks a distinct advance towards a text-book which shall give its readers a clear outline of modern theory as it is at present developed.

ELEMENTARY PRINCIPLES OF AVIATION.

(1) *Elementary Aëronautics, or the Science and Practice of Aërial Machines.* By A. P. Thurston. Pp. vii+126. (London: Whittaker and Co., 1911.) Price 3*s*. 6*d*. net.

(2) *The Principles of Aëroplane Construction.* With Calculations, Formulæ, and 51 Diagrams. By R. Kennedy. Pp. vii+137. (London: J. and A. Churchill, 1911.) Price 5*s*. net.

(1) "ELEMENTARY AËRONAUTICS" is a careful collection of available information, together with some elementary theorems in aërodynamics which are, on the whole, good. It is necessary in considering early theories in aëronautics, that the reader should be carefully informed as to the limitations imposed by the initial assumptions, and also of departures from usual practice. This feature is not always sufficiently emphasised in the present work.

Generally speaking, frictional resistances are ignored without mention, and on p. 20 a new definition of stream lines is given which is quite foreign to the more usual definition adopted in mathematical aërodynamics. Further, the equation used in this case is only applicable to an incompressible fluid, and it is possible that for propellers such an assumption may not be justifiable.

A small point of printing is worth noting. Suffixes are not always clearly indicated, and might easily be misread for factors. An obvious case occurs at the bottom of p. 5, where $P\alpha \cos\alpha$ is written for $P_\alpha \cos\alpha$.

The first thirty-one pages provide a sound *résumé* of current data, accompanied by illustrations of the motion of air round obstacles. The advantage of aërocurves as compared with planes is clearly and correctly indicated. The work then proceeds immediately to less certain ground in the discussion of stability. The formula for damping of oscillations deduced on p. 37 appears to be wrong, as the damping effect of a plane is largely dependent on the forward speed—an effect which is ignored.

The chapter on propellers and helicopters is good only if it be clearly borne in mind that ideal conditions are assumed for most of the theoretical deductions. Air is supposed to be a frictionless fluid, and it needs some little care to distinguish between deductions from theory and experiment. With the assumptions clearly stated the chapters would be sound.

The applications of principles and tables to designs will be quite easily understood and appreciated, the calculations involving only the most elementary knowledge of algebra, and the guiding principles being quite trustworthy.

Laboratory apparatus does not make an impressive portion of the book, the notes given being of very general interest only, and in most cases insufficient to give any practical guidance to students new to experimental aërodynamics.

The remainder of the book is then occupied by descriptions of the successful flying machines and engines. As before, when the author was dealing with established data, the work is good, and as complete as is possible at the present time, the items of further interest being difficult to obtain.

The book is well worth reading by anyone starting on a study of aëronautics, as, in spite of its simple and elementary character, it is a fairly complete survey of the more trustworthy existing knowledge and practice.

(2) It is exceedingly difficult to appreciate the point of view of the author of this book. The mechanical principles involved are curiously contorted, and a brand new theory of lift is put forward which the author confesses may be defective. The theory is then justified by the remark that if modified as indicated "such a theory could not give any determinate data."

Many of the calculations are nevertheless right, and, in fact, are usually so on the assumptions adopted.

Passing over minor points, we find on p. 17 that velocity and acceleration have come to mean so much the same thing to the author, that the reader is told that if V be the vertical velocity of a weight W, which is moved by pushing an inclined plane under it, the vertical force on the plane when moving with constant forward velocity is greater than the force when the plane is at rest by $\frac{WV}{g}$. By sacrificing consistency, however, the author gets back to better dynamical principles when dealing with fluids.

In order to make the mass of fluid dealt with determinate, various arbitrary and improbable assumptions are made, and considering everything, the consequent numerical results are remarkably good. A wholesome respect for records of flights enables the author to extract multiplying factors to replace defects of theory.

On p. 23 is given an *a priori* proof that a "partial vacuum cannot be produced in the neighbourhood of an aëroplane in an open atmosphere. In view of experimental evidence that "partial" vacua are extremely important, an *a priori* proof is absolutely worthless. The argument is, however, consistent with a general attitude of doubt as to the value of experiments on models, the law of relative motion, and the resources of scientific inquiry not being fully appreciated. (Pp. 62–3, &c.)

The very difficult problem of obtaining automatic stability is dismissed in five lines as a simple problem having many simple solutions.

To anyone beginning the serious study of flight this book would appear to be a dangerous introduction.

L. BAIRSTOW.

OUR BOOK SHELF.

School of Agriculture, Cambridge. A Course of Practical Work in Agricultural Chemistry for Senior Students. By Prof. T. B. Wood. Pp. 56. (Cambridge: University Press, 1911.) Price 2*s.* 6*d.* net.

IN this modest booklet Prof. Wood sets out the practical exercises through which his students are expected to work during their course in the Cambridge School of Agriculture. It will be studied with interest by teachers of agricultural chemistry in other colleges, who have not as yet any very extensive text-book literature at their disposal. Further, many of them will be anxious to learn as much as possible of the secret of Prof. Wood's success, and to see the details of the course he has evolved since he has been responsible for the teaching of agricultural chemistry at Cambridge.

The exercises set are mainly analytical. Right from the outset the student has to use the accepted method, working it out in all its details; there are no short class-room methods such as would have to be discarded later. Much time is thus saved, for the student has nothing to unlearn when he leaves college and has to attack actual problems in a technical laboratory. The system is only possible, of course, when the student has already had a certain amount of experience of chemical work before turning to agricultural chemistry, but this ought always to be the case.

Where methods are so conventional as they necessarily are in agricultural chemistry, there is little room for originality, but Prof. Wood is not entirely hampered by custom, and has not hesitated to give newer methods where any advantage is to be gained. Thus he uses Neubauer's method for determining the potash and phosphoric acid in soils, which for some reason or other is not commonly used in England in spite of its accuracy and rapidity. He also describes the volumetric method of determining phosphoric acid, in addition to the ordinary gravimetric method. Other exercises include short studies of clay, sand, and humus, the retention of manures by soil, and experiments on oils and proteins. Sufficient detail is everywhere given to enable the student to work on his own account, but there is nothing superfluous, and the whole forty sections go into fifty pages. Altogether the book can be cordially recommended for advanced students, and also for the growing class of men who have to carry out agricultural examinations and analyses but do not want to purchase the large costly manuals. Most of the routine work of an agricultural laboratory is described.

E. J. R.

Physical Geography for Schools. By B. Smith. Pp. viii+190. (London: A. and C. Black, 1911.) Price 3*s.* 6*d.*

"WE have," wrote W. D. Cooley in 1875, "numerous treatises on physical geography which are in reality merely outlines of geology," and he attributed them to the influence of the ardent geologists of half a century earlier who had ennobled the rudiments of geography connected with their own pursuits with the title of physical geography.

Mr. Bernard Smith's text-book shows that there is still ground for Mr. Cooley's complaint, for it treats physical geography as mainly geology. It describes the physical process at work on the earth's surface, and deals inadequately with the distribution of the results and their influence on human development. The book is admirably illustrated, but a large proportion of its 221 figures are geological, and many of the best are from the collection of the Geological Survey. The photograph of the deck of a warship (p. 180) might have been replaced by one of more geographical value.

The book makes no claim to originality either in subject or method. It begins with short accounts of the solar system and the atmosphere; most of the book is devoted to a description of the composition, sculpture, and forms of the land, and it ends with a brief summary of the geological history of the British Isles. The author occasionally assumes too much knowledge of other sciences, and gives some explanations, as of the electro-magnetic theory of light, which are unnecessary in a geographical text-book.

On its lines the book is well done, but the paragraph on p. 12, "The atmosphere is heated chiefly in two ways—by the internal heat of the earth and by the sun's rays," would suggest that the internal heat has a powerful effect. The term caldera is used for a large crater, whereas it is better limited to a crater formed by subsidence. There are inevitably a few mistakes, such as the statement that the Colchester earthquake destroyed from twelve to thirteen thousand buildings; the title of a view of Stirling calls the river there the Tay, and the Midland Valley of Scotland is described as a lowland plain.

Die Elemente des Herzmuskels. By Prof. A. Dietrich. Pp. 46. (Jena: Gustav Fischer, 1910.) Price 1.20 marks.

The twelfth of the series of short monographs published under the editorship of Profs. Gaup and Nagel is a very able and interesting account of the minute structure of cardiac muscle, by Prof. Dietrich, of Charlottenburg. Perhaps of most value at the moment is his concise and judicious statement of our knowledge of the structure and distribution of the atrio-ventricular bundle, that complex system of peculiar fibres collecting the whole musculature of the heart under its extended grasp, as if for purposes of coordination. More original and of great interest is his discussion as to the meaning of the transverse lines which are still very generally accepted as limits to those individual cells by the juxtaposition of which the fibres of cardiac muscle are said to be formed. Faith in this view was somewhat shaken when it was found the structural element of major importance, the intra-cellular contractile fibrils, swept through these lines without interruption. More recently this view has been still further discredited by proof of their irregularity of occurrence in relation to the nuclei of the tissue.

Prof. Dietrich does not attempt to arrive at any very definite conclusion in this matter, but his treatment of the subject includes an excellent and impartial summary of views advanced by other recent investigators, and is illuminated by the results of his own experience and observations. It seems clear that these lines are definite incidents of structure of invariable occurrence and not artefacts due to conditions prevailing only at death or in the technique of the histologist. That is to say, Prof. Dietrich makes this clear, and his observations of their differential distribution in various districts of the wall of the heart, and discussion as to the circumstances more characteristically prevalent in each of these districts deserve special attention.

Black's Medical Dictionary. Edited by John D. Comrie. Pp. x+855. Fourth edition. (London: A. and C. Black, 1910.) Price 7s. 6d. net.

This book, which has now reached its fourth edition, contains an extraordinary amount of information in a comparatively small space. So far as we have been able to test it the details given seem generally to be accurate, and we consider that it well fulfils its avowed function of imparting medical knowledge in comparatively non-technical language, such as is required by the district nurse, health visitor, clergyman and missionary, ship's captain, colonist, traveller, and others. We think that some of the rare conditions mentioned, such as acromegaly, myasthenia, and syringomyelia, might well have been omitted, and the space gained have been devoted to such a subject as the management of labour, which is too briefly treated. Similarly, the pages devoted to the history of anæsthetics are of no real value, and had they been cut down to one-half, and a few practical hints given on the administration of anæsthetics (which occasionally has to be done by a missionary, ship's captain, &c.), the book would have gained in usefulness.

What will the Weather be? The Amateur Forecaster's Vade Mecum. By H. G. Busk. Pp. 36. (Cambridge: W. Heffer and Sons, Ltd., 1911.) Price 6d. net.

It is less than a year ago that the first edition of this useful booklet appeared. We notice that in the new edition tables for confirming a forecast, and a note on the significance of a barogram, have been added.

LETTERS TO THE EDITOR.

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

The Early History of the Gibraltar Cranium.

The Gibraltar cranium is generally regarded by anthropologists as one of the most important discoveries yet made of the Neanderthal type of man. Unfortunately, its early history is imperfectly known. The two following letters help to make good this deficiency. For the first I am indebted to Colonel E. R. Kenyon, Commandant of the Royal Engineers at Gibraltar; for the second, to the Misses Busk, daughters of Mr. George Busk, F.R.S., who in 1868 presented the cranium to the Royal College of Surgeons, England, of which he was at one time president.

Engineer House,
Gibraltar,
April 2, 1910.

"In the Minutes of the Gibraltar Scientific Society, under date March 3, 1848, there is this record":—

Presented a Human Skull from Forbes Quarry, North Front, by the Secretary.

"On February 4, 1846, Lieut. Flint, R.A., was elected secretary, and there is no record of any change. The officers of the society were re-elected in February, 1847, and February, 1848.

"The last recorded meeting of the society was in May, 1853.

"The old plans have been examined, and no place named 'Forbes Quarry' can be found, but I think there can be no doubt that it is the disused limestone quarry shown on the Ordnance Survey south-east of the ancient 'Forbes Barrier.' The obsolete batteries near there are the 'Forbes Batteries,' and these are the only sites to which the name 'Forbes' is attached."

"E. R. Kenyon,
"Col., Chief Engineer."

"P.S.—Lieut. Flint died at Mauritius as a captain on January 12, 1857."

The famous Neanderthal remains were found in 1857, and are usually regarded as the first discovered remains of that remarkable race of early Europeans now known by the name of Neanderthal man (*Homo primigenius*, Schwalbe). It will be thus seen that the Gibraltar cranium was the first discovered trace of Neanderthal man, having been found nine years before the type-specimen.

The second letter is from Dr. Hugh Falconer to Mr. George Busk. The date of the letter was certainly 1864; Dr. Falconer and Mr. Busk were then preparing a report on a large collection of fossil remains from caves at Gibraltar for the British Association meeting at Bath in that year. In this collection was the famous cranium. The collection was made and sent home by Captain Brome, who was in charge of the garrison prison. Unfortunately, his scientific enthusiasm led to his dismissal from his post and from the Services; he had employed prisoners to help him in the scientific investigations which led to the discovery of the remarkable cave fauna of Gibraltar. Mr. Busk took a leading part in obtaining from fellow men of science financial sympathy on behalf of Captain Brome.

21 Park Crescent,
August 27 (1864).

"My Dear Busk,

"A hint or two about the names which I have been rubbing up for the Priscan Pithecoid skull, *Homo var. calpicus*, from Calpe, the ancient name for the Rock of Gibraltar. What say you?

"For the characters of the face: as all the *pros, orthos, katas*, &c., are already engaged in conjunction with *gnathos*, we must look elsewhere. Βλεμμα—*aspectus, vultus* for a foundation sound well and appropriate—*e.g.* Βλεμεαινῶ "truculus oculis circumspicio." I am sure Pithecoid must have looked terribly truculent.

"Now for the combination. *Pro-blemmatous* at a pinch might do, but I doubt the soundness of the combination, and I think a better might be *agrioblemmatous*, from αγριος, wild or savage, and Βλεμμα. By this happy combination you will unite the truculence of the eye and the savagery of the face. *Agrioblemmatous* is really not a bad idea—it points distinctly to a peculiar savage feature—

"Walk up! ladies and gentlemen. Walk up! and see Professor Busk's Grand, Priscan, Pithecoid, Mesocephalous (!), Prognathous, Agrioblemmatous, Platycnemic, wild Homo calpicus of Gibraltar; Sounds well, anyhow.

"But *mesocephalous* is French-like—radically wrong. The temporal is a mesocephalous bone of the head; but the skull itself cannot be mesocephalous, or a mid-headed portion of itself. *Diacephalous* is better than Broca's term.

"Yours ever,
"H. FALCONER."

The letter shows that the veteran Scot, the pioneer of the Siwalik fauna, had a sense of humour, a facility in coining names, and a very clear conception that *Homo calpicus* was a very distinct variety of mankind. The cranium was duly exhibited at the meeting of the British Association at Bath in 1869, but there is no record in the report of what Mr. Busk said about the skull (except as to where it was found and that it resembled the Neanderthal specimen) nor of Dr. Falconer's taxonomic suggestions.

A. KEITH.

Royal College of Surgeons, Lincoln's Inn Fields, W.C.

A New Mineral?

WHAT may prove to be a new mineral has been obtained from the Du Toits Pan Mine at Kimberley. The material is in two forms: irregular pieces up to half a pound in weight, and small round pellets, which, collected together in a heap, would be mistaken for mixed shot. Some specimens are dull like lead on the outside, while others have a resemblance to polished nickel. The prevailing inside texture is spongy-looking. Under the microscope some of the surfaces are seen to be pitted with holes where the spongy texture reaches the surface. On the other hand, some of the larger pieces have wrinkled surfaces, not pitted; others have bright surfaces intersected with tiny cracks. Many of the specimens are covered with a blackish coating of about the thickness of paint. This is probably graphite; it scrapes off easily enough.

The specific gravity is on the whole something higher than 6·7, but by exactly how much higher it is difficult to say, on account of the porosity of the material. The hardness ranges high, varying from about 6 on a fractured face and on the duller outside surfaces to upwards of 9 on some of the bright surfaces. It is attracted by the magnet to a moderate extent—some pieces very feebly. It is very brittle, and on fracture gives off a strong smell of carbide.

Mr. W. Versfeld, Government analyst, Cape Town, makes out the following analysis:—

	Per cent.
Iron	71·39
Silicon	20·03
Carbon	8·41
	99·83

This composition corresponds approximately with the symbol $Fe_{11}Si_6C_6$. It appears that in chemical properties this mineral is one of the most refractory of substances. The mineral acids, aqua regia, fused potassium bisulphate, have only a slight action upon it. Roasting at a very high temperature causes no change except a slight tarnishing. Fusion with sodic peroxide, however, causes a ready oxidation. Prof. Schwarz, to whom the material was submitted, has taken a great interest in the find, and calls it, therefore, very aptly, a ferriferous carborundum.

Unfortunately, none of the material has yet been found *in situ* (nor is it very likely to be, seeing that the supply has now nearly ceased); all of it, so far, has been picked out at Pulsator by the manager, Mr. J. Stewart, in separating the blue-ground for diamonds. Schwarz points out quite truly that in the absence of a specimen in the blue-ground matrix the history of the material is incomplete. Nevertheless, it seemed advisable to put the facts, so far as they are known, on record.

With regard to the origin of the material, Prof. Schwarz writes as follows:—"Dr. P. A. Wagner states in his paper on 'Kimberlite Occurrences in the Pretoria District' (Trans. Geol. Survey of S. Africa, vol. xiv., p. 62, 1911), that on melting up blue-ground in a crucible, metallic globules of iron were obtained usually enclosed in the olivines crystallised from the fused mass. Mr. Thornton Murray examined the largest of these globules and found it to consist of a perlitic grey cast-iron enclosing flakes of graphite; it weighed one gram, but the average globules were smaller. The new mineral from Du Toits Pan Mine is probably of the same nature produced naturally; some local source of heat, frictional or chemical, due to combustion of gas or otherwise, may have raised a portion of the blue-ground to fusion point, and thus produced the globules and masses by reduction of the ilmenite or even the silicates of iron. The refractory nature of the material renders it possible that it formed as an original constituent of the blue-ground, but the subsequent hydration of the olivine rock to the serpentine breccia would probably have acted more upon the substance than is apparent in the actual specimens. Re-fusion of the hydrated rock seems therefore a more probable explanation." J. R. SUTTON.

Kimberley, August 14.

A Miniature Rainbow.

JUST about three o'clock this afternoon (I had a few minutes previously asked the time at the village post office) I witnessed a remarkable and very beautiful phenomenon. Coming through a woodland walk, I was caught by a heavy downpour of rain. As it was passing away, the sun shone down from a suddenly clear sky over the tops of the trees behind and to the right. Instantly against a screen of dark alder foliage on the left in front, and distant not more than three yards from where I stood, a perfect miniature rainbow was formed, its highest part being just about level with my eyes. It appeared broader than an ordinary rainbow, and much the greater portion was of one deep violet colour, the remaining colours forming merely a narrow border above. Very vivid at first, it quickly faded away, as the shower came to an end.

Kilderry, Londonderry, August 28. W. E. HART.

The Fertility and Extinction of Forest Trees.

THE mountains of Madeira exemplify perhaps more clearly than the denuded Scottish hills the "irreparable loss" which your correspondent "D. W. T." (NATURE, June 1) deplores in the disappearance of the Scotch fir forests. For not only have we exhausted our splendid timber in prodigal excess of economic requirements, but we have further to face the fact that the straggling trees which still survive in remote or precipitous localities appear to have lost much of their former fertility, showing now no tendency to spontaneous spread nor any evidence of the prolific reproduction of former days. Hence we are confronted with the absolute extinction of woods not grown elsewhere—woods of very great botanic interest both in themselves and in relation to problems of origin and distribution.

Madeira (Materia) was the name given originally by the Portuguese discoverers to denote the densely wooded condition of their new possession.

The destruction of the forests began with the first colonists nearly 500 years ago, and was accentuated during the Spanish occupation in the second century of the island history. No replanting whatever has been attempted since, nor have any effective measures been put in force to stay the progress of destruction. The island population, moreover, has increased during the last fifty years from 75,000 to 150,000 people, and the land is everywhere being cleared and occupied.

Nevertheless, the introduction of the *Pinus Pinaster* has during the last 150 years had an important influence on the preservation of the surviving native vegetation, and the tree has become established on the heights from 1500 feet to 3000 feet above the sea in surprising vigour and profusion, supplying fuel and many requirements on which a more durable and valuable wood would be wasted. Some of your readers have seen at my mountain home the stately growth of the Pinaster planted only sixty years ago. The larger trees have a girth, 5 feet above the ground, of 12 to 15 feet, and vary from 80 to 130 feet in height. They lose all their lower branches in due course, many of them standing in majestic isolation to suggest the famous "Spear, to equal which the tallest pine hewn on Norwegian hills to be the mast of some great ammiral were but a wand." These Pinasters were giants when I came into possession thirty-five years ago, and their growth since has been in girth rather than in altitude, though their heads have not yet reached the Ezekiel stage of your correspondent "D. W. T."

In my view we should not trust to the maintenance of a single species in vigour and fertility, and hence I have brought many coniferous and other trees hither to test both quality and rate of growth, and thus their fitness to supplement or supplant our present supplies. Many of the newcomers, though growing into beautiful examples, do not merit extensive plantation, and I have not raised any specimens of Podocarpus, Widdringtonia, Libocedrus, Dacrydium, &c., the merits of which encourage their multiplication; but it is far otherwise with the Douglas fir, the *Taxodium sempervirens*, the *Abies Pinsapo*, *Cupressus macrocarpa*, &c., which are quite at home in their new environment and congenial soil, as also with the *Pinus canariensis* and the *P. longifolia*. The *P. insignis*, however, in this latitude is pre-eminently worthy of general adoption at the elevation of 2000 feet. I received seeds of this species from Kew in Sir J. Hooker's time, and one of the trees from this source has attained a growth of more than 100 feet in twenty-six years; and I have a goodly patch of young trees sown ten years ago which already vary from 25 to 30 feet in height.

But I have written enough to illustrate the importance of planting new varieties when threatened with declining fertility or extinction, though I cannot think the *Pinus silvestris* to be in any such danger. Irreparable loss is mainly the result of improvidence.

It is interesting to note that many of the Madeira trees which have become nearly sterile and almost extinct in the wild state become vigorous and abundantly fertile in cultivated ground.

The *Cerasus lusitanica*, the weeping Juniper (*J. Oxycedrus*), *Phoebe barbusana*, &c., are familiar examples of reviving fertility in altered circumstances.

I have sent from time to time specimens of the Madeira rare woods to the museum at Kew, and amongst them the ebony-like laurel wood of the *Oreodaphne foetens*, the heavy oleaceous wood of the *Notaelea excelsa*, and a long hammock-carrying pole made of Clethra wood, are worth attention.

The *Clethra arborea* is happily still quite common, and attractive at this season with its abundant show of fragrant lily-of-the-valley-like flowers.

Madeira, August 21. MICHAEL GRABHAM.

Non-Euclidean Geometry.

IN my "Theories of Parallelism" I expressed my sense of failure in controverting Bertrand's simple proof (by the consideration of infinite sectors and infinite strips) of Euclid's parallel axiom. This sense of failure has only increased since the publication of my little book.

I have also come across the statement that Poincaré has proved that no Beltrami "trumpet" surface in Euclidean space can completely image a hyperbolic space unless it has a line of discontinuity on it. I would welcome definite information about this. It seems to me an important objection. Had Poincaré this at the back of his mind when he dismissed space-theories as *matters of convenience* only in his brilliant volume "La Science et l'Hypothèse"?

There is something passing strange about the infinite regions of a hyperbolic space. If K is the space-constant and R the radius of a circle in Lobachewskian space, and if R is exceedingly large even compared with K, then the area of the circle appears as an *exponential* infinitude, something like $\pi K^2 \rho^{\frac{R}{K}}$

But if a regular polygon with an indefinitely great number of sides (N, say) can be inscribed in this circle of radius R, the area of each of the N component triangles is only K^2 times the divergence. And the divergence of each triangle cannot very well be supposed to exceed 2π, for then the angle-sum would be 3π. Hence the area of the polygon appears less than $2\pi K^2 N$.

Would readers offer an opinion?

Wrawby, near Brigg. W. B. FRANKLAND.

The Salary of an Assistant Lecturer.

I HAVE read with indignation the advertisement of the City of Bradford Education Committee on p. lxiv of NATURE of August 17 for an assistant lecturer in dyeing at a salary of "60*l.* per annum, with additional payment for evening work (two evenings per week)."

Do the members of this committee realise that they are offering to an assistant lecturer at their college less than the minimum wages—24*s.* a week—demanded by the railway strikers in the North for the lowest and least efficient railway employee?

They may reply that their lecturer can make a little more by extra work—evening work; but so can the railway employee, and the latter may do it without doing any extra work whatever.

According to the conditions of appointment, the person appointed will be required to devote the whole of his time to college work; the hours of actual attendance at the college are thirty-seven per week, the vacations may be curtailed "if necessity demands it," and the amount of the payment for the evening work is not given.

W. H. HODGSON.

Tredethlyn, Port Isaac, Cornwall, August 22.

Obsolete Botanical and Zoological Systems.

IN reply to the request of L. C. M. in your issue of August 3, the following references may be of interest to him. "Insect Architecture," Charles Knight and Co., Ludgate Street, 1845, contains a chapter upon systematic arrangement of insects, which contains the following:—Aristotle's, Linnæus's, De Geer's, Aldrovand's, Vallisnieri's, Fabricius's, Latrielle's, Swammerdam's, Ray and Willughby's, Cuvier's, Lamarck's, Sir Everard Home's, Clairville's, Leach's, Stephen's, and McLeay's classifications. Hoping this may be of use. M. NIBLETT.

52 Oxford Road, Chesterton, Cambridge.

THE SUK PEOPLES.[1]

MR. BEECH has written an extremely interesting book, the possession of which will be a necessity to every anthropologist and student of African languages; and the introduction to this work by Sir Charles Eliot is not a few vapid pages of commendatory remarks signed by a notable name, but an essential portion of the book itself.

Mr. Beech commences his work by a description of the Sūk people, and a sketch of their affinities with the surrounding peoples. He comes to the conclusion which was first published by the writer of this review in 1902, that the so-called Sūk peoples are really an assemblage of very diverse Negro and Negroid types whom the force of circumstances has driven into something like tribal cohesion in that picturesque country of deep ravines, high plateaux, volcanic peaks, and hot plains, between Lakes Rudolf and Baringo on the east, and the Elgon and Nandi plateaux on the west. Mr. Beech thinks that the traditions of the old men show that there were (in the main) two original tribes living in the western part of the Sūk country (the Elgeyo escarpment), the names of which were Chuk or Chok (the origin of the present name, which is a Masai corruption popularised by Joseph Thomson), and Seker; and that fugitives and adventurers from various surrounding districts entered the Sūk country, and intermarried with the two original tribes. "Every type is represented, from the tall, handsome Hamite, with almost perfect features, to the short, dwarf-like pygmy, with spread nose and bolting eyes."

The author is inclined to think that this last-named type characterised both the original Chuk and Seker. Elsewhere in the book, in connection with the illustrations, Mr. Beech refers to a "Bushman-like" type. Some of the first explorers who wrote on the subject of the Sūk people (including the reviewer) were apt to speak of the Bushmanlike type of Pygmy amongst them and amongst the neighbouring Andorobo (the Andorobo, be it observed, speak a language which is related to that of the Sūk, the Nandi, &c.). It is, we believe, the case that one or two trustworthy observers have noted types of physique amongst the Andorobo which offer a slight resemblance to the Bushman, but it now seems to be clear that the Pygmy type of Sūk, which also reappears amongst the Bantu tribes of Mount Elgon, as well as farther west in eastern Uganda, is decidedly not of Bushman affinities, but, on the contrary, obviously connected with the Congo Pygmy. This would seem to be the case with the dwarf tribes of southern Ethiopia first seen by the missionary Krapf, and of the Red Bongo, and other dwarf peoples of the Egyptian Sudan. There is no marked steatopygia amongst the Pygmy Sūk or any of the dwarf races just mentioned. In other anatomical features connected with the external genitalia of men and women (which it is not necessary to specify here, but which are clearly illustrated in Dr. Péringuey's work on the Stone Age in South Africa), they are almost the opposite pole amongst Negro races to the Bushman

Pastoral Suk (type 1). From "The Suk: their Language and Folklore."

The one or two illustrations of Pygmy types of Sūk in Mr. Beech's book are of value in emphasising this fact (the non-Bushman likeness of the Pygmy Sūk), the more so as they are taken from nude figures.

As regards the Sūk language, Mr. Beech comes to conclusions which seem to the reviewer to be thoroughly sound. He recognises the great affinity between Sūk and Nandi (to which we would venture to add the Ndorobo, Sotik, and other "Nandi" languages, and shows that the Turkana—that giant race of Lake

[1] "The Suk: their Language and Folklore." By M. W. H. Beech. With an introduction by Sir Charles Eliot. Pp. xxiv+151+3 maps+24 plates. (Oxford: Clarendon Press, 1911.) Price 12s. 6d. net.

Rudolf though it has so many affinities with the Sūk in regard to head-dress, costume, and customs, is far more nearly related to the Masai-Bari group in language. In fact, this book supplies a good deal of evidence which would show that Nandi and Sūk and the allied languages, though they must be classed in the same group with the Nilotic and Masai tongues, nevertheless stand very much apart from their congeners, and no doubt include a considerable element of pre-existing tongues quite unrelated to those sex-denoting languages which sprang into existence in the Nile Valley, influenced, it may be, in a slight degree by the Hamitic tongues of invading White men.

In a general way it may be said that the Masai-Bari-Turkana section of these Nilotic tongues is sex-denoting, and that the other groups (Shiluk-Dinka-Jaluo and Nandi-Sūk) are not; or, at least, that the principle of indicating the female sex in pronouns and prefixes has very much weakened. In reference to this argument may be mentioned the tendency on the part of certain German and English writers on African languages in recent times to persist in classing the Nilotic languages or members of the Nilotic family as "Hamitic," because they, like the totally unrelated Bongo language group of the western Egyptian Sudan, are sex-denoting. This idea in the syntax may have been inspired originally by invading Caucasians of Hamitic speech, but the result is attained, not—as in the case of Hausa and Musga—by the deliberate adoption of Hamitic feminine particles, but by the use of Negro vocables common also to the Bantu languages to indicate sex, such as *ol* or *lu* for the masculine (Bantu, *lume*), and *na* or *nya* (a word originally meaning "mother") for the feminine.

A great many interesting points in connection with African philology are indicated or are explained in this valuable little book, which may be finally commended for its lightness in the hand and for the mass of first-rate information which is packed into a small compass.

H. H. JOHNSTON.

WESTLAND—A NEW ZEALAND PROVINCE.[1]

WESTLAND is the province on the western coast of the South Island of New Zealand. Its name brings back a vision of a land covered by forests of tropical luxuriance, rising from a blue sea fringed by a white line of surf to blue mountains capped with fields of snow, of clean glaciers flowing steeply down into glades of tree ferns, and of a succession of pictures so varied and all so perfect in composition that we regard Westland as the most beautiful country it has been our privilege to see.

Miss M. Moreland tells in this volume the story of a ride through this district; and though she gives singularly little information, her book conveys a pleasing impression of her keen enjoyment of the scenery, and her enthusiastic admiration of the people. She dedicates her book to the New Zealanders who taught her to love their land. She rode from the Canterbury Plains across the Southern Alps to the western coast, and then down Westland, and back by the southern road to the eastern side of the New Zealand Alps. The book is illustrated by forty-eight excellent photographs and two maps. The author is not a geographer, and it was apparently only the special charm of the New Zealand flora that has roused her interest in botany; she was startled to find that the New Zealand lily is a tree, the Cordyline, that the pines equally exceed the stunted pines of Scotland, and that the flax, the name of which she always spells Formium, has a much longer and stronger fibre than the European flax. She expresses her great indebtedness for her knowledge of the plants to the work of Laing and Blackwell.

The Minarets: from the Tasman Glacier. From "Through South Westland."

While in Westland she visited a survey camp, and one of its members talked to her so enthusiastically about the silver cone of "Mount Aspiring" that she resolved to visit it, and after sundry misadventures reached the valley at its foot. She did not climb it. The first ascent was reserved for Captain Head. "For us," she says, "it is enough to have seen the great Silver Cone against the blue; we come no more." This

[1] "Through South Westland: a Journey to the Haast and Mount Aspiring, New Zealand." By A. Maud Moreland. Pp. xviii+221. (London: Witherby and Co., 1911.) Price 7s. 6d. net.

remark expresses the nature of the book. The author is satisfied with seeing; she has made no new routes and collected no new information, and some of her statements, such as that the egg of the Kiwi is as large as the adult bird, are untrustworthy; but she will doubtless feel repaid if her book leads others to visit Westland, and share her keen enjoyment of that beautiful land.

THE REV. F. J. JERVIS-SMITH, F.R.S.

BY the death of the Rev. Frederick Jervis-Smith on August 23, at sixty-three years of age, the world of science has lost an original and acute thinker and a man who had a genius for designing and constructing instruments of delicacy and precision. Trained as a mechanical engineer, he gave up the calling of his choice, went to Oxford and entered the Church for family reasons. The only son of the Rev. Prebendary Frederick Smith, of Taunton, he became the patron of the living of St. John's, Taunton, and was vicar for a few years. But he recognised that his real gifts were for science, and he took his workshop to Oxford, where he became Millard lecturer in experimental mechanics at Trinity College.

The teaching laboratory in Trinity fitted up by Jervis-Smith was worked in connection with the chemical laboratory in Balliol, and afterwards with the laboratory in St. John's, fitted up by Bosanquet, the three laboratories being close together. The passage opened between Trinity and Balliol in 1879 was known as "the scientific frontier."

In the Millard Laboratory Jervis-Smith constructed many of his well-known instruments, among which special mention must be made of his electric chronograph. Instead of the ordinary device of a heavy pendulum or rod falling under the accelerating force of gravity, Jervis-Smith made a carriage to run down rails so inclined that the velocity became constant after a certain travel. This carriage carried a smoked surface on which electromagnetic styli made their trace, as well as a vibrating tuning-fork. This uniformity of movement greatly simplified the conversion of the distance between the marks of the styli into time. The styli and the electromagnets were very small, and the retardation of the release on breaking the circuits was made by an ingenious system of winding the coils, both very small and nearly uniform.

Jervis-Smith had intended to use his chronograph in the investigation of the changes of velocity in the propagation of the flame in the explosion of gases; and, indeed, he made several sets of experiments on the propagation of the explosion of electrolytic gas under pressure in steel pipes, but he returned to the improvement of the instrument. Prof. H. B. Dixon carried out all his later researches on the velocity of the explosion-wave in gases with the help of electromagnetic styli constructed by Jervis-Smith. This chronograph has been largely used for measuring the flight of projectiles. Of his other instruments, the best known are the dynamometer and the integrator, but many of his ideas have been adopted in other measuring and recording instruments.

Jervis-Smith was endeared to his friends by his simple character, his dry humour, and the kindness of his heart. He would put himself to endless trouble to help a friend in any experimental problem, and he always managed to convey the idea that one was doing him a service by asking for his help. His skill and courage in saving life on the river at Oxford were recognised by the award to him of the Royal Humane Society's medal. He married Miss Annie Eyton Taylor, and leaves her and one son to mourn his loss.

THE BRITISH ASSOCIATION AT PORTSMOUTH.

THE week's meeting of the British Association at Portsmouth has now drawn to a close, and some general impressions of the gathering may not be out of place. In the first place, the weather conditions in Portsmouth, as in most other parts of the United Kingdom, have been exceptional as regards absence of rain and high thermometric readings. Only on one day has rain fallen during the whole of the week, which, speaking off-hand, has probably been a very rare occurrence even during the eighty odd years of the association's existence.

The attendance has been low, which is to be deplored, as on the whole the standard of the scientific work has been high. The address of the president (reported in full in our last number) was delivered in the Town Hall. The attendance at the sections, which began their work on Thursday morning, was not large, but the presidential addresses were of great interest and value. The largest number of members seems of recent years to be attracted to the sections dealing with the subjects which come into everyday life, and of which the "man in the street" is conscious. Thus in the economic and the education sections the speakers had fair audiences. Agriculture (Sub-section K) also appealed to a good many members.

With the fine weather, naturally the garden-parties were much appreciated, and on Saturday the all-day excursions were practically all up to the limit as regards numbers. One party was conducted over Goodwood House, and entertained at tea by Mr. Hussey Freke, the agent to the Duke of Richmond; another was the guest of the Duke of Norfolk at Arundel Castle. Other excursions were in the Isle of Wight and to the New Forest. It conduced much to the pleasantness of each excursion that certain gentlemen gave their local knowledge and services to act as guides to the several parties.

There were, as usual, two evening lectures—the first, on "The Physiology of Submarine Work," by Dr. Leonard Hill, attracting a fair audience; the second was by Prof. A. C. Seward on "Links with the Past in the Plant World."

During the meeting various lectures of considerable interest were arranged, and it seemed a pity that they were not more widely advertised. Mr. F. Enock lectured on "Fairy-flies," and Dr. Francis Darwin on "The Balance-sheet of a Plant."

There was a great demand for tickets for the naval display on Monday afternoon, which gave the visitors an insight into the mass of detail and training required by naval commanders of the present day. The party was taken on board the battleship *Revenge*, and watched an attack by torpedo-boat destroyers and four or five submarines specially told off for the occasion.

Most sections finished their work on Tuesday, but a few energetic ones had material to keep them going until Wednesday.

The meeting next year is to be held at Dundee, beginning on September 4, and the president will be Prof. E. A. Schäfer, F.R.S. The invitation of the City and University of Birmingham to meet there in 1913 was unanimously accepted at the council meeting on September 1. The council also resolved by a majority to recommend that agriculture be constituted a separate section of the association, and this recommendation has been adopted by the General Committee and the Committee of Recommendations, so that there will be twelve sections in future, agriculture being Section M.

SECTION C.

GEOLOGY.

OPENING ADDRESS BY ALFRED HARKER, M.A., F.R.S., PRESIDENT OF THE SECTION.

Some Aspects of Modern Petrology.

IN accordance with the custom which permits the occupant of this chair to open the proceedings with observations on some selected subject, I wish to invite your attention to certain points concerning the genetic relations of igneous rocks. The considerations which I shall have to lay before you will be in some measure tentative and incomplete; and indeed, apart from personal shortcomings, this character must necessarily attach to any discussion of the subject which I have chosen. For petrology is at the present time in a state of transition—the transition, namely, from a merely descriptive to an inductive science—and at such a time wide differences of opinion are inevitable. If I should seem to do less than justice to some views which I do not share, I hope this fault will be attributed to the limitations of time and space, not to any intention of abusing the brief authority with which I find myself invested.

The application of microscopical and special optical methods, initiated some fifty years ago by Dr. Sorby, gave a powerful impetus to the study of the mineral constitution and minute structure of rocks, and has largely determined the course of petrological research since that epoch. For Sorby himself observation was a means to an end. His interest was in the conclusions which he was thus enabled to reach relative to the conditions under which the rocks were formed, and his contributions to this problem will always rank among the classics of geology. The great majority of his followers, however, have been content to record and compare the results of observation without pushing their inquiries farther; and indeed the name "petrography," often applied to this line of research, correctly denotes its purely descriptive nature. A very large body of facts has now been brought together, and may be found, collated and systematised by a master-hand, in the monumental work of Rosenbusch. Beyond their intrinsic interest, the results thus placed on record must be of the highest value as furnishing one of the bases upon which may eventually be erected a coherent science of igneous rocks and igneous activity.

In earnest of this promise, recent years have witnessed a very marked revival of interest in what we must call at present the more speculative aspects of petrology. This manifests itself on the side of the petrographer in a growing disposition to seek a rational interpretation of his observations in the light of known physical principles, and on the side of the field geologist in a more constant regard for the distribution, mutual associations, and mode of occurrence of igneous rocks. I will add, as another hopeful sign of the times, a decided *rapprochement* between the laboratory and the field, too often treated in practice as distinct departments.

As regards the former, the movement which I have noticed is merely a return to the standpoint of Sorby, the father of modern petrology. It is true indeed that, before his time, the problem of the origin of igneous rocks had engaged the ingenuity of Scrope and Darwin, of Bunsen and Durocher, and many others; and the bold speculations of the heroic days of geology have justly exercised a lasting influence. The petrologist of to-day, however, has at his command a much ampler range of information than was possessed by his predecessors. In addition to the rich store of petrographical data already mentioned, he can press into service on the one hand the results of physical chemistry and on the other much additional knowledge which has been gathered concerning the structure of the earth's crust and the distribution of various rock-types, both in space and in time. Either of these branches of the subject would furnish material for a much longer address than my assurance could venture or your complacence would endure. I have chosen the geographical aspect of petrology; but, before proceeding to this, I will say a few words concerning the experimental side.

Data from the Experimental Side.

That the modern developments of physical chemistry, starting from the phase rule of Willard Gibbs, must in theory furnish all that is necessary to elucidate the crystallisation of igneous rock-magmas, has long been perceived by some petrologists. This recognition is in itself an advance. Natural rock-magmas, however, are far more complex solutions than those which chemists have employed in working out their laws, and the problem in its entirety is of a kind almost to daunt inquiry. Despite the courageous attempt made by Prof. Vogt, whose enthusiastic lead has done so much to inspire interest in the subject, it seems clear that the application of the laws of chemistry to the particular class of cases with which the petrologist is concerned demands as a prerequisite a large amount of experimental work in the laboratory. The high melting-points of the rock-forming minerals, their extreme viscosity, and other specific properties render such work extremely difficult and laborious. That most of the practical difficulties have now been overcome is due in the first place to Dr. A. L. Day and his colleagues of the Geophysical Laboratory at Washington, who have thus opened out what is virtually a new field of investigation. The methods of high temperature measurement have been perfected and the thermometric scale standardised up to 1550° C., thus embracing the whole range of rock-formation. Calorimetric measurements have been so far improved that it is now possible, for instance, to determine specific heats, even in the highest part of this range, with an accuracy ten times greater than has hitherto been usual at ordinary temperatures. Incidentally there has been, in the hands of Mr. F. E. Wright, a notable enlargement of the scope of ordinary petrographical methods, since it has been found necessary to devise special means of measuring with precision the crystallographic and optical constants of very minute crystals.

The American chemists have already determined the temperature-range of stability of numerous rock-forming minerals. Beginning with the simpler cases and working always with chemically pure material, they have established quantitatively the mutual relations of the various possible forms in a number of two-component systems and in one of three components. So far as these instances go, the mutual lowering of melting-points in a silicate-magma is now a matter of precise measurement, and it is no longer inferred, but demonstrated, that the order of crystallisation of the minerals depends upon their relative proportions in the magma. The perfect isomorphism of the plagioclase felspars has been finally established, and a certain degree of solid solution between quite different minerals has furnished the explanation of some apparent anomalies, such, for instance, as the variable composition of the mineral pyrrhotite. As a single illustration of how these investigations in the laboratory provide the working petrologist with new instruments of research, I will cite the conception of a geological temperature-scale, the fixed points on which are given by the temperature-limits of stability of various minerals. It is often possible, for example, to ascertain whether quartz in a given rock has crystallised above or below 575° C., this being the inversion-point between the α- and β- forms of the mineral. At about 800° there is another inversion-point, above which quartz is no longer stable, but gives place to cristobalite. In like manner we know that wollastonite in a rock must have crystallised below 1190°, pyrites below 450°, and so for other cases. We may confidently hope that, with the aid of such data, we shall soon be enabled, by simple inspection, to lay down in degrees the temperature-range of crystallisation of a given igneous rock.

There are now several laboratories where high-temperature research, of the rigorous order indicated, is being carried out; but the work is peculiarly arduous, and results come slowly. Some branches of the inquiry, notably those involving high pressures, and again the investigation of systems into which volatile components enter, are as yet virtually untouched. For these reasons it would be premature to hazard at this stage any more detailed forecast of the services to be rendered to petrology by synthetic experiment. I will accordingly leave this attractive subject, and pass on from the laboratory to the field.

Geographical Distribution of Igneous Rocks.

Here the existing situation is very different. Instead of following out definite lines already laid down, we are concerned in reducing to order a great mass of discrete facts drawn from many sources. The facts which enter into consideration are those touching the distribution of various igneous rocks in time, in space, and in environment, including their relation to tectonic features; the mutual association of different rock-types and any indications of law in the order of their intrusion or extrusion; and, in short, all observable relations which may be presumed to have a genetic significance. The digestion of this mass of data has already led to certain generalisations, some of which are accepted by almost all petrologists, while others must be regarded as still on their trial.

Of the former kind is the conception of petrographical provinces, which was put forward by Prof. Judd twenty-five years ago, and has exercised a profound influence on the trend of petrological speculation. It is now well established that we can recognise more or less clearly defined tracts, within which the igneous rocks, belonging to a given period of igneous activity, present a certain community of petrographical characters, traceable through all their diversity or at least obscured only in some of the more extreme members of the assemblage. Further, that a province possessing an individuality of this kind may differ widely in this respect from a neighbouring province of like date; while, on the other hand, a striking similarity may exist between provinces widely separated in situation or in age. It is natural to attribute community of chemical and mineralogical characters among associated rocks to community of origin. The simplest hypothesis is that which supposes all the igneous rocks of a given province to be derived by processes of differentiation from a single parent-magma. This may be conceived, for the sake of simplicity, as initially homogeneous, though doubtless some of the causes which contribute to promote heterogeneity were operative from the earliest stage. Granted this hypothesis, it follows that the points of resemblance among the rocks of a province will indicate the nature of the common parent-magma, while the points of diversity will throw light on the causes of differentiation. The observed sequence in time of the various associated rock-types will also have an evident significance, especially if, as there are good reasons for believing, differentiation in igneous rock-magmas is largely bound up with progressive crystallisation. Those petrologists, on the other hand, who attach importance to the absorption or "assimilation" of solid rock-matter by molten magmas, are bound to consider both the nature of the chemical variation and the local distribution of the different types with constant reference to the composition of the country-rocks. The balance of opinion, and I think of argument, would assign the variation, at least in the main, to differentiation; and there are well-known principles, chemical and mechanical, which theoretically must operate to produce a diversity of ultimate products from a magma originally uniform. How far these principles are in practice adequate to the demands which have been made on them, is a question not to be finally resolved without quantitative knowledge which is still a desideratum. Experiment may in time come to our aid. My design to-day is rather to offer some remarks upon a distinct, though allied, problem—viz., that presented by the petrographical provinces themselves.

The geographical distribution of different kinds of igneous rocks long ago engaged the attention of Humboldt, Boué, and other geologists, and the subject has always possessed a certain interest in view of the association of most metalliferous deposits with igneous rocks. It has, however, acquired a new importance in recent years in connection with questions of petrogenesis which are still under discussion. The problem is, in brief, to account for the existence of petrographical provinces and for the observed facts relative to their distribution. One theory, advocated especially by Dr. G. F. Becker, invokes primæval differences in composition between different parts of the globe, which have persisted throughout geological time. It involves the hypothesis that igneous rock-magmas result from the refusion of pre-existing rocks within a limited area. Indeed Becker discards altogether the doctrine of differentiation, and conceives the varied assemblage of rocks in a given province as produced by admixture from a certain number of primitive types. These, he says, should be recognisable by their wide distribution and constant character. It is clear, however, that, on the hypothesis of admixture, the primitive types must be those of extreme composition. These are, in fact, always the rarest and the most variable, pointing not to admixture but to differentiation as the cause of the diversity. A theory which attributes the special characteristics of petrographical provinces to permanent heterogeneity in the composition of the globe is difficult to reconcile with the small extent and sharp definition of some strongly characterised provinces, such as that of Assynt or of the Bohemian Mittelgebirge. A more fatal objection is that petrographical provinces are not in fact permanent. A good illustration is afforded by the midland valley of Scotland, an area our knowledge of which has been much enlarged by the recent work of the Geological Survey. It was the theatre of igneous activity in Lower Old Red Sandstone times and again in the Carboniferous, but, in respect of mineralogical and chemical composition, the two suites of rocks present a striking contrast. The Old Red Sandstone lavas are mostly andesites, though ranging from basalts on the one hand to rhyolites on the other, and the associated intrusions are mainly of diorite, quartz-diorite, and granite, with porphyrites and other dyke-rocks. In the Carboniferous, on the other hand, we find porphyritic basalts, mugearites, and trachytes (including phonolitic types), with picrites, teschenites, monchiquites, orthophyres, and other allied rocks. It would be possible to cite many other cases illustrating the same point.

The Alkaline and Calcic Branches.

The two Scottish suites of Upper Palæozoic rocks just mentioned fall into opposite categories with reference to what is now becoming recognised as the most fundamental distinction to be made among igneous rocks. The earlier set is typical of the andesitic division and the later of the tephritic; or, using other equivalent names, the one belongs to the calcic (or "alkali-calcic") branch and the other to the alkaline. I will adopt the latter terminology as being generally familiar to petrologists; but the characteristics of the two branches, which are too well known to need recapitulation here, are more clearly definable in mineralogical than in chemical language. This twofold division of igneous rocks is, of course, in no wise a final or exhaustive treatment of the subject; but as a first step towards a natural or genetic classification it seems to be established beyond question. No third branch in any degree comparable with the two and distinct from them has been proposed. The charnockites and their allies represent but a single rock-series, and Rosenbusch has not made clear his reasons for separating them from the calcic rocks. The "spilitic" suite of Dewey and Flett is made to embrace a somewhat miscellaneous collection of types, and any close genetic relationship among them can scarcely be considered as proved. It is perhaps permissible to suggest that, *e.g.*, the quartz-diabases are, here as in Scotland, quite distinct in their affinities from the types rich in soda. These latter, constituting the bulk of the proposed suite, would seem to belong quite naturally to the alkaline branch, the question of the magmatic or solfataric origin of the albite being in this connection immaterial.

A given petrographical province is either of calcic or of alkaline facies, typical members of the two branches not being found together. The apparent exceptions are, I think, not such as to modify very seriously the general rule. Mr. Thomas, in describing an interesting suite of rocks from Western Pembrokeshire, recognises the alkaline affinities of most of them, but assigns some of the more basic types to the opposite branch. In a very varied assemblage we not infrequently meet with a few extreme types which, occurring in a calcic province, recall the characters of alkaline rocks, or conversely. Such anomalies have been pointed out by Daly, Whitman Cross, and others. They are found among the later derived types, referable to prolonged or repeated differentiation, and they are to be expected especially where the initial magma was not very strongly characterised as either calcic or alkaline.

Having regard to the known exposures of igneous rocks over the existing land-surface of the globe, it seems that there is a very decided preponderance of the calcic over the alkaline branch. This, as we shall see, is probably a fact of real significance, but it is nevertheless noticeable that increasing knowledge tends partly to redress the balance. In our own country, in addition to the Scottish Carboniferous rocks and those probably of Ordovician age in Pembrokeshire, we have the remarkable Lower Palæozoic intrusions of Assynt, in Sutherland, of strongly alkaline character, as described by Dr. Teall and more recently by Dr. Shand; while Dr. Flett has recognised alkaline rocks of more than one age in Cornwall and Devon, and Mr. Tyrrell is engaged in studying another interesting province, of Permian age, in Ayrshire.

That the distinction between the alkaline and the calcic rocks embodies some principle of real and fundamental significance becomes very apparent when we look at the geographical distribution of the two branches. Taking what the German petrographers call the "younger" igneous rocks, *i.e.*, those belonging to the latest system of igneous activity, we find it possible to map out the active parts of the earth's crust into great continuous regions of alkaline rocks on the one hand and of calcic on the other. An alkaline region comprises numerous petrographical provinces, which may differ notably from one another, but agree in being all of alkaline facies. In like manner a common calcic facies unites other provinces, which collectively make up a continuous calcic region. Concerning the igneous rocks of earlier periods our knowledge is less complete, but, so far as it goes, it points to the same general conclusions.

These considerations enable us to simplify at the outset the problem before us. If we would seek the meaning and origin of petrographical provinces, we must inquire in the first place how igneous rocks as a whole come to group themselves under two great categories, which, at any one period of igneous activity, are found in separate regions of the earth's crust. The fact that a given district may form part of a calcic province at one period and of an alkaline one at another, precludes the hypothesis that the composition of igneous rocks depends in any degree upon peculiarities inherent from the beginning in the subjacent crust. The same objection applies with scarcely less force to various conflicting suggestions based on an assumed absorption or "assimilation" of sedimentary rocks by igneous magmas. Thus Jensen supposes the alkaline rocks to be derived by the assimilation or fusion of alkaline sediments at great depths. Daly propounds the more elaborate, and on a first view paradoxical, theory that alkaline have been derived from calcic magmas as a consequence of the absorption of limestone. These geologists agree in regarding the alkaline rocks as relatively unimportant in their actual development and in some sense abnormal in their origin. For Suess, on the other hand, it is the calcic rocks which owe their distinctive characters to an absorption of sedimentary material, enriching the magma in lime and magnesia. Apart from difficulties of the physical and chemical kind, all such theories fail to satisfy, in that they ignore the separation of the two branches of igneous rocks in different regions of the globe, each of which includes sediments of every kind. What then is the real significance of this regional separation? The obvious way of approaching the question is to inquire first whether the alkaline and calcic regions of the globe present any notable differences of a kind other than petrographical.

Relation between Tectonic and Petrographical Facies.

The close connection between igneous activity and displacements of the earth's crust has been traced by Suess, Lossen, Bertrand, de Lapparent, and others, and is a fact sufficiently well recognised. We have here, indeed, two different ways of relieving unequal stresses in the crust, and it is not surprising that they show a broad general coincidence both in space and in time. We can, however, go farther. Not only the distribution of igneous rocks in general, but the distribution of different kinds of rocks, is seen to stand in unmistakable relation to the leading tectonic features of the globe. It is very noticeable that petrographical provinces, and in particular provinces belonging to opposite branches, are often divided by important orographic lines. This is illustrated by the Cordilleran chain in both North and South America, and again by some of the principal arcs of the Alpine system in Europe. If, now, we examine the actual distribution more closely, in the light of Suess's analysis of the continents and oceanic basins, we perceive another relation still more significant. It is that, as regards the younger igneous rocks, the main alkaline and calcic regions correspond with the areas characterised by the Atlantic and Pacific types of coast-line respectively; I briefly drew attention to this correspondence in 1896, and a few years later Prof. Becke, of Vienna, arrived independently at the same generalisation. Recalling the two classes of crust-movements discriminated by Suess, he says it appears that the alkaline rocks are typically associated with subsidence due to radial contraction of the globe, and the calcic rocks with folding due to lateral compression. The greater part of Becke's memoir is devoted to a comparison of the two branches in respect of chemical composition; but here, I think, he has been misled by taking as representative of the whole alkaline "*Sippe*" or tribe the rocks of one small and peculiar province, that of the Bohemian Mittelgebirge. Some petrologists have followed Becke in adopting the terms Atlantic and Pacific as names, or at least synonyms, for the two branches of igneous rocks. Others, perhaps with some justice, deprecate the use of the same terms in a petrographical as well as a tectonic sense, so long as the implied relationship is still a matter of discussion.

I would point out in passing that the association of the alkaline rocks with areas of subsidence helps to explain the relatively small part which they play in the visible portion of the earth's surface. We may not unreasonably conjecture, for instance, that the volcanic islands scattered sparingly over the face of the Atlantic Ocean, from the Azores to Tristan d'Acunha, are merely fragments of a very extensive tract of alkaline rocks now submerged.

The generalisation associated with the name of Becke, in so far as it may ultimately commend itself to general acceptance, must have an important bearing on the problem of the origin of petrographical differences. The time is not ripe for any dogmatic pronouncement, but I will venture to indicate briefly the general trend of the inferences to be drawn. It seems clear that only a trivial effect at most can be allowed to original and permanent heterogeneity of the earth's crust, or to such accidents as the absorption by an igneous magma of a limited amount of the country-rock. The division between alkaline and calcic regions, and the separation of distinct provinces within such regions, point rather to the same general cause which, at a later stage, produced the diversity of rock-types within a single province, that is, to magmatic differentiation. Here, however, the differentiation postulated must be on a very wide scale, and must take effect in the horizontal direction. Its close connection with crust-movements clearly indicates differential stress as an essential element in the process. The actual mechanism can be at present only a matter of speculation, but I think the clue will be found in such observations as those of Mr. Barrow on the pegmatites of the Scottish Highlands. Conceive an extensive tract to be underlain by a zone which is neither solid nor liquid, but composed of crystals with an interstitial fluid magma. If this be subjected to different pressures in different parts of its horizontal extent, its uniformity will necessarily be disturbed, the fluid portion being squeezed out at places of higher pressure and driven to places of lower pressure. The precise nature of the differentiation thus set up will depend on the relative compositions of the crystalline and fluid portions, and the subject could not be very profitably discussed without fuller knowledge concerning the order of crystallisation in rock-magmas. Whether or not the explanation be ultimately found in this direction, the relation between the two tectonic types and the two branches of igneous rocks must, I think, find a place in the final solution of the problem.

I intimated at the outset that my remarks would not be confined to matters already settled and indisputable. It will be easily understood that some statements which I have made, for the sake of clearness, without qualification are subject to exceptions, and exceptions have, indeed, been urged by critics whose opinions are entitled to respect. The most uncompromising of these critics, Dr. Whitman Cross, has laid it down that: "Only generalisations without known exceptions in experience can be applied to the construction of a system that may be called natural." I hold, on the contrary, that such a science as Geology can be advanced only by the inductive method, which implies provisional hypotheses and successive approximations to the truth. A generalisation which brings together a mass of scattered observations, and endows them with meaning, is not invalidated by the discovery of exceptions. These merely prove that it is not a final expression of the whole truth, and may point the way to its revision and correction.

Take, for instance, our provisional law of the distribution of the two branches of igneous rocks in defined regions. It has been objected that leucitic lavas, having therefore very decided alkaline or Atlantic affinities, are known at several places within the limits of the main Pacific region, where they are associated with andesitic and other calcic rocks. Now, the only area for which we have anything like full information is the island of Java. Here, according to Verbeek and Fennema, the great plateau-lavas of Tertiary age are exclusively of andesitic types, and the same is true of the long chain of 116 volcanic centres, which represent the later revival of activity. As against this record there are five volcanoes, long extinct, which at one stage erupted leucitic lavas. Whether we suppose these to be aberrant derivatives from an andesitic magma, or, much more probably, an incursion from the neighbouring alkaline region, it seems reasonable to regard these very exceptional occurrences as of the second order of importance, and to set them aside in a first attempt to reduce the facts to order.

The discovery of various alkaline rocks on Hawaii, Samoa, Raratonga, Tahiti, and other islands in the midst of the Pacific Ocean raises, I think, a different question. So far as is known, these rocks are not found in close association with characteristic calcic types. Suess's masterly discussion of all the geographical and hydrographical data hitherto obtained makes it clear that an Atlantic as well as a Pacific element of structure enters into some parts of the Pacific basin. In certain areas, such as the Galapagos Archipelago, the coming in of the Atlantic *régime* is quite clearly reflected in an alkaline facies of the igneous rocks, and such exceptions are therefore of the kind which go to prove the rule. Both Max Weber and Lacroix have expressed the opinion that the andesitic branch of rocks is characteristic of the border of the great Pacific basin rather than the interior. It is possible that further knowledge may justify this conclusion, and still only confirm the relation which is claimed between the two tectonic types and the two petrographical facies. Meanwhile, we find clear evidence elsewhere that vertical subsidence and lateral thrust have sometimes occurred in the same region or in the same petrographical province: nor need we go far from home to learn that the complexity of structure thus implied is accompanied by a corresponding peculiarity of petrographical facies.

The North British Tertiary Province.

In order to illustrate this point in a concrete instance, I will discuss very briefly a single petrographical province, viz. that which occupied the northern part of Britain in early Tertiary times. Prof. Judd has regarded this as forming part of a larger "Brito-Icelandic province"; but, while recognising many affinities between our rocks and those of higher latitudes, I think that the North British area possesses enough individuality to be more properly treated as a distinct unit. The record of igneous action here is exceptionally complete and well displayed. Our knowledge of it is derived, in the first place, from Prof. Zirkel, Sir Archibald Geikie, and Prof. Judd, and more recently from the detailed work carried out by the Geological Survey of Scotland. This latter is, as regards the Isle of Mull, still in progress, and will doubtless, when completed, throw additional light on some questions still obscure.

The province includes all western and southern Scotland, with the northern part of Ireland, and extends southward as far as Anglesey and Yorkshire; but the chief theatre of igneous activity was the sunken and faulted tract of the Inner Hebrides, between the mainland of Scotland, on the one hand, and the Archæan *massif* of the Outer Isles on the other. It is here that the volcanic accumulations attain their greatest thickness, and here, closely set along a N.-S. line, are the plutonic centres of Skye, Rum, Ardnamurchan, and Mull. Farther south are the volcanic plateau of Antrim and the neighbouring plutonic centres of the Mourne Mountains and Carlingford, while the two centres of Arran and that of Ailsa lie on a parallel line only a little farther east. In addition, it is clear that igneous activity extended westward over a tract now submerged under the Atlantic, and here, too, plutonic centres were not wanting. One is exposed in St. Kilda, 50 miles west of the Outer Hebrides, and another has been inferred by Prof. Cole from a study of the stones dredged on the Porcupine Bank, 150 miles west of Ireland.

The connection of igneous action in this province with the subsidence of faulted blocks of country is too plain to be missed; and so far, excepting the tendency to a definite alignment of the foci of activity, we seem to be dealing with a typical example of the Atlantic *régime*. The actual tectonic relations are, however, of a more complex kind, and undoubtedly involve the element of lateral thrust as well as vertical subsidence. This is more particularly in the neighbourhood of those special centres which were marked at one stage by plutonic intrusions. The evidence is seen in sharp anticlinal folding; sometimes also in crush-brecciation along quasi-horizontal bands and (in Rum) contemporaneous gneissic structure in the plutonic masses themselves. The disturbances in Mull, as described by Mr. Bailey, are especially interesting. The whole eastern coast-line of the island is determined by a system of concentric curved axes of folding, affecting all the rocks up to the Tertiary basalts, which are in places tilted almost vertically. The curved axes are disposed with reference to the plutonic centre of the island, and a somewhat similar arrangement is found on the east side of the Skye centre. All these facts go to show that in the district surrounding any one of the special centres there was developed a complex system of stresses, which found relief partly in igneous action, partly in displacements of the solid rocks. Nor were the effects confined to the plutonic phase. At a later epoch the influence of these local stresses is sometimes indicated by the diversion of the very numerous dykes from their normal north-westerly direction to a radial arrangement about the special centres, as is seen partly in Skye and more strikingly in Rum. There are also local groups of dykes developed only in these districts, and these again sometimes have a radial arrangement. More remarkable are the groups of inclined sheets which are found about the same centres, usually intersecting the plutonic rocks and a small fringing belt, and constantly dipping inwards. Such sheets occur in immense numbers in the gabbro mountains of Skye and Mull, and they are to be recognised also in Rum and Ardnamurchan.

It is plain, then, that this province exemplifies at once the two tectonic types distinguished by Suess. There has been a general subsidence affecting the area as a whole, but not all parts equally, and with this we must connect those groups of igneous rocks which have a wide distribution throughout the province. But there have also been movements in the lateral sense, more strictly localised and more sharply accentuated, and to these belong evidently the plutonic rocks with various other groups which are their satellites. I have pointed out these facts elsewhere, but failed to follow out the logical conclusion on the petrographical side. Influenced by the strongly marked characters of the plutonic series, I assigned the North British Tertiary rocks, not without some misgivings, to the calcic or Pacific region. Suess, having regard probably to the broader tectonic features rather than to petrographical data, has included our area in the Atlantic region.

Concerning the calcic facies of the plutonic rocks there can be no question. They constitute a well-defined "rock-series," intruded in order of decreasing basicity, and ranging from ultrabasic to thoroughly acid. The ultrabasic rocks, as developed in Rum and Skye, have a lime-felspar as one of their chief components: there are no picrites (in the original sense of Tschermak) or other alkaline types. The eucrite group, found in Rum, Ardnamurchan, and the Carlingford district, is also characterised by a felspar near anorthite. Gabbros are represented at nearly all the several centres, and in Arran they are accompanied by norites. The granites and granophyres fall into two subgroups. The less acid is usually augitic, while the more acid, found in Arran, St. Kilda, and the Mourne Mountains, carries hornblende and sometimes biotite.

This series is known in various provinces of Pacific facies. A peculiarity of it is that it is a broken series, types of mean acidity being absent. This has an interesting consequence. In many places a granite magma, invading rocks so different from itself as gabbro or eucrite, has caused energetic mutual reactions, and a set of hybrid rocks has been produced, which serves in a limited sense to fill the gap in the series.

The only known exceptions to the calcic facies of our Tertiary plutonic rocks are perhaps significant in that they occur near the northern and southern limits of the principal belt of activity. The massive gently inclined sheets of granite and granophyre which make up part of the southern end of Raasay consist largely of microperthite, and contain abundant riebeckite, a distinctively alkaline mineral known at only one spot in Skye. The microperthitic granites of Arran do not carry riebeckite, but it is found in the well-known rock of Ailsa Craig, farther south.

The local groups of minor intrusions—acid, basic, and ultrabasic—related to the several plutonic centres have the same calcic facies as the plutonic rocks of which they are satellites. It appears, however, that they sometimes tend to a more alkaline composition towards the borders of their respective districts. Thus the Skye granite is surrounded by a roughly oval area, within which are found numerous dykes and sills of felsite and granophyre, in general augitic; but on the fringe of the area these rocks give place to orthophyres, with biotite or hornblende, and to bostonites.

Turn now to the rocks of regional distribution. The most important are, of course, the basalt lavas. They are all felspar-basalts, but a very general feature is the filling of their numerous amygdaloidal cavities with zeolites, such as analcime, natrolite, chabazite, and stilbite. These minerals are certainly not mere weathering-products. When I examined the basalts of Skye and the Small Isles some years ago, I regarded the zeolites as solfataric products, formed at the expense of the felspar by the action of volcanic water, while the rocks were still at a somewhat high temperature. Subsequent reconsideration has led me to regard these minerals rather as primary constituents of the rock, crystallised directly from the final residual magma, which had become relatively enriched in water by the abstraction of the anhydrous minerals. Such was the conclusion reached by Mr. James Strachan for the Antrim basalts, and a study of examples from Mull and Skye has enabled me to confirm and extend his interesting observations. Analcime in particular is not always confined to the steam-cavities, but in some cases occurs interstitially in the rock, where it is certainly not derived from felspar, and, indeed, has all the appearance of a primary constituent. The augite of these analcime-bearing basalts has in thin slices a purplish tint, with sensible pleochroism. From these and other features it appears that this group of rocks reveals on examination decided, though not very strongly marked, alkaline affinities.

Volcanic rocks of other than basaltic composition are not largely developed. They include both rhyolites and trachytes, the former without very distinctive characters, but the latter falling naturally into the alkaline division. In describing formerly a group of rhyolites and trachytes on the northern border of the Cuillins, I connected it with the neighbouring plutonic centre, but I have since found other trachytes in Skye: there is a fine development exposed in the glen above Bracadale. From this, and from the situation of the Antrim rhyolites, I infer that these felspathic and acid lavas, though distributed sporadically, belong to the regional or Atlantic suite.

Consider next the widespread group of basic sills. The common non-porphyritic dolerite sills have, in most districts, little that is indicative of alkaline affinities, though chemical analyses show a rather noteworthy amount of soda. In the porphyritic dolerites this characteristic is much more apparent, and, indeed, these rocks are almost identical with the "Markle type" so largely represented among the alkaline rocks of the Scottish Carboniferous province. Mugearite, a type still richer in alkalies, is likewise common to the two provinces. As we approach the limits of the principal belt of activity, alkaline characteristics become well marked even in the common non-porphyritic dolerites. This is shown in Raasay and the northern part of Skye by the coming in of the purple pleochroic augite, while farther north, in the Shiant Isles, analcime enters, and even, according to a record of Heddle, nepheline.[1] At the other extreme, in southern Arran, occur the analcime-dolerite sills of Clauchland and Dippin.

The regional basic dykes, which are mostly posterior in age to the sills, exhibit more variety of composition. Some with abundant porphyritic felspars resemble the Markle type of dolerite, and there are others of mugearitic nature, but these are only a minority. In Argyllshire there are basic dykes with purple pleochroic augite, and even some of camptonite and monchiquite; but these latter at least I should exclude as being probably of late Palæozoic age.[2] The undoubtedly Tertiary dykes, however, exhibit a variety which can be explained only as the result of repeated differentiation. The distribution of some of the groups indicates the existence at this late stage of subsidiary centres of differentiation, distinct from the plutonic centres. Thus trachyte dykes are found especially throughout a tract extending from the south-western part of Skye through the middle of Argyllshire, while there is an isolated area of these dykes about Drynoch, on the opposite side of the Skye mountains. Here we have an evidently alkaline type. On the other hand, there are rocks which, taken by themselves, must be assigned to the calcic division. Augite-andesites, for example, are well known, especially in parts of western Argyllshire, in Arran and the Cumbraes, and in the outlying districts of the north of Ireland, Anglesey, and the north-east of England. That these rocks have arisen as products of a subsidiary differentiation we have in some cases almost ocular demonstration; for in Arran and elsewhere augite-andesites are found in remarkably intimate association with complementary types, often pitchstones of alkaline composition.

Even from so brief and imperfect a sketch we may, I think, draw some conclusions which have a wider application. This province exemplifies at once the two main tectonic types, and also comprises representatives of the two great branches of igneous rocks. Those rocks which are related to broad movements of Atlantic type indicate a parent magma of decided, though not strongly marked, alkaline nature; while those related to local movements of Pacific type clearly come from a calcic magma. There are some facts which suggest that the rocks tend to become more alkaline as we recede from the chief centres of activity, and this suggestion applies to some calcic as well as alkaline groups of rocks. Finally, it appears that the relative simplicity of arrangement was disturbed at a late stage by the effects of subsidiary differentiation, the province tending then to break up into districts related to new centres. Operating upon an initial magma not very strongly characterised, this later differentiation has even given rise to aberrant rock-types which overstep the petrographical boundary-line between the two branches.

Petrogenesis and Systematic Petrography.

From such considerations as I have hastily passed in review, it is evident that a survey of igneous rocks as they actually occur in the field leads to a conception of their mutual relationships very different from that embodied in the current schemes of systematic petrography. It may be of some interest, in conclusion, to expand this remark a little farther, although I am sensible that in so doing I lay myself open to the charge of vain speculation.

From the petrogenetic point of view, the most fundamental division among igneous rocks is that between the alkaline and calcic branches. This result, independently arrived at on petrographical grounds by several authorities, seems to be firmly established by the broad distribution of the two branches in different regions of the globe. But, if this argument be admitted, it follows that the next step in a natural grouping of igneous rocks should be suggested by a comparison of the characteristics of the various provinces into which the great regions divide. Many of these provinces have now been partly studied, and their special characteristics can often be expressed in concise terms: *e.g.* among alkaline rocks the relative proportion of potash to soda may be a characteristic common to a whole province. More precisely, by averaging the

[1] The dolerite here is intimately associated with ultrabasic rocks, as has been described by Judd.

[2] A like remark applies to the highly alkaline dykes of the Orkneys, which do not agree even in direction with the Tertiary suite.

chemical analyses of the chief rock-types, weighted according to their relative abundance, it is possible to calculate approximately the composition of the parent-magma of a province. Noting that nearly identical assemblages of rocks sometimes occur in widely separate provinces and at different geological periods, we have some reason for expecting that the provincial parent-magmas may ultimately be reduced to a limited number of types. Whether these types will be sufficiently definite to serve as a basis of classification it is too early to say.

For the sake of argument, I have taken chemical composition as the criterion. It is certain, however, that a rock-magma consists, not of free oxides, but mainly of silicate-compounds, and the variation produced by magmatic differentiation is a variation in the relative proportions of such compounds. The characteristics common to a set of cognate rock-types will therefore be more properly expressed in mineralogical than in chemical terms. If, to fix ideas, we take as representative of a province its principal plutonic series, we shall often find that some particular mineral or some special association of minerals stands out as a distinctive feature. For instance, in the charnockite-norite series of southern India the characteristic ferro-magnesian mineral is hypersthene; in the granite-gabbro series of the British Tertiary it is augite; and in the granite-diorite series, which predominates among the "newer granites" of the Scottish Highlands, hornblende and biotite. These three sets of rocks, all of calcic facies, are easily distinguishable in isolated specimens.

Each such rock-series embraces types ranging from acid to ultrabasic. This variation is ascribed to a later differentiation of the parent-magma of the province, and, therefore, in an arrangement based on genetic principles, it will find expression, not in the main divisions of the scheme, but in the subdivisions. Here is an essential difference between an ideal petrogenetic classification and the petrographical systems which are, or have been, in use. If we are content to limit our study of igneous rocks to specimens in a museum, the distinction of acid, neutral, basic, and ultrabasic may seem to be one of first importance. It has, in fact, been employed for the primary divisions in some formal schemes, *e.g.* in that put forward by Löwinson-Lessing. In a less crude system, like that of Rosenbusch, this element disappears, but the underlying idea still remains. There is a division into families, such as the granite-family and the gabbro-family, but the term, in so far as it implies blood-relationship, is a misnomer. The augite-granite of Mull is evidently more closely related to its associated gabbro than it is, say, to the biotite-granite of Peterhead or the hypersthene-granite of Madras.

The differentiation which evolves a varied series of plutonic rocks from a common parent-magma is clearly not of the same kind as that which gave rise to the parent-magma itself. It appears that the external mechanical element is here a less important factor, and the variation set up is, therefore, more closely in accordance with the uninterrupted course of crystallisation. This is clearly indicated when we compare the order of intrusion of the several rocks of the series with the order of crystallisation of their constituent minerals. The history of the series is in a sense epitomised in the history of each individual type, corresponding in both cases with continued fall of temperature and progressive change in the composition of the residual magma. In a large number of rocks, more particularly those of complex constitution, the order of crystallisation follows Rosenbusch's empirical law of decreasing basicity, and the plutonic intrusions then begin with the most basic type and end with the most acid. I mention this only to point out that, while the larger divisions of our ideal classification will have a certain geographical and tectonic significance, the subdivisions will show a certain correspondence with the sequence in time of the various cognate rock-types.

To pursue the subject farther would serve no useful purpose. It is clear that, if a natural—by which I mean a genetic—classification of igneous rocks is ever to become a reality, much work must first be done, both in the field and in the laboratory, each petrographical province being studied from the definite standpoint of the evolution of its rock-types from one parent stock. Such researches as those of Brögger in the Christiania province may serve as a model. It would be rash to venture at present more than the most general forecast of the lines which future developments may follow; but I think it calls for no less hardihood to set limits to what may ultimately be possible in this direction. There are those who would have us abandon in despair all endeavour to place petrography upon a genetic basis, and fall back upon a rigid arbitrary system as a final solution of the difficulty. This would be to renounce for ever the claim of this branch of geology to rank as a rational science. I have said enough to show that I am one of those who take a more hopeful view of the future of petrology, confidently expecting it to show, like the past, a record of continued progress.

SECTION D.

ZOOLOGY.

OPENING ADDRESS BY PROF. D'ARCY WENTWORTH THOMPSON, C.B., PRESIDENT OF THE SECTION.

Magnalia Naturae; or, The Greater Problems of Biology.

THE science of Zoology, all the more the incorporate science of Biology, is no simple affair, and from its earliest beginnings it has been a great and complex and many-sided thing. We can scarce get a broader view of it than from Aristotle, for no man has ever looked upon our science with a more far-seeing and comprehending eye. Aristotle was all things that we mean by "naturalist" or "biologist." He was a student of the ways and doings of beast and bird and creeping thing; he was morphologist and embryologist; he had the keenest insight into physiological problems, though lacking that knowledge of the physical sciences without which physiology can go but a little way: he was the first and is the greatest of psychologists; and in the light of his genius biology merged in a great philosophy.

I do not for a moment suppose that the vast multitude of facts which Aristotle records were all, or even mostly, the fruit of his own immediate and independent observation. Before him were the Hippocratic and other schools of physicians and anatomists. Before him there were nameless and forgotten Fabres, Röesels, Réaumurs, and Hubers, who observed the habits, the diet, and the habitations of the sand-wasp or the mason-bee; who traced out the little lives, and discerned the vocal organs, of grasshopper and cicada; and who, together with generations of bee-keeping peasants, gathered up the lore and wisdom of the bee. There were fishermen skilled in all the cunning of their craft, who discussed the wanderings of tunny and mackerel, sword-fish or anchovy; who argued over the ages, the breeding-places, and the food of this fish or that; who knew how the smooth dogfish breeds two thousand years before Johannes Müller; who saw how the male pipe-fish carries its young before Cavolini; and who had found the nest of the nest-building rock-fishes before Gerbe rediscovered it almost in our own day. There were curious students of the cuttle-fish (I sometimes imagine they may have been priests of that sea-born goddess to whom the creatures were sacred) who had diagnosed the species, recorded the habits, and dissected the anatomy of the group, even to the discovery of that strange hectocotylus arm that baffled Delia Chiaje, Cuvier, and Koelliker, and that Verany and Heinrich Müller re-explained.

All this varied learning Aristotle gathered up and wove into his great web. But every here and there, in words that are unmistakably the master's own, we hear him speak of what are still the great problems and even the hidden mysteries of our science; of such things as the nature of variation, of the struggle for existence, of specific and generic differentiation of form, of the origin of the tissues, the problems of heredity, the mystery of sex, of the phenomena of reproduction and growth, the characteristics of habit, instinct, and intelligence, and of the very meaning of Life itself. Amid all the maze of concrete facts that century after century keeps adding to our store, these, and such as these, remain the great mysteries of natural science—the *Magnalia naturae*, to borrow a great word from Bacon, who in his turn had borrowed it from St. Paul.

Not that these are the only great problems for the biologist, nor that there is even but a single class of great problems in Biology. For Bacon himself speaks of the *magnalia naturae, quoad usus humanos*, the study of which has for its objects "the prolongation of life or the retardation of age, the curing of diseases counted incurable, the mitigation of pain, the making of new species and transplanting of one species into another," and so on through many more. Assuredly I have no need to remind you that a great feature of this generation of ours has been the way in which Biology has been justified of her children, in the work of those who have studied the *magnalia naturae, quoad usus humanos*.

But so far are biologists from being nowadays engrossed in practical questions, in applied and technical Zoology, to the neglect of its more recondite problems, that there never was a time when men thought more deeply or laboured with greater zeal over the fundamental phenomena of living things; never a time when they reflected in a broader spirit over such questions as purposive adaptation, the harmonious working of the fabric of the body in relation to environment, and the interplay of all the creatures that people the earth; over the problems of heredity and variation; over the mysteries of sex, and the phenomena of generation and reproduction, by which phenomena, as the wise woman told, or reminded, Socrates, and as Harvey said again (and for that matter, as Coleridge said, and Weismann, but not quite so well)—by which, as the wise old woman said, we gain our glimpse of insight into eternity and immortality. These, then, together with the problem of the Origin of Species, are indeed *magnalia naturae*; and I take it that inquiry into these, deep and wide research specially directed to the solution of these, is characteristic of the spirit of our time, and is the pass-word of the younger generation of biologists.

Interwoven with this high aim which is manifested in the biological work of recent years is another tendency. It is the desire to bring to bear upon our science, in greater measure than before, the methods and results of the other sciences, both those that in the hierarchy of knowledge are set above and below, and those that rank alongside of our own.

Before the great problems of which I have spoken, the cleft between Zoology and Botany fades away, for the same problems are common to the twin sciences. When the zoologist becomes a student, not of the dead, but of the living, of the vital processes of the cell rather than of the dry bones of the body, he becomes once more a physiologist, and the gulf between these two disciplines disappears. When he becomes a physiologist, he becomes, *ipso facto*, a student of chemistry and of physics. Even mathematics has been pressed into the service of the biologist, and the calculus of probabilities is not the only branch of mathematics to which he may usefully appeal.

The physiologist has long had as his distinguishing characteristic, giving his craft a rank superior to the sister branch of morphology, the fact that in his great field of work, and in all the routine of his experimental research, the methods of the physicist and the chemist, the lessons of the anatomist, and the experience of the physician are inextricably blended in one common central field of investigation and thought. But it is much more recently that the morphologist and embryologist have made use of the method of experiment, and of the aid of the physical and chemical sciences—even of the teachings of philosophy: all in order to probe into properties of the living organism that men were wont to take for granted, or to regard as beyond their reach, under a narrower interpretation of the business of the biologist. Driesch and Loeb and Roux are three among many men who have become eminent in this way in recent years, and their work we may take as typical of methods and aims such as those of which I speak. Driesch, both by careful experiment and by philosophic insight, Loeb, by his conception of the dynamics of the cell and by his marvellous demonstrations of chemical and mechanical fertilisation, Roux, with his theory of autodetermination, and by all the labours of the school of *Entwickelungsmechanik* which he has founded, have all in various ways, and from more or less different points of view, helped to reconstruct and readjust our ideas of the relations of embryological processes, and hence of the phenomenon of life itself, on the one hand to physical causes (whether external to or latent in the mechanism of the cell), or on the other to the ancient conception of a Vital Element alien to the province of the physicist.

No small number of theories or hypotheses, that seemed for a time to have been established on ground as firm as that on which we tread, have been reopened in our day. The adequacy of natural selection to explain the whole of organic evolution has been assailed on many sides; the old fundamental subject of embryological debate between the evolutionists or preformationists (of the school of Malpighi, Haller, and Bonnet) and the advocates of epigenesis (the followers of Aristotle, of Harvey, of Caspar F. Wolff, and of Von Baer) is now discussed again, in altered language, but as a pressing question of the hour; the very foundations of the cell-theory have been scrutinised to decide (for instance) whether the segmented ovum, or even the complete organism, be a colony of quasi-independent cells, or a living unit in which cell differentiation is little more than a superficial phenomenon; the whole meaning, bearing, and philosophy of evolution has been discussed by Bergson, on a plane to which neither Darwin nor Spencer ever attained; and the hypothesis of a Vital Principle, or vital element, that had lain in the background for near a hundred years, has come into men's mouths as a very real and urgent question, the greatest question for the biologist of all.

In all ages the mystery of organic form, the mystery of growth and reproduction, the mystery of thought and consciousness, the whole mystery of the complex phenomena of life, have seemed to the vast majority of men to call for description and explanation in terms alien to the language which we apply to inanimate things; though at all times there have been a few who sought, with the materialism of Democritus, Lucretius, or Giordano Bruno, to attribute most, or even all, of these phenomena to the category of physical causation.

For the first scientific exposition of Vitalism we must go back to Aristotle, and to his doctrine of the three parts of the tripartite Soul: according to which doctrine, in Milton's language, created things "by gradual change sublimed, To vital spirits aspire, to animal, To intellectual!" The first and lowest of these three, the ψυχὴ ἡ θρεπτική, by whose agency nutrition is effected, is ἡ πρώτη ψυχή, the inseparable concomitant of Life itself. It is inherent in the plant as well as in the animal, and in the Linnæan aphorism, *Vegetabilia crescunt et vivunt*, its existence is admitted in a word. Under other aspects, it is all but identical with the ψυχὴ αὐξητική and γεννητική, the soul of growth and of reproduction: and in this composite sense it is no other than Driesch's "Entelechy," the hypothetic natural agency that presides over the form and formation of the body. Just as Driesch's psychoid or psychoids, which are the basis of instinctive phenomena, of sensation, instinct, thought, reason, and all that directs that body which entelechy has formed, are no other than the αἰσθητική whereby *animalia vivunt et sentiunt*, and the διανοητική to which Aristotle ascribes the reasoning faculty of man. Save only that Driesch, like Darwin, would deny the restriction of νοῦς, or reasoning, to man alone, and would extend it to animals, it is clear, and Driesch himself admits,[1] that he accepts both the vitalism and the analysis of vitalism laid down by Aristotle.

The πνεῦμα of Galen, the *vis plastica*, the *vis vitae formatrix*, of the older physiologists, the *Bildungstrieb* of Blumenbach, the *Lebenskraft* of Paracelsus, Stahl, and Treviranus, "shaping the physical forces of the body to its own ends," "dreaming dimly in the grain of the promise of the full corn in the ear,"[2] these and many more, like Driesch's "entelechy" of to-day, are all conceptions under which successive generations strive to depict

1 "Science and Philosophy of the Organism" (Gifford Lectures), ii. p. 83, 1908.

2 *Cit.* Jenkinson (*Art.* "Vitalism" in *Hibbert Journal*, April, 1911) who has given me the following quotation: "Das Weitzenkorn hat allerdings Bewusstsein dessen was in ihm ist und aus ihm werden kann, und träümt wirklich davon. Sein Bewusstsein und seine Träume mögen dunkel genug sein"; Treviranus, "Erscheinungen und Gesetze des organischen Lebens, 831.

the something that separates the earthy from the living, the living from the dead. And John Hunter described his conception of it in words not very different from Driesch's, when he said that his principle, or agent, was independent of organisation, which yet it animates, sustains, and repairs; it was the same as Johannes Müller's conception of an innate "unconscious idea."

Even in the Middle Ages, long before Descartes, we can trace, if we interpret the language and the spirit of the time, an antithesis that, if not identical, is at least parallel to our alternative between vitalistic and mechanical hypotheses. For instance, Father Harper tells us that Suarez maintained, in opposition to St. Thomas, that in generation and development a Divine interference is postulated, by reason of the perfection of living beings; in opposition to St. Thomas, who (while invariably making an exception in the case of the human soul) urged that, since the existence of bodily and natural forms consists solely in their union with matter, the ordinary agencies which operate on matter sufficiently account for them.[1]

But in the history of modern science, or of modern physiology, it is, of course, to Descartes that we trace the origin of our mechanical hypotheses—to Descartes, who, imitating Archimedes, said, "Give me matter and motion, and I will construct the universe." In fact, leaving the more shadowy past alone, we may say that it is since Descartes watched the fountains in the garden, and saw the likeness between their machinery of pumps and pipes and reservoirs and the organs of the circulation of the blood, and since Vaucanson's marvellous automata lent plausibility to the idea of a "living automaton"—it is since then that men's minds have been perpetually swayed by one or other of the two conflicting tendencies, either to seek an explanation of the phenomena of living things in physical and mechanical considerations, or to attribute them to unknown and mysterious causes, alien to physics and peculiarly concomitant with life. And some men's temperaments, training, and even avocations, render them more prone to the one side of this unending controversy, as the minds of other men are naturally more open to the other. As Kühne said a few years ago at Cambridge, the physiologists have been found for several generations leaning, on the whole, to the mechanical or physico-chemical hypothesis, while the zoologists have been very generally on the side of the Vitalists.

The very fact that the physiologists were trained in the school of physics, and the fact that the zoologists and botanists relied for so many years upon the vague, undefined force of "heredity" as sufficiently accounting for the development of the organism, an intrinsic force the results of which could be studied, but the nature of which seemed remote from possible analysis or explanation—these facts alone go far to illustrate and to justify what Kühne said.

Claude Bernard held that mechanical, physical, and chemical forces summed up all with which the physiologist has to deal. Verworn defined physiology as "the chemistry of the proteids"; and I think that another physiologist (but I forget who) has declared that the mystery of life lay hidden in "the chemistry of the enzymes." But of late, as Dr. Haldane showed in his address a couple of years ago to the Physiological Section, it is among the physiologists themselves, together with the embryologists, that we find the strongest indications of a desire to pass beyond the horizon of Descartes, and to avow that physical and chemical methods, the methods of Helmholtz, Ludwig, and Claude Bernard, fall short of solving the secrets of physiology. On the other hand, in zoology, resort to the method of experiment—the discovery, for instance, of the wonderful effects of chemical or even mechanical stimulation in starting the development of the egg—and again the ceaseless search into the minute structure, or so-called mechanism, of the cell—these, I think, have rather tended to sway a certain number of zoologists in the direction of the mechanical hypothesis.

[1] "Cum formarum naturalium et corporalium esse non consistat nisi in unione ad materiam; ejusdem agentis esse videtur eas producere, cujus est materiam transmutare. Secundo, quia cum hujusmodi formae non excedant virtutem et ordinem et facultatem principiorum agentium in natura, nulla videtur necessitas eorum originem in principia reducere altiora.—Aquinas, *De Pot.* Q. iii., a. 11: cf. Harper, "Metaphysics of the School," iii. 1, p. 152.

But, on the whole, I think it is very manifest that there is abroad on all sides a greater spirit of hesitation and caution than of old, and that the lessons of the philosopher have had their influence on our minds. We realise that the problem of development is far harder than we had begun to let ourselves suppose: that the problems of organogeny and phylogeny (as well as those of physiology) are not comparatively simple and well-nigh solved, but are of the most formidable complexity. And we would, most of us, confess, with the learned author of "The Cell in Development and Inheritance," "that we are utterly ignorant of the manner in which the substance of the germ-cell can so respond to the influence of the environment as to call forth an adaptive variation; and again, that the gulf between the lowest forms of life and the inorganic world is as wide as, if not wider than, it seemed a couple of generations ago."[1]

While we keep an open mind on this question of Vitalism, or while we lean, as so many of us now do, or even cling with a great yearning, to the belief that something other than the physical forces animates and sustains the dust of which we are made, it is rather the business of the philosopher than of the biologist, or of the biologist only, when he has served his humble and severe apprenticeship to philosophy, to deal with the ultimate problem. It is the plain bounden duty of the biologist to pursue his course, unprejudiced by vitalistic hypotheses, along the road of observation and experiment, according to the accepted discipline of the natural and physical sciences; indeed, I might perhaps better say the physical sciences alone, for it is already a breach of their discipline to invoke, until we feel we absolutely must, that shadowy force of "heredity" to which, as I have already said, biologists have been accustomed to ascribe so much. In other words, it is an elementary scientific duty; it is a rule that Kant himself laid down[2] that we should explain, just as far as we possibly can, all that is capable of such explanation in the light of the properties of matter and of the forms of energy with which we are already acquainted.

It is of the essence of physiological science to investigate the manifestations of energy in the body, and to refer them, for instance, to the domains of heat, electricity, or chemical activity. By this means a vast number of phenomena, of chemical and other actions of the body, have been relegated to the domain of physical science and withdrawn from the mystery that still attends on life: and by this means, continued for generations, the physiologists, or certain of them, now tell us that we begin again to descry the limitations of physical inquiry, and the region where a very different hypothesis insists on thrusting itself in. But the morphologist has not gone nearly so far as the physiologist in the use of physical methods. He sees so great a gulf between the crystal and the cell, that the very fact of the physicist and the mathematician being able to explain the form of the one, by simple laws of spatial arrangement where molecule fits into molecule, seems to deter, rather than to attract, the biologist from attempting to explain organic forms by mathematical or physical law. Just as the embryologist used to explain everything by heredity, so the morphologist is still inclined to say—"the thing is alive, its form is an attribute of itself, and the physical forces do not apply." If he does not go so far as this, he is still apt to take it for granted that the physical forces can only to a small and even insignificant extent blend with the intrinsic organic forces in producing the resultant form. Herein lies our question in a nutshell. Has the morphologist yet sufficiently studied the forms, external and internal, of organisms in the light of the properties of matter, of the energies that are associated with it, and of the forces by which the actions of these energies may be interpreted and described? Has the biologist, in short, fully recognised that there is a borderland, not only between physiology and physics, but between morphology and physics, and that the physicist may, and must, be his guide and teacher in many matters regarding organic form?

Now this is by no means a new subject, for such men as Berthold and Errera, Rhumbler and Dreyer, Bütschli and Verworn, Driesch and Roux, have already dealt or

[1] Wilson, *op. cit.* 1906, p. 434. [2] In his "Critique of Teleological Judgment."

deal with it. But on the whole it seems to me that the subject has attracted too little attention, and that it is well worth our while to think of it to-day.

The first point, then, that I wish to make in this connection is that the Form of any portion of matter, whether it be living or dead, its form and the changes of form that are apparent in its movements and in its growth, may in all cases alike be described as due to the action of Force. In short, the form of an object is a "diagram of forces"—in this sense, at least, that from it we can judge of or deduce the forces that are acting or have acted upon it; in this strict and particular sense it is a diagram; in the case of a solid, of the forces that *have* been impressed upon it when its conformation was produced, together with those that enable it to retain its conformation; in the case of a liquid (or of a gas), of the forces that are for the moment acting on it to restrain or balance its own inherent mobility. In an organism, great or small, it is not merely the nature of the *motions* of the living substance that we must interpret in terms of Force (according to Kinetics), but also the *conformation* of the organism itself, whose permanence or equilibrium is explained by the interaction or balance of forces, as described in Statics.

If we look at the living cell of an Amœba or a Spirogyra we see a something which exhibits certain active movements, and a certain fluctuating, or more or less lasting, form; and its form at a given moment, just like its motions, is to be investigated by the help of physical methods, and explained by the invocation of the mathematical conception of force.

Now the state, including the shape or form, of a portion of matter is the resultant of a number of forces, which represent or symbolise the manifestations of various kinds of Energy; and it is obvious, accordingly, that a great part of physical science must be understood or taken for granted as the necessary preliminary to the discussion on which we are engaged.

I am not going to attempt to deal with, or even to enumerate, all the physical forces or the properties of matter with which the pursuit of this subject would oblige us to deal—with gravity, pressure, cohesion, friction, viscosity, elasticity, diffusion, and all the rest of the physical factors that have a bearing on our problem. I propose only to take one or two illustrations from the subject of *surface-tension*, which subject has already so largely engaged the attention of the physiologists. Nor will I even attempt to sketch the general nature of this phenomenon, but will only state (as I fear for my purpose I must) a few of its physical manifestations or laws. Of these, the most essential facts for us are as follows:—Surface-tension is manifested only in fluid or semi-fluid bodies, and only at the surface of these: though we may have to interpret surface in a liberal sense in cases where the interior of the mass is other than homogeneous. Secondly, a fluid may, according to the nature of the substance with which it is in contact, or (more strictly speaking) according to the distribution of energy in the system to which it belongs, tend either to spread itself out in a film, or, conversely, to contract into a drop, striving in the latter case to reduce its surface to a minimal area. Thirdly, when three substances are in contact (and subject to surface-tension), as when water surrounds a drop of protoplasm in contact with a solid, then at any and every point of contact certain definite angles of equilibrium are set up and maintained between the three bodies, which angles are proportionate to the magnitudes of the surface-tensions existing between the three. Fourthly, a fluid film can only remain in equilibrium when its curvature is everywhere constant. Fifthly, the only surfaces of revolution which meet this condition are six in number, of which the plane, the sphere, the cylinder, and the so-called unduloid and catenoid are the most important. Sixthly, the cylinder cannot remain in free equilibrium if prolonged beyond a length equal to its own circumference, but, passing through the unduloid, tends to break up into spheres: though this limitation may be counteracted or relaxed, for instance, by viscosity. Finally, we have the curious fact that, in a complex system of films, such as a homogeneous froth of bubbles, three partition-walls and no more always meet at a crest, at equal angles, as, for instance, in the very simple case of a layer of uniform hexagonal cells; and (in a solid system) the crests, which may be straight or curved, always meet, also at equal angles, four by four, in a common point. From these physical facts, or laws, the morphologist, as well as the physiologist, may draw important consequences.

It was Hofmeister who first showed, more than forty years ago, that when any drop of protoplasm, either over all its surface or at some free end (as at the tip of the pseudopodium of an Amœba), is seen to "round itself off," that is not the effect of physiological or vital contractility, but is a simple consequence of surface-tension—of the law of the minimal surface; and in the physiological side, Engelmann, Bütschli, and others have gone far in their development of the idea.

It was Plateau, I think, who first showed that the myriad sticky drops or beads upon the weft of a spider's web, their form, their size, their distance apart, and the presence of the tiny intermediate drops between, were in every detail explicable as the result of surface-tension, through the law of minimal surface and through the corollary to it which defines the limits of stability of the cylinder; and, accordingly, that with their production, the will or effort or intelligence of the spider had nothing to do. The beaded form of a long, thin pseudopodium, for instance, of a Heliozoan, is an identical phenomenon.

It was Errera who first conceived the idea that not only the naked surface of the cell, but the contiguous surfaces of two naked cells, or the delicate incipient cell-membrane or cell-wall between, might be regarded as a weightless film, whose position and form were assumed in obedience to surface-tension. And it was he who first showed that the symmetrical forms of the unicellular and simple multicellular organisms, up to the point where the development of a skeleton complicates the case, were one and all identical with the plane, sphere, cylinder, unduloid and catenoid, or with combinations of these.

It was Berthold and Errera who, almost simultaneously, showed (the former in far the greater detail) that in a plant each new cell-partition follows the law of minimal surface, and tends (according to another law which I have not particularised) to set itself at right angles to the preceding solidified wall, so giving a simple and adequate physical explanation of what Sachs had stated as an empirical morphological rule. And Berthold further showed how, when the cell-partition was curved, its precise curvature, as well as its position, was in accordance with physical law.

There are a vast number of other things that we can satisfactorily explain on the same principle and by the same laws. The beautiful catenary curve of the edge of the pseudopodium, as it creeps up its axial rod in a Heliozoan or a Radiolarian, the hexagonal mesh of bubbles, or vacuoles, on the surface of the same creatures, the form of the little groove that runs round the waist of a Peridinian, even (as I believe) the existence, form, and undulatory movements of the undulatory membrane of a Trypanosome, or of that around the tail of the spermatozoon of a newt—every one of these, I declare, is a case where the resultant form can be well explained by, and cannot possibly be understood without, the phenomena of surface-tension; indeed, in many of the simpler cases the facts are so well explained by surface-tension that it is difficult to find place for a conflicting, much less an over-riding, force.

I believe, for my own part, that even the beautiful and varied forms of the Foraminifera may be ascribed to the same cause; but here the problem is just a little more complex, by reason of the successive consolidations of the shell. Suppose the first cell or chamber to be formed, assuming its globular shape in obedience to our law, and then to secrete its calcareous envelope. The new growing bud of protoplasm, accumulating outside the shell, will, in strict accordance with the surface-tensions concerned, either fail to "wet" or to adhere to the first-formed shell, and will so detach itself as a unicellular individual (Orbulina), or else it will flow over a less or greater part of the original shell until its free surface meets it at the required angle of equilibrium. Then, according to this angle, the second chamber may happen to be all but detached

(Globigerina), or, with all intermediate degrees, may very nearly wholly enwrap the first. Take any specific angle of contact and presume the same conditions to be maintained, and therefore the same angle to be repeated, as each successive chamber follows on the one before, and you will thereby build up regular forms, spiral or alternate, that correspond with marvellous accuracy to the actual forms of the Foraminifera. And this case is all the more interesting, because the allied and successive forms so obtained differ only in degree in the magnitude of a single physical or mathematical factor; in other words, we get not only individual phenomena, but lines of apparent *orthogenesis*, that seem explicable by physical laws, and attributable to the continuity between successive states in the continuous or gradual variation of a physical condition. The resemblance between allied and related forms, as Hartmann demonstrated and Giard admitted years ago, is not always, however often, to be explained by common descent and parentage.[1]

In the segmenting egg we have the simpler phenomenon of a "laminar system," uncomplicated by the presence of a solid framework; and here, in the earliest stages of segmentation, it is easy to see the correspondence of the planes of division with what the laws of surface-tension demand. For instance, it is not the case (though the elementary books often represent it so) that when the totally segmenting egg has divided into four segments, the four partition walls ever remain in contact at a single point; the arrangement would be unstable, and the position untenable. But the laws of surface-tension are at once seen to be obeyed when we recognise the little *cross-furrow* that separates the blastomeres, two and two, leaving in each case three only to meet at a point in our diagram, which point is in reality a section of a ridge or crest.

Very few have tried, and one or two (I know) have tried and not succeeded, to trace the action and the effects of surface-tension in the case of a highly complicated, multi-segmented egg. But it is not surprising if the difficulties which such a case presents appear to be formidable. Even the conformation of the interior of a soap-froth, though absolutely conditioned by surface-tension, presents great difficulties, and it was only in the last years of Lord Kelvin's life that he showed all previous workers to have been in error regarding the form of the interior cells.

But what, for us, does all this amount to? It at least suggests the possibility of so far supporting the observed facts of organic form on mathematical principles as to bring morphology within or very near to Kant's demand that a true natural science should be justified by its relation to mathematics.[2] But if we were to carry these principles further, and to succeed in proving them applicable in detail, even to the showing that the manifold segmentation of the egg was but an exquisite froth, would it wholly revolutionise our biological ideas? It would greatly modify some of them, and some of the most cherished ideas of the majority of embryologists; but I think that the way is already paved for some such modification. When Loeb and others have shown us that half, or even a small portion, of an egg, or a single one of its many blastomeres, can give rise to an entire embryo, and that in some cases *any* part of the ovum can originate *any* part of the organism, surely our eyes are turned to the *energies* inherent in the matter of the egg (not to speak of a presiding entelechy), and away from its original formal operations of division. Sedgwick has told us for many years that we look too much to the individuality of the individual cell, and that the organism, at least in the embryonic body, is a continuous syncytium. Hofmeister and Sachs have repeatedly told us that in the plant, the growth of the mass, the growth of the organ, is the primary fact; and De Bary has summed up the matter in his aphorism, *Die Pflanze bildet Zellen, nicht die Zelle bildet Pflanzen*. And in many other ways, as many of you are well aware, the extreme position of the cell-theory, that the cells are the ultimate individuals, and that the organism is but a colony of quasi-independent cells, has of late years been called in question.

There are no problems connected with Morphology that appeal so closely to my mind, or to my temperament, as those that are related to mechanical considerations, to mathematical laws, or to physical and chemical processes.

I love to think of the logarithmic spiral that is engraven over the grave of that great anatomist, John Goodsir (as it was over that of the greatest of the Bernouillis), so graven because it interprets the form of every molluscan shell, of tusk and horn and claw, and many another organic form besides. I like to dwell upon those lines of mechanical stress and strain in a bone that give it its strength where strength is required, that Hermann Meyer and J. Wolff described, and on which Roux has bestowed some of his most thoughtful work; or on the "stream-lines" in the bodily form of fish or bird, from which the naval architect and the aviator have learned so much. I admire that old paper of Peter Harting's in which he paved the way for investigation of the origin of spicules, and of all the questions of crystallisation or pseudo-crystallisation in presence of colloids, on which subject Lehmann has written his recent and beautiful book. I sympathise with the efforts of Henking, Rhumbler, Hartog, Gallardo, Leduc, and others to explain on physical lines the phenomena of nuclear division. And, as I have said to-day, I believe that the forces of surface-tension, elasticity, and pressure are adequate to account for a great multitude of the simpler phenomena, and the permutations and combinations thereof, that are illustrated in organic Form.

I should gladly and easily have spent all my time this morning in dealing with these questions alone. But I was loath to do so, lest I should seem to overrate their importance, and to appear to you as an advocate of a purely mechanical biology.

I believe all these phenomena to have been unduly neglected, and to call for more attention than they have received. But I know well that though we push such explanations to the uttermost, and learn much in the so doing, they will not touch the heart of the great problems that lie deeper than the physical plane. Over the ultimate problems and causes of vitality, over what is implied in the organisation of the living organism, we shall be left wondering still.

To a man of letters and the world like Addison, it came as a sort of revelation that Light and Colour were not objective things, but subjective, and that back of them lay only motion or vibration, some simple activity. And when he wrote his essay on these startling discoveries, he found for it, from Ovid, a motto well worth bearing in mind, *causa latet, vis est notissima*. We may with advantage recollect it when we seek and find the Force that produces a direct Effect, but stand in utter perplexity before the manifold and transcendent meanings of that great word "cause."

The similarity between organic forms and those that physical agencies are competent to produce still leads some men, such as Stéphane Leduc, to doubt or to deny that there is any gulf between, and to hold that spontaneous generation or the artificial creation of the living is but a footstep away. Others, like Delage and many more, see in the contents of the cell only a complicated chemistry, and in variation only a change in the nature and arrangement of the chemical constituents; they either cling to a belief in "heredity," or (like Delage himself) replace it more or less completely by the effects of functional use and by chemical stimulation from without and from within. Yet others, like Felix Auerbach, still holding to a physical or quasi-physical theory of life, believe that in the living body the dissipation of energy is controlled by a guiding principle, as though by Clerk Maxwell's demons; that for the living the Law of Entropy is thereby reversed; and that Life itself is that which has been evolved to counteract and battle with the dissipation of energy. Berthold, who first demonstrated the obedience to physical laws in the fundamental phenomena of the dividing cell or segmenting egg, recognises, almost in the words of John Hunter, a quality in the living protoplasm, *sui generis*, whereby its maintenance, increase, and reproduction are achieved. Driesch, who began as a "mechanist," now, as we have

[1] Cf. Giard, "Discours inaugurale." *Bull. Scientif.* (3), 1, 1888.

[2] "Ich behaupte aber dass in jeder besonderen Naturlehre nur so viel *eigentliche* Wissenschaft angetroffen werden konne, als darin Mathematik anzutreffen ist."—Kant, in Preface to "Metaphys. Anfangsgründe der Naturwissenschaft" (Werke, ed. Hartenstein, vol. iv. p. 360).

seen, harks back straight to Aristotle, to a twin or triple doctrine of the soul. And Bergson, rising into heights of metaphysics where the biologist, *qua* biologist, cannot climb, tells us (like Duran) that life transcends teleology, that the conceptions of mechanism and finality fail to satisfy, and that only "in the absolute do we live and move and have our being."

We end but a little way from where we began.

With all the growth of knowledge, with all the help of all the sciences impinging on our own, it is yet manifest, I think, that the biologists of to-day are in no self-satisfied and exultant mood. The reasons and the reasoning that contented a past generation call for reinquiry, and out of the old solutions new questions emerge; and the ultimate problems are as inscrutable as of old. That which, above all things, we would explain, baffles explanation; and that the living organism is a living organism tends to reassert itself as the biologist's fundamental conception and fact. Nor will even this concept serve us and suffice us when we approach the problems of consciousness and intelligence and the mystery of the reasoning soul; for these things are not for the biologist at all, but constitute the Psychologist's scientific domain.

In Wonderment, says Aristotle, does philosophy begin,[1] and more than once he rings the changes on the theme. Now, as in the beginning, wonderment and admiration are the portion of the biologist, as of all those who contemplate the heavens and the earth, the sea, and all that in them is.

And if Wonderment springs, as again Aristotle tells us, from ignorance of the causes of things, it does not cease when we have traced and discovered the proximate causes, the physical causes, the Efficient Causes of our phenomena. For beyond and remote from physical causation lies the End, the Final Cause of the philosopher, the reason Why, in the which are hidden the problems of organic harmony and autonomy and the mysteries of apparent purpose, adaptation, fitness, and design. Here, in the region of teleology, the plain rationalism that guided us through the physical facts and causes begins to disappoint us, and Intuition, which is of close kin to Faith, begins to make herself heard.

And so it is that, as in Wonderment does all philosophy begin, so in Amazement does Plato tell us that all our philosophy comes to an end.[2] Ever and anon, in presence of the *magnalia naturae*, we feel inclined to say with the poet:

> οὐ γάρ τι νῦν τε κἀχθές, ἀλλ' ἀεί ποτε
> ζῇ ταῦτα, κοὐδεὶς οἶδεν ἐξ ὅτου 'φάνη.

"These things are not of to-day nor yesterday, but evermore, and no man knoweth whence they came."

I will not quote the noblest words of all that come into my mind, but only the lesser language of another of the greatest of the Greeks: "The ways of His thoughts are as paths in a wood thick with leaves, and one seeth through them but a little way."

SECTION E.

GEOGRAPHY.

OPENING ADDRESS BY COLONEL C. F. CLOSE, C.M.G., R.E., PRESIDENT OF THE SECTION.

I PROPOSE to devote the first part of this address to an examination of the purpose and position of Geography, with special reference to its relations with other subjects. It will not be possible entirely to avoid controversial matters; but, if some of the questions touched on are controversial, this only means that these questions have a certain importance. I shall try to describe the facts of the case impartially.

In the second part I shall try to indicate briefly what the Government, as represented by the great Departments of State, is doing for Geography.

PART I. *The Position of Geography with reference to other Subjects.*

It is no secret that the geographical world is not unanimous about the meaning and object of Geography. The definitions suggested by such writers as Mr. Chisholm, Prof. Davis, Prof. Herbertson, Mr. Mackinder, or Dr. Mill, are not in agreement. From time to time an attempt is made to formulate some statement which shall not commit the subscribers to anything very definite. But differences of opinion on the subject persist.

There are, of course, a great many ways of approaching the question. Let us, for example, examine the proceedings of such representative bodies as the British Association and the Royal Geographical Society, and of such assemblies as the International Geographical Congresses, and let us see if we can find out what is, as a fact, the scope of the subject as dealt with by these bodies. They are institutions which work in the full light of day, and they are too large to be dominated for any length of time by individuals. If we can find any working principle, any common term, amongst these societies, we shall have gone some way towards arriving at a solution of the problem.

A simple method of investigation is to discuss the character of the publications of these societies and of the lectures delivered before them. And I feel that I cannot do better than devote most of this brief analysis to the Royal Geographical Society and its admirably edited Journal. Here we are on safe ground. If an inhabitant of another planet wished to know what we understand by astronomy we could confidently refer him to the Monthly Notices of the Royal Astronomical Society. If he were curious about the condition of geology, we should give him the volumes of the Geological Society. And, if he were so rash as to ask what are the objects of the modern mathematician, we should hand him the papers published by the London Mathematical Society. The "Geographical Journal" occupies no lower a position with reference to Geography than do the other journals mentioned with reference to the sciences with which they deal.

In analysing the contributions to the Royal Geographical Society, it is important to start with an honest classification. In the endeavour to be impartial I have chosen the classification which was adopted for the last International Geographical Congress, *i.e.* that held at Geneva in 1908. This Congress was divided into fourteen sections. It will serve to clear the ground if we deal first with sections 12, 13, and 14; these are the Teaching of Geography, Historical Geography (which was mainly concerned with the history of travel and exploration), and Rules and Nomenclature. For the purpose of discovering what Geography is, these three sections will not be of any assistance. Every subject has its educational side, its history, and its rules and nomenclature. The subject proper was, therefore, divided into eleven sections. The eleven sections are the following:—

(1) Mathematical and Cartographical Geography.
(2) General Physical Geography.
(3) Vulcanology and Seismology.
(4) Glaciers.
(5) Hydrography (Potamography and Limnology).
(6) Oceanography.
(7) Meteorology and Climatology; Terrestrial Magnetism.
(8) Biological Geography.
(9) Anthropology and Ethnography.
(10) Economic and Social Geography.
(11) Explorations.

Before applying this classification to the work of the Geographical Society, I wish to call attention to the extremely frank way in which vulcanology, seismology, meteorology, climatology, terrestrial magnetism, anthropology, and ethnography are included in Geography. The list, in fact, covers ground occupied by several sections of the British Association.

I have investigated the work of the Geographical Society for the five complete years 1906 to 1910. The original contributions to the "Geographical Journal" have been examined for that period, omitting from consideration contributions on the subjects of teaching, the history of exploration, and rules and nomenclature.

There are altogether 296 original papers which come under one or another of the eleven headings given above. Of these papers, 171, or 57 per cent., deal with Explorations and Travels. There is a great drop to the next largest section, General Physical Geography, which

[1] "Met." I., 2,982b, 12, &c.
[2] Cf. Coleridge, "Biogr. Lit."

accounts for thirty papers, or about 10 per cent. Adhering to the order of the Geneva Congress, the complete list is as follows:—

Original Contributions to the Proceedings of the Royal Geographical Society during the five years 1906 *to* 1910.

Subject	Percentage
(1) Mathematical and Cartographical Geography	3
(2) General Physical Geography	10
(3) Vulcanology and Seismology	5
(4) Glaciers	3
(5) Hydrography (Potamography and Limnology)	5
(6) Oceanography	3
(7) Meteorology and Climatology; Terrestrial Magnetism	3
(8) Biological Geography	1
(9) Anthropology and Ethnography...	3
(10) Economic and Social Geography	7
(11) Explorations	57

The main conclusion is obvious enough. For the principal Geographical Society in the world, Geography is still mainly an affair of explorations and surveys; if to this item we add cartography, we account for 60 per cent. of the activities of the Society.

There is another important deduction which is natural and unforced: the papers on vulcanology and seismology and on glaciers could have been read with perfect appropriateness before the Geological Society; those on meteorology and climatology before the Meteorological Society; and those on anthropology and ethnography before the Anthropological Society. To make quite sure of this point I will cite a few titles of the papers read: "The Great Tarawera Volcanic Rift," by J. M. Bell; "Recent Earthquakes," by R. D. Oldham; "Glacial History of Western Europe," by Prof. T. G. Bonney; "Climatic Features of the Pleistocene Ice Age," by Prof. A. Penck; "Rainfall of British East Africa," by G. B. Williams; "Geographical Distribution of Rainfall in the British Isles," by Dr. H. R. Mill; "Geographical Conditions affecting Population in the East Mediterranean Lands," by D. G. Hogarth; "Tribes of North-Western Se-Chuan," by W. N. Fergusson.

This little list of typical subjects indicates clearly that there is a large group of contributions which would have found an appropriate home in the journals of the Geological, Meteorological, and Anthropological Societies; there is a possible corollary that, since men who make a life-study of these subjects are best capable of dealing with them, the authors of the above type of paper who submit their work to the Geographical Society in so doing appeal rather to the public at large than to men of their own special sciences.

We may therefore sum up the results of this brief investigation into the work of the Royal Geographical Society by saying that 60 per cent. of it is concerned with exploration and mapping, and that some of the remainder could be dealt with appropriately by the learned societies concerned, but that the Geographical Society serves as a popularising medium. It also serves a useful purpose as a common meeting-ground for vulcanologists, seismologists, oceanographers, meteorologists, climatologists, anthropologists, and ethnographers.

Another line of investigation may be profitably pursued. Who are, by common consent, the leading geographers of the world? No doubt the explorers come first in popular estimation, such men (omitting British names) as Peary, Charcot, Sven Hedin. Then after this type would come the men of learning who stand out in any International Congress. These men stand out because they have, by their own exertions, increased the sum of human knowledge. Omitting, for the moment, the consideration of exploration and mapping, we find that in an international congress a large number of the most celebrated geographers are eminent as geologists. In such a gathering we can also pick out those who have advanced the sciences of meteorology or anthropology. Now, suppose the position reversed. Let the functions of geology be supposed to be somewhat in dispute and those of geography perfectly definite, and further let us suppose that at an international meeting of geologists a large proportion of the men of real distinction were geographers. We may in this way get an idea of what geography looks like from the outside.

I think that at this point we may explain, in a preliminary way, the work of the Geographical societies, after the fashion of the "Child's Guide to Knowledge":—

Question. What is Geography?

Answer. There is no generally accepted definition of Geography.

Question. Can we not form some idea of the scope of the subject by considering the work of the Royal Geographical Society?

Answer. Yes; 60 per cent. of this work deals with explorations, surveys, and mapping, and of the rest a considerable portion consists of matter which could be discussed appropriately before the Geological, Meteorological, and Anthropological Societies.

Question. What, then, leaving maps out of consideration, are the useful functions of a Geographical society?

Answer. A Geographical society serves to popularise the work of men who labour in certain fields of science, and such a society forms a very convenient meeting-ground for them.

Question. What is a geographer?

Answer. The term geographer is sometimes applied to explorers; sometimes to men who compile books derived mainly from the labours of surveyors, geodesists, geologists, climatologists, ethnographers, and others; sometimes to those who compile distributional maps.

Question. Can a geographer who has not made a special study of one or more of such subjects as geodesy, surveying, cartography, geology, climatology, or ethnography, hope to advance human knowledge?

Answer. He can do much to popularise these subjects, but he cannot hope to do original work.

Another way of attempting to ascertain the meaning and object of Geography is to study the character of the instruction given in the universities, and we may suppose that this can be fairly judged by the contents of standard text-books. Let us take, for example, the "Traité de Géographie Physique" of M. E. de Martonne, formerly Professor of Geography at the University of Lyons, now Professor at the Sorbonne. The work in question was published in 1909, and is divided into four main sections—Climate, Hydrography, Terrestrial Relief, and Biogeography.

The first sentence of the book is "What is Geography?" Twenty-four pages are devoted to discussing this question, which the writer, with all his skill and learning, finds it difficult to answer definitely and convincingly. One receives the impression of the dexterous handling of a difficult question, and of a generally defensive attitude. In this book geography is said to depend on three principles. The principle of *extension*, the principle of *coordination*, and the principle of *causality*. As an illustration of the meaning of the principle of extension, we are told that "the botanist who studies the organs of a plant, its conditions of life, its position in classification, is not doing geographical work; but if he seeks to determine its area of extension, *il fait de la géographie botanique*." I believe that we have here reached a critical point. The claim is, that when, in the prosecution of a botanical study, a map is used to show the distribution of a plant, the use of such a map converts the study into a branch of geography. Well, it is a question of definition and convention, which cannot, I imagine, be settled except by the general agreement of all the sciences. We have to make up our minds whether a man who constructs a distributional map is doing "geography." One thing, I suppose, is not doubtful. When the map is made it will be better interpreted by a botanist than by a person ignorant of botany. In the same way the discussion of an ordinary geological map is best undertaken by a geologist, and so on. It would appear that geography, in the sense mentioned, is not so much a subject as a method of research.

It will be convenient here to say a few words about the relations between societies and schools of Geography, and those two important subjects geodesy and geology. Curiously enough, there is not, and has never been, in the United Kingdom a society or body specially charged with the study of geodesy. Geodesy, in fact, has no regular home in these islands. But the Royal Geographical Society has done a good deal in the past few years to stimulate an interest in the subject, thereby fulfilling what I believe to be one of the Society's most useful functions, that of popularisation.

If, however, an authoritative opinion were required on any geodetic question, where could it be obtained? Well, I suppose there is no doubt that the headquarters of this branch of learning is the International Geodetic Association; but the scientific work itself is being largely carried out at the Geodetic Institute at Potsdam, by the Survey of India, by the Geodetic Section of the Service Géographique, by the U.S. Coast and Geodetic Survey, and by similar bodies. Geodesy, especially in its later developments, is a definitely scientific subject which demands much study and application. It is but slightly touched upon by the schools of Geography. Perhaps I may here point out that geodesy is by no means mainly concerned with the shape of the spheroid. The chief problems are now those of isostasy and local attraction generally, the real shape of the sea-surface, the continuity of the crust of the earth, and changes of density therein.

The position in which Geography finds itself with regard to Geology can be clearly seen if reference is made to the new edition of the "Encyclopædia Britannica." In the eleventh volume of this work are two important articles, "Geography," by Dr. H. R. Mill, and "Geology," by Sir Archibald Geikie. In the article on "Geography" we find a description of geomorphology as that part of Geography which deals with terrestrial relief, and a remark is made that "opinion still differs as to the extent to which the geographer's work should overlap that of the geologist." In this article, however, most of the authorities quoted are geologists, and the author remarks that "the geographers who have hitherto given most attention to the forms of the land have been trained as geologists."

Turning to the article on "Geology," we find an important section on "Physiographical Geology," which is described as dealing with the investigation of "the origin and history of the present topographical features of the land." Now this is the exact field claimed for geomorphology. It has been observed by others, notably by Prof. de Martonne, that the interpretation of topographic forms has been most successfully undertaken by geologists, and he gives as an instance of this the good work done by the United States Geological Survey.

I do not know whether any geographer untrained as a geologist has contributed anything of value to geomorphology.

Another test which may be applied is the following: Let us imagine Geography to be non-existent, and note what the effect would be. Suppose there were no such things as Government Geographical Services, or Schools of Geography at the Universities, or Geographical Societies. The first and most obvious result would be that most, if not all, of our apparatus of exploration and mapping would have disappeared. But as we are all in agreement as to the necessity of this branch of human effort, let us restore this to existence and examine the effect of the disappearance of the rest.

So far as concerns geodesy, we should still possess the International Geodetic Association, the Geodetic Institute at Potsdam, and the United States Geodetic Survey, and similar bodies. But we should have lost the means of popularising geodesy in the proceedings of Geographical Societies; and, as there would be now no geographical text-books, elementary geodesy would not find itself between the same covers as climatology and geomorphology.

As regards geomorphology, or physiographical geology, not very much difference would be noted. The geologists would still pursue this important subject; but here again their writings would perhaps appeal to a more expert and less popular audience, although it is not to be forgotten that many admirable introductions to the subject have been written by geologists.

Much the same might be said about meteorology and climatology. There would be text-books devoted to these studies, but there might be a diminution of popular interest.

Such names as phyto-geography would disappear, but the study of botany (if we permit it the use of distributional maps) would not be affected. The loss to knowledge would be mainly that of getting to a certain extent out of touch with the public. The constitutions of the various learned bodies would remain the same, and so would their functions. The constitution of the Royal Society, which has never recognised geography as a subject, would be totally unaffected.

If we thus study the relations between Geography and other subjects we are almost bound to arrive at the conclusion that Geography is not a unit of science in the sense in which geology, astronomy, or chemistry are units. If we inquire into the current teaching of Geography, and examine modern text-books, we find that most of the matter is derived directly from the workers in other fields of study. And if we inquire into the products of Geographical societies, it becomes evident that one of the most important functions fulfilled by these useful bodies is to popularise the work of geodesists, geologists, climatologists, and others, and to provide a common meeting-ground for them. If Geography had been able to include geology and the other sciences which deal with earth-knowledge, it would then, indeed, have been a master science. But things have worked out differently.

I shall very probably be told that, in laying some stress on the above-mentioned aspects of the subject, I have forgotten that the main purpose of Geography is the study of the earth as the home of man, or the study of man as affected by his environment, and that, however necessary it may be to begin with a foundation of geodesy, geology, and climatology, we must have as our main structure the investigation of the effect of place conditions on the races of man, on human history and human industry, on economics and politics.

It is obviously and abundantly true that no student of history, economics, or politics can disregard the effect of geographical environment. But it is not, as a fact, disregarded by writers on these subjects. The question is, to a large extent, whether we should annex these portions of their studies, group them, and label them "Geography." Our right to do this will depend on the value of our own original investigations. We have the right to use the results obtained by others, provided that we add something valuable of our own.

Before this human aspect of geography—or, for that matter, any other aspect of the subject—is recognised by the world of science as an independent, indispensable, and definite branch of knowledge, it must prove its independence and value by original, definite, and, if possible, quantitative research.

Part II. *Geography and the Government Departments.*

Whatever definition of Geography is accepted, we are all in agreement that the map is the essential foundation of the subject. I propose now to indicate very briefly how the British Government, as represented by the great Departments of State, is, in this respect, assisting the cause of Geography. The Departments which are interested in maps and surveys are the following:—The Admiralty, the War Office, the Colonial Office, the India Office, the Board of Agriculture, and the Foreign Office.

The immense services rendered, not only to this country, but to the whole world, by the Hydrographic Department of the Admiralty are known to all. But it would be somewhat rash of a soldier to talk about hydrographic surveys, so I will confine my remarks to surveys on land.

First, it should be remarked that the British Government as a whole has for many years shown its interest in Geography, and has recognised the good work done by the Royal Geographical Society by contributing an annual sum of 500*l.* towards the funds of the Society. Next, it should be noted that from time to time British Governments have contributed large sums of money towards Arctic and Antarctic exploration. The most recent examples of this very practical form of encouragement will be remembered by all; I mean the Government expenditure on Scott's first Antarctic Expedition and the handsome sum contributed towards the cost of Shackleton's great journey.

Turning now to the *War Office*, the first matter to which I would call attention is that nearly all the accurate topographical surveys of the Empire have been started by soldiers. This applies to the United Kingdom, Canada, Australia, South Africa, Tropical Africa, and last, but greatest of all, India. The accounts of the struggles of soldiers at the end of the eighteenth century to obtain sanction for what is now known as the Ordnance Survey form very interesting reading. In fact, all over the world it was military requirements which produced the topographical map; and it is still the War Offices of the world which control the execution of almost all geographically important surveys. During the last few years the largest block of work undertaken by the War Office has been the accurate survey of the Orange Free State, which has an area of about 52,000 square miles—nearly the size of England—and an adjacent reconnaissance survey in the Cape of Good Hope covering an area of a hundred thousand square miles. There has been some inevitable delay (due to causes which need not be gone into now) in the publication of the sheets of this survey, but the work is being pushed on. The survey of the Orange Free State is fully comparable with the admirable surveys carried out by the French Service Géographique de l'Armée in Algeria and Tunis. Some work has also been done in the Transvaal. Other surveys carried out in recent years under the direct control of the War Office are those of Mauritius, St. Helena, a portion of Sierra Leone, Malta, and Hong Kong.

The most notable work which is now being carried out in the *Self-Governing Dominions* is the Militia Department Survey of Canada, with which excellent progress has been made.

The total area of the Crown Colonies and Protectorates under the rule of the *Colonial Office* amounts to about two million square miles. British African Protectorates form a large portion of this total, and I will indicate briefly what is being done to survey these tropical Protectorates. From the geographical point of view the brightest regions are East Africa, Uganda, and Southern Nigeria. In East Africa topographical surveys of the highlands and coast belt are being pushed on by military parties as part of the local survey department. The area of exact work done amounts now to some 30,000 square miles. In Uganda a military party has recently completed a large block of country, and in this Protectorate thoroughly trustworthy maps of 32,000 square miles are now available. In Southern Nigeria a completely reorganised survey department is tackling in a thoroughly systematic fashion the difficult task of mapping a forest-clad country. We shall shortly see the results.

For the information of those who have not travelled in Tropical Africa it should be remarked that surveying in such countries is attended by every sort of difficulty and discomfort, and too often by illness and serious discouragement. It is one thing to sit at home in a comfortable office and plan a scheme of survey, and quite another thing to carry it out on the spot. We do not, I am convinced, give enough honour and credit to those who actually get the work done in such trying circumstances. Honest, accurate survey work in the tropics puts a much greater strain on a man than exploratory sketching. To picture what the conditions are, imagine that you are to make a half-inch survey of the South of England: cover the whole country with dense forest; put mangrove swamps up all the estuaries; raise the temperature to that of a hot-house; introduce all manner of insects; fill the country with malaria, yellow fever, blackwater fever, and sleeping sickness; let some of your staff be sick; then have a fight with the local treasury as to some necessary payment, and be as cheerful as you can. That is one side of the medal. On the other side there is the abiding interest which the surveyor feels in the country, the natives, and the work; the sense of duty done; and the satisfaction of opening up and mapping for the first time a portion of this world's surface.

There is no time to mention other surveys in Africa, and I will pass on to a very interesting part of the world, the Federated Malay States. In this prosperous country much excellent geographical work is being done by the combined survey department which was established under a Surveyor-General in the year 1907. The department is in good hands, and the commencement of a regular topographical series is being undertaken.

I wish it were possible to prophesy smooth things about Ceylon. From our special point of view the situation leaves much to be desired. There is not yet published a single topographical map, and the topographical surveys are progressing at a rate which, under favourable conditions, may result in the maps being completed in the year 1970.

In closing this inadequate review of the principal surveys which are being undertaken in the Crown Colonies and Protectorates, I should mention that the coordinating factor is the Colonial Survey Committee, which every year publishes a report which is presented to Parliament.

The *India Office* is, of course, concerned with that great department the Survey of India. The Indian Empire has an area of about 1,800,000 square miles, and as, under the arrangements approved in 1908, the standard scale of survey is to be one inch to one mile, the area of paper to be covered will be 1,800,000 square inches. Actually this is divided into about 6700 sheets. The Survey of India has always been famous for its geodetic work and for its frontier surveys and methods. Its weak point used to be its map reproduction. This has been greatly improved. But personally I feel that if, for most military and popular purposes, a half-inch map is found suitable for England, as is undoubtedly the case, there is no reason why a half-inch map should not also be suitable for India. It is mainly a question of putting more information on the published map, and of engraving it and using finer means of reproduction. If this smaller scale were adopted all the information now presented could be shown, and the number of the sheets would be reduced from 6700 to 1675, a saving of 5000 sheets. It is difficult to avoid the feeling that the Survey of India is over-weighted with the present scheme. The scheme has, however, many merits. It will be impossible to carry it out unless the department is kept at full strength.

The *Board of Agriculture* is the Department which is charged with the administration of the Ordnance Survey. The Ordnance Survey spends some 200,000*l.* a year, and for that sum it furnishes the inhabitants of the United Kingdom with what are, without doubt, the finest and most complete series of large-scale maps which any country possesses. There is nothing in any important country (such as France, Germany, Italy, Russia, or the United States) to compare with our complete and uniform series of sheets on the scale of $\frac{1}{2500}$. These sheets are sold at a nominal price, and are, in effect, a free gift to landowners, agents, and all who deal with real property. They are also, of course, invaluable to county and borough engineers and surveyors. They really are a national asset which is not half enough appreciated. The whole conception of these large-scale plans has stood the test of time, and is greatly to the honour of a former generation of officers.

Much might be said about the small-scale maps of the Ordnance Survey, which are now published in a very convenient form. As mentioned below, the latest small-scale Ordnance map is the new international map on the million scale. Some sheets of this map will shortly be published.

The *Foreign Office* is concerned with the surveys of the Anglo-Egyptian Sudan, which are at present mainly of an explanatory character. The taking over of the Province of Lado has recently thrown fresh work on the Sudan Survey Department. The Foreign Office, which administers Zanzibar, has recently given orders for the survey of the Island of Pemba, a dependency of Zanzibar, and this is being carried out by a small military party.

But the greatest service to Geography rendered by the Foreign Office in recent years was the encouragement given to the project of the International Map by the assembly of an international committee in November, 1909. Sir Charles (now Lord) Hardinge presided at the opening session. There were delegates from Austria-Hungary, France, Germany, Great Britain, Canada and Australia, Italy, Russia, Spain, and the United States, and, as is known, the resolutions which were devised by the Committee were agreed to unanimously. After the conclusion of the work of the Committee the Government communicated the resolutions to all countries which had not been represented, and nearly all the replies which have been received are favourable. Maps in exact accordance with the resolutions are, it is understood, being produced by France, Hungary, Italy, Spain, the United States, and other countries, and, so far as we are concerned, by the General Staff and the Ordnance Survey. These maps will be shown at the International Geographical Congress which meets at Rome in October next.

I have now come to the end of this rapid sketch of the geographical work of the official world. It is work which, though often of an apparently humdrum character, outweighs in importance the sum total of all which can be undertaken by private agency or by societies. But it is the very legitimate business of societies to criticise and encourage.

It is, in fact, not only our manifest duty to encourage the systematic mapping of the world on which we live, but we should do all we can to ensure the perfection, and suitability for their special purposes, of the maps themselves. In the surveying of the earth's surface and its representation by means of maps we are treating of matters which are essentially and peculiarly our own.

It would appear that another great function of Geography, as represented by Geographical societies and congresses, is to serve as a popularising medium for such sciences as geodesy, geology, climatology, and anthropology, and also to serve as the means of bringing together the workers in these sciences. We may be told that, so far as this Association is concerned, the exact study of geodesy and meteorology is dealt with by Section A, geology by Section C, and anthropology by Section H, but there is, I believe, no other section which forms a more convenient general meeting-ground for all the workers in the various divisions of earth-knowledge. We ourselves have our own special work, work which is shared by no others, the great task of mapping the world. This task is such a necessary one, and it is of such genuine value to so many studies, that by assisting in it we are really furthering the Advancement of Science, which is the object of this great Association.

NOTES.

COLONEL C. F. CLOSE, C.M.G., R.E., has been appointed Director-General of the Ordnance Survey in succession to Colonel S. C. N. Grant, C.M.G., R.E.

DR. F. GRANT OGILVIE, C.B., has been appointed by the President of the Board of Education director of the Science Museum. He will continue to fill his present position of secretary for the Science Museum and the Geological Survey and Museum.

THE memory of Alessandro Volta was honoured on Friday last by a meeting held at his grave at Camnago, at which were present Signor Calissano, Minister of Posts and Telegraphs, M. Buebs, director of the Belgian telegraphs, Signor Pietro Volta (a nephew of the inventor), and many telegraphists from all parts of the world. Several speeches were delivered, and a memorial stone bearing an inscription recording the esteem in which Volta is held was inaugurated. The ceremony was followed by a luncheon, provided by the Mayor, and the placing of wreaths, at Como, on the Volta monument.

THE Brussels correspondent of *The Times* announces the death of Prof. F. Swarts, the holder for many years of the chair of general chemistry at the University of Ghent.

THE death is announced, at the age of sixty-four years, of Mr. T. Hurry Riches, locomotive superintendent of the Taff Vale Railway. Mr. Riches, who was held in high esteem as an engineer, for three successive years filled the presidency of the South Wales Institute of Engineers. He was also an ex-president of the Institute of Mechanical Engineers, a member of the Iron and Steel Institute, of the British Association, of the council of the University College of South Wales and Monmouthshire, of the council of governors of the Imperial College of Science and Technology, of the council of the Institute of Metals, and a governor of the National Museum of Wales. He served as chairman of the mechanical engineering section of the Franco-British Exhibition, and as reporter for Great Britain and the colonies to the International Railway Congress of 1910 upon railway motor-cars.

DR. GILMAN A. DREW, assistant director of the Woods Hole Marine Biological Laboratory, has been appointed resident assistant director of the laboratory, and will in future devote his whole time to the work at Woods Hole.

IT is announced in *Science* that Prof. A. J. Hitchcock, of the United States Department of Agriculture, has left for Panama to join the Smithsonian expedition for the biological survey of the Panama Canal zone. He will also investigate the grasses of the five Central American Republics on behalf of the department with which he is connected.

ACCORDING to advices received at Cordova, Alaska, the Smithsonian Institution's glacial expedition has had an unlucky accident. As Profs. R. F. Starr and Lawrence Madden were crossing the Yukon on their way to Fairbanks, their wagon was upset by the current. The explorers themselves got ashore in safety, but all their field notes, cameras, and exposed films were lost.

The Electrician, quoting from the French official gazette "L'Officiel," states that a committee dealing with the hygienic aspects of illumination has been appointed by the Minister of the Interior in France. The objects of the committee include the general effects of illumination on health, the framing of simple rules as to the best means of applying customary systems of lighting to various industrial operations, the nature and causes of short sight and impairment of vision, and their connection with defective living conditions, the study of methods of measuring illumination, &c.

A BRUSSELS correspondent of *The Times* states that a special commission was recently appointed to study the utilisation of aëroplanes for ensuring rapid communication with districts of the Belgian Congo that are still unprovided with railways and roads, and that it has been decided to await the results of certain tests to be carried out in France. Attempts will be made to traverse a desert about 1200 kilometres (750 miles) across, and to establish landing stations 400 kilometres apart, fitted with wireless telegraphy. The aëroplanes will have to convey three passengers and a relatively heavy load of victuals, water, tools, &c. It is hoped that this line will be established in 1912. A first subsidy of 16,000*l*. has been voted for the establishment of these communications.

ACCORDING to a Reuter telegram, the acting Russian Consul at Kwang-cheng-tse reports the outbreak at Changchun, Manchuria, of an unknown disease. The sufferers are attacked by headache and violent diarrhœa, and lose the power of speech. Death occurs in two or three days. The Chinese and Japanese doctors are, it is said, doubtful of the nature of the disease.

THE Board of Agriculture and Fisheries has decided to appoint a departmental committee to inquire into the circumstances of the recent outbreaks of foot-and-mouth disease, and to consider whether any further measures can be adopted to prevent their recurrence. The committee will be appointed and sit in the autumn under the chairmanship of Sir Ailwyn Fellowes.

THE fifty-second course of lectures and demonstrations for sanitary inspectors, held under the auspices of the Royal Sanitary Institute, will begin on Monday, September 18, and close on Friday, December 1. The course will be divided into two parts. The first part will consist of six lectures dealing with elementary physics and chemistry in relation to water, soil, air, ventilation, and meteorology. The second part will deal with meat and food inspection, including the taking of samples of water, food, and drugs for analysis. On October 6 a course of lectures to assist school teachers and other students entering for examinations in hygiene in its bearing in school life, and for women health visitors and school nurses, will be held at the Royal Sanitary Institute and Parkes Museum. A course of practical training for meat inspectors will be begun on October 13.

AT the National Congress of Applied Chemistry, which is to be held at Turin from September 23 to 28, a general discussion will take place on the fiscal and customs practice in regard to the industrial use of alcohol, and Prof. Miolati will give an experimental demonstration of the use of atmospheric nitrogen for industrial purposes.

A FUNGUS FORAY in connection with the Yorkshire Naturalists' Union is arranged to take place in Mulgrave Woods, Sandsend, near Whitby, from Saturday, September 23, to Thursday, September 28. The following papers and lecture will be delivered:—on September 23, notes on the Uredinaceæ, by Mr. R. H. Philip; fungi found in sewage-polluted West Riding streams, and in other places, by Mr. J. W. H. Johnson; and on September 25 Mr. George Massee will lecture on "Diseases of Plants caused by Fungi."

THE annual Fungus Foray of the South-Eastern Union of Scientific Societies will be held at Hastings on Saturday, September 30. The gathering will be preceded, on September 29, by the delivery (at the Museum, Hastings) of a popular lecture on "Fungi," by Mr. E. W. Swanton. Those intending to take part in the foray are requested to give intimation to this effect, by September 27, to Mr. G. Abbott, 2 Rusthall Park, Tunbridge Wells.

ADDRESSES will be delivered as follows at the reopening of certain of the London medical schools:—St. George's Hospital, on October 2, by Dr. H. A. Miers, F.R.S., on "Lucidity"; Middlesex Hospital, on October 2, by Dr. C. Berkeley; University College Hospital, on October 2, by Sir William Ramsay, K.C.B., F.R.S.; London (Royal Free Hospital) School of Medicine for Women, on October 2, by Sir William Butlin; London Hospital, on October 3, the "Schorstein" lecture by Dr. J. Mackenzie, and on October 4 a further lecture will be delivered on the subject of "Auricular Fibrillation."

THE Meteorological Office in its recent issue of the Weekly Weather Report gives a summary of the weather for the summer, comprised by the thirteen weeks from June 4 to September 2. The mean temperature for the period was above the average over the entire kingdom, the excess ranging from about 4° in the east of England to rather more than a degree in the north of Scotland. The extreme temperature exceeded 90° in all the English districts, and was as high as 98° in the Midlands and 97° in the east of England. The rainfall was deficient over the entire country, except in the north of Scotland, where the excess was only 0·05 inch. The largest deficiency was 3·16 inches in the south-east of England and 3·00 inches in the south-west of England. The aggregate measurement of rain ranged from 3·34 inches in the south-east of England to 10·62 inches in the north of Scotland. The number of rainy days was everywhere deficient, the greatest deficiency being 19, in the Channel Islands. The duration of bright sunshine was everywhere largely in excess of the average, the greatest excess being 225 hours in the south-east of England. The absolute duration ranged from 476 hours in the north of Scotland to 861 hours in the Channel Islands, and 838 hours in the south-east of England. At Greenwich the mean temperature for the summer, June to August inclusive, is 66·1°, which is 3·8° above the normal. The mean for the respective months was: June, 60·8°; July, 68·3°; August, 69·1°, the excess in the last-mentioned month being 6·2°. The August mean is fully 2° higher than any previous record for the corresponding month. The mean of the maxima readings is 81·1°, and there is no previous record of the mean exceeding 80°. There have already been 40 days this summer (April 2 to September 5) with the shade temperature above 80°, and in the last seventy years 1868 is the only year with an equal number of hot days, whilst 1846, 1857, and 1859 are the only other years with more than 30 such warm days. The shade temperature of 100° at Greenwich on August 9 establishes a record for absolute temperature. The aggregate rainfall at Greenwich for the three summer months is 3·74 inches, which is 2·80 inches less than the average; the driest month was July, with 0·26 inch. The rainfall this summer is the least since 1885, and 1869, 1864, and 1849 are the only other years since 1841 with so small a summer rainfall. The duration of bright sunshine for the three months is 818 hours, which is 175 hours more than usual; the respective amounts are: June, 223 hours; July, 335 hours; August, 260 hours.

PROF. W. BOYD DAWKINS, F.R.S., delivered his presidential address to the Cambrian Archæological Association at Abergele on August 29, taking as his subject "Some Points in the Pre-history of Wales." In the course of his remarks, he said that at the time when the Neolithic aborigines first found their way so far west in the British Islands, the whole land was covered with forest, the lower portions of the valleys were filled with morasses, and the only tracks were those of the wild animals. The land was some 60 feet above its present level, and the coast-line included the area of Anglesea. The Neolithic farmers and herdsmen were a small, oval-headed people, well formed, and had been clearly proved to be identical with the Iberian peoples of history. They were represented to-day by the small, dark element in the Welsh population. The next elements in the Welsh population were the taller, broad-headed people who lived in Wales in the Bronze age. Their civilisation was derived from the Continent, and they were identified with the earlier division of the Celtic peoples, the Goidels, termed by Rhys the Q Celts. In the prehistoric Iron age a new civilisation made its appearance. That, too, was probably introduced by invading tribes from the Continent, and these belonged to the Brythons, or P Celts, of Rhys. These represented the third element, and no new traceable element was added by the Roman occupation.

THE Bulletins of the Johns Hopkins Hospital for July and August (xxii., Nos. 244 and 246) contain matter of much medical interest. In No. 246 Dr. S. A. Knopf describes, under the name of "the starnook," a device for open-air treatment. It consists of a small room or chamber, sufficiently large to contain a small bed, built of wood or galvanised iron on a balcony, or against a window and supported on posts. The walls are louvred, and partly consist of shutters which can be opened, and the roof also can be raised and entirely opened in fine weather. The idea is that it may be used in towns and cities where there is no ground attached to the dwelling available for the erection of an ordinary "shelter."

IN *The Journal of Hygiene* for July (vol. xi., No. 2), among many papers of much scientific value, Mr. C. Walker describes experiments on the inoculation of "materies morbi" through the human skin by flea-bites. The results obtained indicate that there is very little risk of this occurring. Even with the plague bacillus and animals susceptible to infection with it, such as the rat and guinea-pig, the results were negative. The author suggests that this may be due to the fact that in his experiments the bites were usually single. In view of the accepted theory that plague is conveyed by fleas, these experiments are of considerable importance.

IN *The Journal of Anatomy and Physiology* for July (vol. xlv., part iv.), Mr. E. S. Mawe directs attention to a curious method of predicting the sex of infants. It seems that there is an ancient Japanese belief that the sex can be predicted by the arrangement of the hair on the neck of the child born immediately before. It is said that when the hairs converge the next child is usually a girl, and when they diverge, a boy. Mr. Mawe gives the results of an examination of 300 cases, and they certainly appear to afford a good deal of support to this belief. He suggests that there may be some Mendelian interpretation, but it is not easy to see what Mendelism can have to do with it.

THE August number of *The Quarterly Journal of Microscopical Science* (vol. lvii., part i.) contains several very interesting memoirs, and the illustrations are of a remarkably high standard of excellence. Dr. W. E. Agar describes the spermatogenesis of Lepidosiren, and it is worthy of note that in order to carry out this work it was necessary for him to undertake an expedition to the swamps of the Paraguayan Chaco. It is satisfactory to observe that he is able to confirm the accounts given by workers on other types of the fairing of "homologous" chromosomes in the process of reduction, which is of such deep significance from the point of view of the theory of heredity. Mr. Geoffrey Smith has a short paper on the rapid increase in size of the hen's comb prior to each period of egg-laying, in which he shows that the method by which poultry keepers are in the habit of predicting when a hen is about to lay is really based upon a sound foundation. The temporary increase in size of the comb is shown to be due to infiltration of fat into its connective tissue core. Protozoology is well represented by an elaborate memoir on the cæcal parasites of fowls, by Mr. C. H. Martin and Miss Muriel Robertson, and comparative anatomy by a paper on the fresh-water medusa, *Limnocnida tanganicae*, by Mr. C. L. Boulenger.

A PARLIAMENTARY return of the number of experiments performed on living animals during the year 1910 has recently been issued. The total number of experiments returned during 1910 for England and Scotland reaches the large total of 95,731. Of these, however, 90,792 are of the nature of inoculations, hypodermic injections, and other simple procedures; even the prick of a needle, or feeding with an entirely harmless material, if for the acquisition of new knowledge, is classed as an "experiment" under the Act. The inspectors report that they have everywhere found the animals suitably lodged and well cared for, and the licensees attentive to the requirements of the Act, as well as to the conditions appended to their licences. Only two slight irregularities have occurred during the year.

"REPTILES OF ALL LANDS" is the title of a fully illustrated popular article communicated by Mr. R. L. Ditmars to *The National Geographic Magazine* for August. After mentioning that reptiles are now a degenerate group, although probably more numerous in species than formerly, the author gives a sketch of the three principal ordinal groups living at the present day. The gharial of the Ganges is regarded as the largest existing member of the whole class, Mr. Ditmars refusing apparently to recognise the enormous dimensions which have recently been attributed to the South American anaconda. According to his view, the largest known serpent is the Malay python, which attains a length of about 30 feet, or the same as that of the gharial. Mr. Ditmars, in the legend to the illustration on page 625, repeats the misstatement, to which we have previously directed attention, that the South American bushmaster is the only viperine snake which lays eggs.

ACCORDING to the local Press, a flying fish (*Exocoetus volitans*) was recently taken in a mackerel-net off the village of Wyke Regis, close to Weymouth. Its total length was 11¾ inches. This appears to be the first definitely authenticated specimen taken on the British coast. A trigger-fish (*Balistes caprinus*) was also caught about the same time near Weymouth, this being the third Dorset example, the two others having been taken near the same place respectively in 1873 and 1905.

THE following method for the destruction of rats, adopted by M. de Kruyff, of the Agricultural Bureau of the Dutch Indies at Buitenzorg, Java, is given in a recent American consular report. All visible rat holes were first stopped with earth to ascertain which holes were inhabited. Half a teaspoonful of carbon bisulphide was poured in each of the holes found to be inhabited, and after a delay of a few seconds to allow the liquid to evaporate, the mixture of vapour and air was ignited. The result was a small explosion, which filled the hole with poisonous gases and killed all the rats almost instantly. A pound of bisulphide is sufficient for more than 200 rat holes; 131 dead rats were found in forty-three holes which were opened after the operation. It is further stated that satisfactory results in exterminating porcupines have been obtained by this method.

A CIRCULAR respecting the work of the Aberdeen University Bird-migration Inquiry has been issued by Prof. J. Arthur Thomson and Mr. A. L. Thomson. The object of the movement is the collection of more definite information on migration by the method of placing aluminium rings on the feet of a large number of birds, in the hope of hearing of the subsequent movements of some proportion of the birds. The rings are inscribed with the address "Aberdeen University," and a number (or number and letter combination) different in each case. The rings are placed on young birds found in the nest, or on any old ones that can be captured without injury. The following extracts are taken from the circular above-mentioned:—"(1) It is particularly requested that all who may shoot, capture, or kill, or even hear of any of our marked birds, should let us know of the occurrence. As accurate particulars of date and locality as possible are desired, but, above all, the number (or number and letters) on the ring. Indeed, except where it has been possible to re-liberate the bird uninjured, the ring itself should always be sent, or the ring and foot, or even the whole bird. We always refund postage if asked to do so." "(2) We invite the cooperation in the actual work of marking of any who are specially interested, and have some knowledge of birds, and also time and opportunity for the work. The necessary rings, schedules, postage stamps, &c., are supplied by us, without charge, and we undertake to let the marker know of each case of a bird marked by him being recovered, and to let him have copies of printed reports as far as possible."

A VERY complete account is given by Dr. H. Wallner in the *Mitteilungen der k.k. Geographischen Gesellschaft* (No. 7, Band 54) of the Alm region of Lungau, in the eastern Alps. Where these Alpine pastures are suitably developed there is an annual migration of flocks and their herdsmen from the valley to the high slopes in the early summer, and a return downwards in the autumn, thus constituting a class of semi-nomadic communities as described by Ratzel. The general position of these pastures, their climatic and physiographic conditions, are carefully worked out, and on this basis the distribution of the scattered settlements, the ways and means of communication, the periodical movement of both men and animals, have been thoroughly investigated, not merely by way of description, but by that strictly quantitative method which is so essential for the scientific development of human geography.

DR. E. RÜBEL has compiled a very comprehensive ecological account of the highly interesting Bernina Valley and adjacent country, that is published in Engler's *Botanische Jahrbucher* (vol. xlvii., parts i. and ii.). Seven chapters deal with topography, climate, geology—contributed by Dr. E. Blösch—plant societies, vertical distribution, geography, and a comparison of the floras on the north and south slopes. No fewer than seventy-five plant associations are described under twenty-three formations, and these are grouped under the classes of woods, bushes, shrubs, grasses and swamps, water and rock formations. The most important trees are *Pinus Cembra* and *Larix decidua*, that grow either separately or mixed, as in the beautiful woods towards the lower end of the Roseg Valley. The shrubby and grass associations are perhaps the most interesting. The highest vertical range is that of the *Carex curvula* association, which ascends somewhat higher than 10,000 feet. A list of 100 species that grow above the snow limit is given; to *Silene exscapa* and *Ranunculus glacialis* is assigned the maximum limit of 3500 metres. The illustrations are numerous and excellent, while an interesting item is provided in the record of light measurements.

A COLLECTION of papers dealing with the fauna and flora of Boulder County, Colorado, is published in the University of Colorado Studies (vol. viii., No. 4). Prof. T. D. A. Cockerell contributes a catalogue of protozoa, including mycetozoa and arthropoda; as the author notes, it is remarkable that a preliminary list of mycetozoa from this semi-arid region should contain more than fifty species; Badhamia, Physarum, Stemonitis, and Comatricha are well represented. A description of the lodge-pole pine forests of Boulder Park is provided by Miss K. Bruderlin. The lodge-pole pine, *Pinus Murrayana*, produces the climax formation at an elevation varying between 9000 and 10,000 feet; aspen, Engelman spruce, and subalpine fir form local associations. Species of Vaccinium, roses, and *Arctostaphylos uva-ursi* are the prevailing shrubs.

THE annual report of the county surveyor of Kent, Mr. Maybury, shows the effect of the wear and tear of the roads of this county due to motor traffic, and the consequent increase of the cost of their maintenance. More than 800,000 gallons of tar were used last year on 371 miles of road in Kent in painting the surface to prevent its disintegration. The report states that although this process has proved of very great service, and that the dust nuisance is now a thing of the past, yet on the most important roads where the commercial motor traffic is greatest, some more efficient means of preservation will have to be used than tar painting, and it may become necessary to cover the surface with granite macadam grouted with tar or pitch. As mentioned in a previous note, experiments are about to be conducted by the Road Board to ascertain the most effective method.

WORKS are now being carried out for the purpose of improving the harbour at Lagos, in South Africa. Owing to the dangerous and uncertain condition of the bar at the entrance to the harbour, it is impossible for ocean steamers to enter, and the whole of the traffic has to be transported to the steamers by means of surf boats, at a cost varying from five to thirteen shillings a ton. As the traffic is rapidly increasing, having risen from 154,000 tons in 1900 to more than 300,000 tons, this additional cost, besides the increased risk, is becoming a matter of very serious importance. In order to obtain safe access to the harbour, a mole is being constructed 10,000 feet long, which will project about 7000 feet beyond the present line of foreshore. This mole has a top width of 20 feet, with base of about 100 feet, and rises 9 feet 9 inches above low water, and is composed of granite rubble blocks. When this mole is completed further works are to be carried out on the other side of the entrance.

THE deterioration of stored coal and its liability to spontaneous combustion are questions of great practical importance, and have been the subject of numerous investigations in different countries. The University of Illinois Bulletin No. 46, which deals with the spontaneous combustion of coal, with special reference to bituminous coals of the Illinois type, by S. W. Parr and F. W. Kressmann, gives an account of an exhaustive set of experiments. It is shown that coal is continuously oxidised, a number of more or less distinct oxidation processes being involved. There is a certain critical temperature above which the oxidation is ultimately destructive. The effects of external sources of heat, state of division of the coal, presence of moisture and of iron pyrites are detailed, and a set of principles summarised, which must be observed in any attempt at the prevention of spontaneous combustion. The most important points are the avoidance of any external source of heat which may in any way contribute toward increasing the temperature of the coal, the elimination of coal dust or finely divided material, and dryness in storage. Storage under water would prevent both deterioration and spontaneous combustion, but its industrial practicability is still an open question, and can only be determined by actual experience. In a valuable appendix a historical review of the whole subject is given, together with a summary of the opinions of various workers on the same subject.

AT the July meeting of the International Photometric Commission, held at Zürich, an important paper was communicated by Messrs. W. J. A. Butterfield, J. S. Haldane, and A. P. Trotter on the corrections for the effects of atmospheric conditions on photometric flame standards. It is known that the light given by the standard flame (Harcourt pentane lamp or Hefner amylacetate lamp) depends upon the atmospheric pressure, the humidity, and the amount of carbon dioxide present. In these experiments a special steel compression chamber was fitted up in such a manner that one of these variables could be altered, the other two being kept constant, the corresponding changes in the illuminating power of the flame being balanced against an electric lamp worked under constant conditions. The results are summarised in two formulæ, for the Harcourt and Hefner lamps respectively, showing the actual light of the lamp, expressed in terms of the light under normal conditions, the pressure, and the existing percentages of carbon dioxide and aqueous vapour in the air. A few experiments were also carried out on the effect of variations in the atmospheric conditions on the light of gas and candle flames. It was found that the changes were in the same direction, and approximately of the same order, as those of the Harcourt standard, and the conclusion is drawn that small variations in the atmospheric conditions of a gas testing room will not appreciably affect the results of photometric comparisons in which the Harcourt or Hefner lamp is used as the standard of light, and that these standards will give as accurate results as are anyhow practically obtainable in determinations of the illuminating power of gas, if they are used in all ordinary circumstances without correction for any divergence from normal atmospheric conditions.

WITH reference to a statement to be found in our issue of May 25 (p. 412) in a review of "Salvarsan or 606 (Dioxy-Diamino-Arsenobenzol): its Chemistry, Pharmacy, and Therapeutics," by Dr. W. H. Martindale and W. W. Westcott, in which trypan red is named as a remedy for bovine piroplasmosis (Texas fever), a correspondent resident in Australia has written to ask where the drug can be obtained, its price, and any literature concerning it. In reply, we would point out that the reference to "trypan red" was made in error (see correction on p. 526 of NATURE for June 15); the drug for the treatment of piroplasmosis is "trypan blue," particulars as to the cost of which can probably be obtained from such a firm as E. Merck, 16 Jewry Street, London, E.C. The remedy is discussed by Nuttall and Hadwen in *Parasitology* for 1909. We are informed that *large* doses of quinine have also been found to exert a curative action on bovine piroplasmosis in Malaya and Guatemala.

OUR ASTRONOMICAL COLUMN.

THE SPECTRUM OF KIESS'S COMET.—With spectrographs attached to the equatorial of the Juvisy Observatory, MM. de la Baume Pluvinel and Baldet secured photographs of the spectrum of comet 1911*b*, which they discuss in a paper published in No. 8 of the *Comptes rendus* (August 21). On their best photograph, the two bright bands at λ 4735 and λ 3882 are accompanied by many fainter bands, which present one or two noteworthy features. Three feeble condensations at λλ 3914, 4005, and 4026 are apparently only in the tail; they probably correspond with the λ 3914 of the kathode spectrum of nitrogen and with the doublet (λ 4003 and λ 4023) given by Fowler. While agreeing with the majority of cometary spectra, that of comet 1911*b* is different in many respects from those of several recent comets. For instance, the great comet 1910*a* showed a most intense continuous spectrum, of which there is very little in the radiations from the Kiess comet. Again, in Morehouse's comet the doublets traced by Fowler were common to the nucleus and the tail; here they are peculiar to the tail. To explain this, the authors suggest that in the former case the decomposition of the cyanogen was very active, and so one got the products of the decomposition surrounding the nucleus; but in the case of comet 1911*b* the activity was not so great, and the cyanogen was not sufficiently decomposed until it had been repelled from the nucleus into the tail.

THE ZODIACAL LIGHT.—In No. 4520 of the *Astronomische Nachrichten* Herr Josef Sedláček describes the Zodiacal Light as observed at the Neuschloss in Steiermark Observatory during January and February. At 7h. 15m. (M.E.T.) on January 18 the light was about twice as bright as the brightest part of the Milky Way, and the cone reached up some 49·5° from the horizon; its colour was reddish. On other nights it was noted that the brightness of the light fluctuated considerably with intervals of 1·0 to 1·5 minutes.

METEORITE FINDS.—Publication 145 of the Field Museum of Natural History is devoted to a description, by Mr. O. C. Farrington, of some recent additions of meteorites to the museum of which he is curator.

The Leighton meteorite is a stone weighing about 30 oz. and having a length of 4 inches; it has a very marked brecciated appearance, and contains small grains of nickel-iron. This stone fell on January 12, 1907, at a place eight miles south of Leighton, Colbert County, Alabama.

The Quinn Canyon meteorite, found in August, 1908, in Nevada, is a much larger specimen, and is one of the large iron meteorites of the world. The longest diameter of its oval face is 47 inches, with a diameter at right angles to this of 35 inches, and a circumference of 132 inches; its weight is 3275 lb. In addition to numerous knobs, pittings, furrows, and cylindrical holes all over the iron, the bottom of the meteorite shows two patches of crust of black magnetic iron oxide. These patches are each about 1 inch square, and the oxide adheres so firmly that it can only be detached by the use of a cold chisel and hammer. An analysis shows that the meteorite contains about 91·6 per cent. of iron and about 7·3 per cent. of nickel, and very fine etching figures have been produced. It is supposed to have fallen in a recorded fall which occurred on February 1, 1894.

Mr. Farrington also gives an interesting list of recorded falls since the year 1800, and accepts 331 as properly authenticated. He also analyses the records in months, and finds that May and June show the greatest numbers of falls; November falls below, and August slightly exceeds, the average number. He also gives a complete list of the known falls that have taken place in the United States, with brief particulars of each.

THE LEEDS ASTRONOMICAL SOCIETY.—No. 18 of the Journal and Transactions of the Leeds Astronomical Society contains the report for the year 1910, and also some of the papers read during the session. Of these, several deal with comets; and there is an interesting paper by Mr. Whitmell dealing with lunar eclipses, in which historical eclipses and various features producing and attending eclipses are lucidly described.

AN OPEN-AIR TELESCOPE.—A project for a large, long-focus telescope is described by Prof. Todd in No. 187, vol. xxxii., of *The American Journal of Science*. In order to obtain great size at relatively low cost, Prof. Todd proposes to do away with the costly dome and use the telescope in the open air. At present he describes an altazimuth mounting in which the azimuth motion would be secured by a revolving vertical shaft working on rollers. To secure the easy working of this he proposes to take up most of the weight by flotation with an arrangement whereby the telescope could be clamped in a "safe" position, when not in use, by pumping out part of the supporting liquid. The tube would be built on the cantilever principle, of angle steel, and would be supported in the middle. He estimates that a 60-inch objective would cost about 125,000 dollars, and such a mounting as is proposed would probably cost a like amount. Instead of observing chair, rising floor, &c., he proposes to carry the observer in a light carriage attached to the revolving tailpiece of the telescope, and he discusses the practicability of erecting such an instrument at some such altitude as that of Fuji-yama in Japan (12,400 feet).

LUMINOUS METEOR TRAINS.—Some further work on the origin of luminous and persistent meteor trains is described by Dr. Trowbridge in *The Popular Science Monthly* for August. Dr. Trowbridge has been able to reproduce the phenomena by causing gases at very low pressure to phosphoresce, and he suggests that in the upper air, generally at about fifty or sixty miles' altitude, the conditions are favourable for this action, the phosphorescence being produced by ionisation caused by weak electric currents or intense temperature generated by the meteor's flight.

THE OXFORD UNIVERSITY OBSERVATORY.—Further evidence as to the energy and versatility characteristic of the Oxford University Observatory is forthcoming in the pile of abstracts and papers just received from them. These form part of the volumes issued under the title of "Miscellaneous Papers of the University Observatory, Oxford," and include important papers on the measurement of star photographs, eclipse work, variable star discussions, and mathematical astronomy.

In his report of the work during the year ended April 30, Prof. Turner states that the work of replacing defective plates in zone 25° (the last Oxford zone) was completed, and the volume of measures ready for immediate publication. The question of making differential measures by photographic means of the places of the reference stars has long been under consideration, and an apparently satisfactory method is to be given an extensive trial.

METEOROLOGICAL REPORTS AND YEAR-BOOKS.

VIENNA *Central Meteorological Office* (1908).—The forty-fifth year-book (new series) of this important service appears in the same form as heretofore; it includes daily observations and monthly and yearly results in the international form for a number of stations, hourly observations for Vienna, and temperature and rainfall observations at other stations. Purely rainfall statistics are published by the Hydrographic Office, and observations in Hungary and elsewhere are also separately published. Observations of the upper air are actively carried on by manned and registering balloons. Weather forecasts were sent free to all post and telegraphic offices between April and November, in addition to the daily publications of the usual weather report (with chart). A separate appendix issued with this volume contains the results of thunderstorm observations in Lower Austria in 1902–5, by Dr. A. Defant. These include two maps showing the districts of the first appearance and final disappearance of the storms. The greater elevations of ground are seen to offer favourable conditions for the formation of the storms, and to promote their development in a remarkable manner. Very few storms originate in the more level districts; these check their development, and become the places of dissolution of the storms which approach from other parts.

Meteorological Office (1910).—Summaries of the results have been published of the geophysical and meteorological observations in continuation of the reports of the observatory department of the National Physical Laboratory, in accordance with arrangements made between H.M. Treasury and other authorities. The tables in this volume are given in the usual form, and include observations for Eskdalemuir, magnetic results for Falmouth and Valencia, and the customary table of recent magnetic values for observatories in all parts of the world. In the year 1911 Eskdalemuir will replace Kew with regard to magnetic observations. The following data for Kew are extracted from interesting notes drawn up by Dr. C. Chree:—mean westerly declination, 16° 3·2′; inclination, 66° 58·7′; horizontal force, 0·18503. Solar radiation observations with an Angström pyrheliometer made between 11h. 30m. a.m. and 12h. 30m. p.m., expressed in gram-calories per square centimetre per minute, ranged from 1·105 in August to 0·575 in December; the absolute values were 1·296 in May and 0·484 in December The largest seismograph disturbances occurred on January 22, amplitude (E.-W. displacement) > 17 mm.; June 24, 11 mm., and December 13, 7·5 mm. Dr. Shaw states that the considerations of the most suitable forms for the future publication of the results obtained at the associated observatories, in view of international relationships, is now occupying attention.

Liverpool Observatory (1910).—The report of this valuable institution, maintained in great efficiency by the Mersey Docks and Harbour Board, appears in the same form as in previous years (NATURE, October 27, 1910). The annual means of the principal meteorological elements were practically normal; absolute maximum temperature, 77·3° in June (11·8° below the highest record); minimum, −5·9° in January (7·2° above the lowest record). An interesting experiment was made in the autumn, in connection with the determination of time, by observing the signals sent out by radio-telegraphy from the Eiffel Tower and from the German station at Merddeich; the signals were received at Waterloo station with great clearness. The amplitudes and other details of the seismological disturbances of January 22, June 24, and December 13 agree closely with those recorded at Kew; in the first case the amplitude exceeded the width of the paper.

Norwegian Meteorological Institute (1910).—These valuable observations are published in two volumes, as in previous years:—(1) the year-book containing daily observations with monthly and yearly summaries according to the international scheme, and hourly readings for Christiania; (2) daily amounts of rain and snow with summaries, and normal percentages for as many years as are available. This volume is accompanied by maps showing the annual isohyets for each 200 mm. These give a clear idea of the great variation according to geographical position (see NATURE, July 28, 1910) which it is difficult otherwise to obtain from the great mass of tables. They clearly show the influence of the rain-bringing winds of the Atlantic, and of the configuration of the land. One of the tables, giving the values at selected stations in 1910 in percentages of the normal amounts, shows yearly differences ranging from 59 to 169 per cent. of the normal. We have also received a "summary of air-temperature and rainfall for 1909" in a very handy form, being an excerpt from a periodical publication.

Toronto Observatory (1909).—The results of this valuable series of meteorological observations are given for each month and the year, together with the average for the past seventy years: mean temperature, January, 1909, 26·5°; July, 67·8°; year, 45·9° (average, 45·1°); absolute maximum, 95·8°, in August (highest on record, 99·2°); minimum, −8·7°, on February 1 (lowest on record, −26·5°). Depth of snow, 69·1 inches (mean 66·0 inches); rainfall, 26·01 inches (mean, 26·86 inches). The sunshine during the year was 2068 hours, 44 per cent. of the possible amount. Mean westerly declination was 6° 59·4′; inclination, 74° 37·5′; horizontal force, 0·162988 dyne.

Bremen Observatory (1910).—The observations are published in the same form as in previous years (NATURE, October 27, 1910) as one of the valuable series of German meteorological year-books; it contains, in addition, results for the lustrum 1906–10, and for the thirty-five years 1876–1910, with hourly means for twenty years. The following data are for the 35-year period:—mean temperature: year, 47·7°; January, 32·9°; July, 62·6°; mean of absolute maxima for July, 82·9°; of minima for January, 11·3°. Rainfall: annual amount, 27·23 inches; maximum in twenty-four hours, 3·39 inches. Results of observations with pilot balloons are exchanged daily by telegraph with the aëronautical observatory at Lindenberg.

THE AMERICAN INDIAN LANGUAGES.

THE admirable volume referred to below[1] forms the first portion of a systematic account of the American Indian languages. It has been in preparation for many years, and has grown out of an attempt to prepare a revised edition of Major J. W. Powell's "Introduction to the Study of Indian Languages." The filling of the schedules contained in the "introduction" caused an accumulation of much linguistic material without throwing much light upon the morphology, the phonetics, or the psychological basis of the languages. In this new work special emphasis is placed upon the importance of an analytical study of the languages. The work has been rendered possible by the cooperation of numerous investigators under the auspices of various institutions, particularly the American Museum of Natural History and the University of California.

The subject is introduced by Dr. Franz Boas in a very able exposition of the principles of linguistics as applied to ethnological problems. Though written with especial reference to the problems of American ethnology, this will be found of much value to the general student. In dealing with the three factors of physical type, language, and

[1] "Handbook of American Indian Languages." By F. Boas. Part i. Pp. vii+1069. (Washington: Government Printing Office, 1911.) (Smithsonian Institution, Bureau of American Ethnology, Bulletin No. 40.)

culture, now so often found non-correlative, Dr. Boas does not consider that we are justified in assuming that in primitive communities these three phenomena were necessarily more closely associated than they are now. He recognises that mankind cannot be classified by any one of these factors alone.

In a section on the characteristics of language, Dr. Boas has an important chapter on phonetics generally, and discusses the way in which languages differ in expressing groups of ideas by the grouping of phonetic elements. He takes the sentence as the natural unit for the expression of an idea, and discusses the sentence and its components—words or particles, stems or affixes—especially with regard to the American languages. In these, owing to the close association of the phonetic elements in a sentence, it is not easy clearly to define the terms "word" and "sentence."

In dealing with grammar, Dr. Boas illustrates by means of American languages the nominal categories of gender, plurality, case and tense, and the personal and demonstrative pronouns and verb. This leads to the conclusion that in placing a language, phonetics, vocabulary, and grammatical concepts must each be considered.

In a section on classification the author deals with comparison, mutual influence, the origin of similarities by dissemination or parallel development, and the influence of environment and common psychic traits. Then follows a very practical section on the importance of linguistics as a means, as well as a part, of ethnological studies.

The introduction finally deals with the characteristics of American languages. Dr. Boas does not agree that all these are polysynthetic or incorporating, but points out their common features. He gives a list of fifty-five linguistic families which may be distinguished in North America north of Mexico.

The larger portion of the volume specially appeals to the student of American linguistics. It contains ten grammars of typical languages, each dealt with by a specialist in the group to which it belongs. Thus Dr. P. E. Goddard deals with Athapascan (Hupa), Dr. J. R. Swanton with Tlingit and Haida, and in collaboration with the editor with the Siouan (Dakota). Dr. Boas himself is responsible for the Tsimshian, Kwakiutl, and Chinook languages, Dr. R. B. Dixon for the Maidu, Dr. W. Thalbitzer for the Eskimo, whilst the Algonquian (Fox) is the joint work of Dr. W. Jones and Dr. Truman Michelsen. These works form an excellent preliminary to the detailed study of the several groups. A general plan of presentation is followed in the grammars, modified, however, by the characteristic morphology of the language discussed. Each and all of them will serve as models for future students.

In congratulating the Bureau of American Ethnology and the editor and writers of the present volume on such an excellent account of the languages, one regrets to find that several of the grammars deal with languages which are largely spoken in Canada, and that neither the British Government nor universities have any place for similar detailed studies of the native languages of the Empire. When will any of these provide for the student such matter for study as is to be found in the systematic issue of the instructive and interesting volumes of the American Bureau or in the valuable collections of native texts published by such institutions as the Universities of California or Columbia? Sidney H. Ray.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Mr. G. E. Nicholls, of the zoological department of King's College, London, has been appointed professor of biology at Agra College, University of Allahabad.

The chemical laboratories of the Athens University were destroyed by fire on August 28. A *Times* correspondent estimates the damage at 80,000*l.*

It is announced in *The Popular Science Monthly* that Prof. L. H. Bailey has tendered his resignation of the directorship of the New York College of Agriculture to the trustees of Cornell University.

An offer by Mr. Andrew Carnegie to erect at a cost of 15,000*l.* three suburban branch libraries in Manchester has been accepted by the Manchester Library Committee. The offer is to be considered at the next meeting of the City Council.

At the forthcoming celebration of the quincentenary of the foundation of St. Andrews University, the honorary degree of LL.D. will be conferred upon the following men of science:—Sir T. Clifford Allbutt, K.C.B., F.R.S.; Sir Thomas Barlow, Bart., K.C.V.O., F.R.S.; Prof. A. Crum Brown, F.R.S.; Major P. A. MacMahon, F.R.S.; Prof. R. Meldola, F.R.S.; Prof. W. H. Perkin, F.R.S.; Prof. W. J. Pope, F.R.S.; Lieut.-Colonel D. Prain, C.I.E., F.R.S.; Prof. R. Saundby; Prof. Sir J. J. Thomson, F.R.S.

The London Inter-Collegiate Scholarships Board announce that combined examinations in anatomy and physiology, and in arts and preliminary scientific subjects, will be held on Tuesday, September 19, for Medical Entrance Scholarships and Exhibitions of an aggregate total value of more than 1700*l.*, tenable at University College, King's College, and in the Medical Schools of Westminster Hospital, St. George's Hospital, London School of Medicine for Women, University College Hospital, and King's College Hospital. Particulars and entry forms may be obtained from the deans of the respective medical schools, or from the secretary of the Board, Mr. A. E. G. Attoe, University College, Gower Street.

A circular letter (No. 24) prescribing new regulations for the Royal Navy Medical Service has been issued by the Admiralty. The changes in the organisation and conditions of service take effect, where not already in operation, as from July 1, 1911, except when otherwise stated in the letter. It being considered essential for the scientific development of the Naval Medical Service that it shall possess a School of Medical Instruction and Research situated in the vicinity of London, where it will be in touch with the principal civil medical schools and with the Army Medical School at Millbank, it has been decided to establish a Naval Medical School at the Royal Naval College, Greenwich, in close proximity to the "Dreadnought" Seamen's Hospital and the London School of Tropical Medicine, and in a position, therefore, to carry out its educational and scientific work in close connection with those establishments. There are already in existence at Greenwich excellent chemical and physical laboratories, and the additional laboratories required for medical research will be provided in the college buildings and furnished with the necessary equipment and scientific apparatus. There will be specially appointed to the Naval Medical School as the nucleus of the instructional staff a professor of bacteriology and clinical pathology, and a professor of hygiene. When the structural alterations in that part of the building which has been selected for the purpose have been completed and the school is ready for use, a proportion of the instructional work now carried out at Haslar will be transferred to Greenwich, and such of the instructional staff and equipment as may be considered advisable will be removed to that establishment. It is not proposed, however, that the laboratory at Haslar shall be dismantled. A certain amount of instructional work must still be carried out at that establishment, and at least one medical officer will be retained there for the instruction of acting surgeons. When the Medical School at Greenwich is opened, the first two months of the course for naval surgeons will be passed at that establishment, this period being devoted to the study of tropical medicine, bacteriology and clinical pathology, hygiene, and skiagraphy. The remaining four months will be passed at Haslar, as at present.

The technical colleges throughout the country are now issuing new prospectuses giving details of the courses of work which have been arranged for the forthcoming session. The prospectus of the Municipal Technical Institute, Belfast, for example, is a volume of 350 pages, provided with excellent illustrations of the laboratories, workshops, and so on, and serves excellently to show how successfully the Belfast authorities are carrying out the chief object of the institute, which is to provide instruction in the principles of those arts and sciences which bear directly or indirectly upon the trades and industries of Belfast, and to show by experiment how these principles may be applied to their advancement. A day technical course has been established to supply instruction in the science and technology of mechanical engineering, electrical engineering, the textile industries, and pure and applied chemistry, and is designed to give a sound training to youths who aim at filling positions of responsibility in the city's industries. Among other interesting particulars given in the prospectus of the Technical College, Sunderland, are those referring to the diploma of associate of the college. Students may obtain this diploma in the subjects of engineering, electrical engineering, naval architecture, and chemistry by passing through certain prescribed courses of study. A candidate's claim for a diploma is judged by regularity of attendance, by his successes in the annual class examinations, home-work marks, and evidence of reasonable skill in practical work. An external examiner is appointed to act as assessor in the associateship examinations, which are conducted by the respective heads of departments. It is satisfactory to note that at this college the County Borough of Sunderland grants every year a number of scholarships to apprentices of engineering and shipbuilding firms in Sunderland and the neighbourhood. The apprentice-student scholars attend classes during the winter six months, and during the summer they return to the works at which they are apprenticed. The time spent in the college is reckoned as part of the apprenticeship; the rate of advance in wages is the same as if the apprentices were continuously employed in the shops, and during the summer special facilities in the works are given to the apprentices for traversing all the various stages of work.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 28.—M. Armand Gautier in the chair.—Arnaud **Denjoy**: The *Analysis situs* of the plane.—Jules **Andrade**: A new regulator for chronometers. Two spiral springs are employed in the place of one. The use of Arnold's terminal curves is avoided, and the sinusoidal law of the balance spring is maintained.—M. **Bourgeois**: Determination of the geographical co-ordinates in the colonies by the use of wireless telegraphy. Trial of the method between Paris (Observatory) and Brussels. A compact and portable form of apparatus is described for the determination of differences of longitude. Full details are given of the application of the method to the measurement of the difference of longitude between Paris and Brussels.—A. G. **Webster**: A new mixed problem of the telegraphists' equation.—M. **Tsvett**: A new colour reagent for callose. The blue solution obtained by the spontaneous oxidation by the air of an aqueous solution of resorcinol rendered alkaline by ammonia is proposed as a stain for the distinction of callose in microscopical specimens. Cellulose remains colourless on treating with this reagent; callose is stained blue, an exposure of from thirty to sixty seconds being sufficient. In combination with Congo red, the blue solution is suitable for double staining.—Pierre **Kennel**: The function of the adipose reserve of the adipo-lymphoid bodies. In Batrachians, the adipose reserve is utilised whenever the animal is exposed to bad conditions of nutrition, particularly during hibernation. This reserve also serves in the development of the sexual elements, especially in the elaboration of the deutoplasm of the egg.—Casimir **Cépède**: The cycle of evolution and the systematic affinities of the Haplosporideæ of Donax.—Em. **de Martonne**: The chronology of the Pliocene and Quaternary *thalwegs* of Arc and Isère.

CALCUTTA.

Asiatic Society of Bengal, August 2.—Anand **Koul**: Ancient monuments in Kashmir. The paper contains a short account of twenty-nine monuments which exist in ruins in Kashmir. Some of the monuments are said to have been very old.—Maulavi Qâsim **Hasir**: Fîrûz Shâh's menagerie. The system of providing metropolitan towns with zoological gardens was not unknown to Muslim rulers of India. According to a contemporary writer, the earliest was founded in the middle of the fourteenth century by Sultân Fîrûz Shâh (A.C. 1351–88), who built a *Kûshk* (kiosk) at Firûzâbâd, and acquired animals to be preserved there.—Dr. Satis Chandra **Vidyabhusana**: Gadâdhara, prince of Indian schoolmen. Gadâdhara was born in the village of Laksmichāpara, in the district of Bogra in eastern Bengal, in the seventeenth century A.D. He came to Navadwipa, where he made a special study of logic (Nyáya). He was called the prince of Indian schoolmen, in whom modern logic reached its climax. He was such a thorough-going logician that when on his death-bed he was asked to meditate on the prime cause of the universe, he is said to have exclaimed "Atoms, atoms, atoms!!!"

CONTENTS.

THURSDAY, SEPTEMBER 14, 1911.

LORD KELVIN'S PAPERS.

Mathematical and Physical Papers by the Rt. Hon. Sir William Thomson, Baron Kelvin, O.M., P.C., G.C.V.O., &c. Arranged and revised with brief annotations by Sir Joseph Larmor, Sec. R.S., M.P. Vol. iv., "Hydrodynamics and General Dynamics." Pp. xvi+563. Vol. v., "Thermodynamics, Cosmical and Geological Physics, Molecular and Crystalline Theory Electrodynamics." Pp. xv+602. (Cambridge University Press, 1910–11.) Price 18*s*. each.

THE publication of volumes iv. and v. of Lord Kelvin's "Mathematical and Physical Papers," bringing as it does the collection of these memoirs nearly to an end, is important both to the student of mathematical physics and to the scientific historian. It gives the former access to papers of great value scattered through the Transactions and Proceedings of learned societies, or imbedded in the more easily obtainable but also more unexpected pages of the journals of pure and technical science. The latter will seize the opportunity to compare the utterances of the master during the last decade or two of the nineteenth century and the first seven years of the twentieth, with the last developments of the related theories of electrical action and the ultimate constitution of matter. To those who have come to these developments from the point of view of the Maxwellian electromagnetic theory of light, and find in atomic facts and hypotheses a supplement and to some extent a basis for the undulatory propagation of electric and magnetic action in a non-conducting and uniform medium, some of these utterances will occasion much thought, if they are not, indeed, a source of a good deal of perplexity.

Consider, for example, the Appendix A of the "Baltimore Lectures," and its continuation in volume iv. of the "Papers." One statement is enough to cite: "Stress in ether, being thus freed from the *impossible task of transmitting both electrostatic and magnetic force,* is (we may well imagine) quite competent to perform the simple duty of transmitting magnetic force alone." (The italics are in the original.) The Maxwellian electrician has the notion ingrained in his mind that, when magnetic force is propagated in the medium, electric force is propagated also as a necessary concomitant, and *vice versa,* and therefore supposes that whatever machinery is effective for the one must be equally concerned with the other. Moreover, as Lord Kelvin states in a note to the first article of this appendix, the "so-called 'electromagnetic theory of light'" is to be grafted on to the elastic solid theory of the æther. It is, however, to be remembered that Maxwell came to his theory by way of Faraday's experimental researches and Lord Kelvin's mathematical interpretations, and it may be that these utterances, dark as they may appear to some of us, will in time to come throw light on some of the still unsettled questions of electricity.

The student of these papers has a difficult task; but it is one which, if it be not thrown up in despair, will stimulate his power of independent criticism of physical doctrine.

The arrangement of the papers is both chronological and according to subjects. Hence volume iv., which is mainly devoted to hydrodynamics, goes back to the vortex-motion papers of 1867 and 1869. The first of these contains the famous suggestion that the vortex-rings of Helmholtz are the only true atoms. Their non-creatibility in a perfect fluid does not seem to be regarded as a difficulty, but rather as a recommendation—a creative power above nature brings them into existence, and once they are in existence, their indestructibility by natural agency is assured.

It is rather remarkable that Helmholtz's great paper of 1858, on the integration of the hydrodynamic equations of vortex motion, should not have attracted the active attention of physical mathematicians in this country at an earlier date than 1867. In that year Tait published his translation of the memoir, and made experiments on vortex-rings rendered visible by smoke in his class-room. It was seeing and, so to speak, handling these rings that suggested Kelvin's conception of the vortex-atom constitution of matter, and, with Tait's account of Helmholtz's investigations, led to the paper on vortex-motion in the Edinburgh Transactions for 1869, which will ever rank as one of the great classical memoirs of hydrodynamics. In this Kelvin's point of view and method are curiously different from those of Helmholtz. The results of the latter are derived in the most approved classical manner from the equations of motion of a perfect fluid, unsimplified by the hypothesis of a velocity-potential. It is straightforward mathematical discussion; but the march is that of a clear-eyed intellectual giant, and the stages reached are duly chronicled and described in language which shows how completely the author understood the physical meaning of his mathematical results.

Kelvin, on the other hand, starts from the physical conceptions of linear and angular momentum, and from these ideas, and the impulses required to produce the momenta, the whole subject is developed. The physical meaning of the expressions $\xi = \frac{1}{2}(dw/dy - dv/dz)$, . . . , namely that, multiplied by the moment of inertia about diameters parallel to the axes of coordinates, they are the component angular momentum of an infinitesimal sphere of the fluid with its centre at the point x, y, z, had been given by Stokes in 1845, and thus the existence of a velocity potential the criterion for which is the vanishing of ξ, η, ζ, had been shown to affirm the non-existence of angular momentum in the fluid to which the criterion applied. This physical interpretation is referred to and used by Kelvin, and in a sense is the keynote of his discussion of the subject.

Perhaps the most important of all the results in the memoir is the theorem of Thomson regarding "circulation"—that is, the line integral, along a specified curve or line of the fluid, of the component of flow along the curve at each element. If the path be not closed the time-rate of growth of the flow along any specified path which moves with the fluid is obtained by subtracting the value of the excess of the kinetic energy per unit mass of the fluid, supposed incompressible and under no applied force, above the pressure at the initial end of the curve of integration, from the value at the terminal end. This theorem, in its modification for a compressible fluid in which the pressure is a function of the density, and which is situated in a field of applied force, has been truly said to comprehend the whole of the dynamics of a perfect fluid.

For the vortex-motion application the use is immediate. If the curve be closed the time-rate of growth of circulation for the moving circuit is zero; but the integral which is thus shown to remain constant is half the surface integral of the component of ξ, η, ζ, along the normal to each element of a surface of which the curve is the bounding edge. Hence as the fluid moves this surface-integral remains constant, and if once zero is always zero.

Thus the Kelvin theorem obtains the result for a finite mass of the fluid that is obtained in another way by Helmholtz, and it gives the subject a physical significance at once clear and convincing. The theorem may, however, be made to give at once many well-known results in ordinary fluid motion, which are usually obtained by other methods.

Almost every paper in volume iv. is of a kind to arrest and hold the attention. The papers entitled hydrokinetic solutions are particularly interesting, both on account of their contents and from the fact that they are an excellent example of the best manner of the author, the manner of which the pupils of his higher mathematical class had the most frequent experience. It is probable, however, that the letter to Tait on the influence of wind on waves in water supposed frictionless, and on ripples, was written off as soon as some observations of the kind described in the letter had been made, probably in the yacht *Lalla Rookh*, and had been interpreted by the analysis written down immediately, and therefore in more or less impromptu manner. Scott Russell (though Lord Kelvin was not aware of the fact when he wrote) had noticed, nearly thirty years before, that surface tension must play the most important part in the propagation of the very short waves often seen on a smooth sheet of water; but this short paper proved that as the wave-length diminishes from a great to a very small value, the speed of propagation diminishes to a minimum for a certain wave-length, and then continually increases. This wave-length Lord Kelvin took as that of separation between ripples and ordinary waves.

Anyone can study the matter experimentally from a boat drifting steadily forward in smooth water at a speed of about half a mile per hour, while the wave system is generated by a fishing line stretched by a weight hanging in the water. How many physicists have done this and taken photographs of the wave patterns ("ripples in front and waves of the same velocity behind") with the excellent lenses and cameras which are carried about on every holiday excursion?

The paper on an alleged error in Laplace's theory of the tides the present writer well remembers was dictated in some little excitement by Lord Kelvin just after he had read Ferrel's observations on Laplace's process in the United States Coast Survey Report for 1874, in which certain objections taken by Airy in his article on tides and waves in the *Encyclopedia Metropolitana* were quoted and approved. The point was a curious one, as to whether a certain coefficient K_4 was or was not indeterminate so far as the solution of the differential equation for certain tides was concerned. It is now generally admitted that the constant was not indeterminate, and is correctly determined by Laplace's "exquisitely subtle method."

Perhaps a note might have been added, in connection with the short paper in volume iv. on the precessional motion of a liquid, on the *two* liquid gyrostats which Lord Kelvin was so fond of showing to visitors. In each water is enclosed within a spheroidal shell, but in one the shell is oblate, in the other prolate, with about 5 per cent. deviation from sphericity in each case, and the shell rotates about the axis of figure. The motion of the liquid is stable in the first case, and the gyrostat takes precessional motion like an ordinary gyrostat, while in the other the motion is unstable. The first result showed that the precessional motion of the earth does not furnish a valid argument for the earth's rigidity. The remarkable result has been established that the motion of a liquid in a prolate case is stable if the degree of prolateness be so great that the axial length of the hollow filled by the water is more than three times the diameter. As Greenhill has pointed out, this fact is important in fixing the shape and size of the gas-bags for a dirigible balloon.

The most remarkable series of papers in the two volumes are, however, those on waves in water. Here the exponential solutions given by Fourier for the linear conduction of heat are modified and applied to the long chain of abstruse problems dealt with. The discussion of the front and rear of a free procession of waves, and the papers on the initiation and growth of a train of waves, sheds much light on difficult questions regarding groups of waves, and the manner in which they arise and are propagated from a given form. In the hands of Mr. Green and others it is possible that the analysis may have important applications in the wave theory of light, in connection with Lord Rayleigh's theory of the origin of the periodicity of light which has passed prisms and gratings and other optical instruments. A detailed account of these papers is a fit task for the specialist in hydrodynamics: that they should have been written by Lord Kelvin during the last ten years of his life is not the least wonderful thing about them. To those who came in contact with him, it appeared that he worked more slowly, but not less surely: the impetuosity of his genius was abated, not its natural force.

Of the papers in volume v. we have said nothing, and our space is exhausted. As a rule they are shorter, and in some cases of a slighter character; for example, the excerpts from the technical journals on various questions of electrical practice; but the reader who wishes to follow Lord Kelvin in his more abstract speculations will find plenty of occupation in this volume also. There are his papers on molecular and crystalline theory, which are heroic attempts to find mechanical explanations of such things as the pyroelectricity and piezoelectricity of crystals, and the known chemical and physical properties of gases, liquids, and solid crystalline substances.

That one man should have attacked with so much success so many subjects of transcendent difficulty is a great marvel. But our wonder is mingled with regret that his mind should have been distracted so much as it was from the great themes with which it was pre-eminently fitted to deal. The turning from one thing to another probably, however, did not result in so much dissipation of its energy as might be supposed. He obtained mental refreshment by change of the objects of thought, and often when he returned to the consideration of difficulties obtained their solution with unexpected facility.

The work of editing has been excellently performed by Sir Joseph Larmor. He has appended notes here and there, but with a reverent frugality, and in their substance they are short and to the point.

A. G.

THE NUCLEI OF THE PROTISTA.

Die Konstitution der Protistenkerne, und ihre Bedeutung für die Zellenlehre. By Prof. Max Hartmann. Pp. v+54. (Jena: Gustav Fischer, 1911.) Price 1.60 marks.

THIS paper is an extended version of a lecture delivered by Dr. Hartmann at the International Zoological Congress in 1910. It is an attempt to obtain a simple interpretation of the many complex nuclear conditions recorded in the Protista.

By "constitution" Dr. Hartmann means "morphogenetic constitution," and it appears from his paper that "Protista" means—as is so usual—chiefly the Protozoa.

Dr. Hartmann's views are not easily given or criticised in a short space, for they contain much that is purely hypothetical and highly controvertible. He insists, in the first place, upon the universal occurrence of a centriole in all protists—a contention that is not likely to find universal acceptance. The cyclical changes (centrifugal and centripetal streaming) undergone by this body are also insisted upon.

Nuclei are classified as "monoenergid" and "polyenergid"—"energid" being used in a sense different from that of its inventor, Sachs. Monoenergid or univalent nuclei (*e.g.* in *limax* amœbæ) consist of two components—idio-generative (chromosomes) and locomotor-generative (centrioles, polar caps, &c.). The power of polar division is an important attribute of the locomotor component. Polyenergid nuclei (*e.g.* those of Radiolaria) are those which are really not simple, but multivalent, containing many individualised univalent nuclei inside them. These are the "chromosomes" (*e.g.* in Aulacantha), which are really not chromosomes but nuclei.

Mitosis in the Protozoa is accordingly univalent or multivalent, according as the nucleus is monoenergid or polyenergid. From which it follows that the nuclei and their mitoses are not homologous throughout the Protista. There is no true amitosis in any protist—the process now so called being designated "promitosis."

We are glad to see that Dr. Hartmann now rejects the "box within box" trophokinetic binuclearity hypothesis which he formerly advocated so strongly, and now regards binuclearity—formerly of universal occurrence—as exceptional in the Protista. "Generative chromidia" he regards as monoenergid nuclei which have escaped from a polyenergid nucleus. The formation of new nuclei from chromidia is therefore "explained"—the nuclei are really there all the time, but at last become visible. There are also numerous other curious interpretations of protozoan nuclei resulting from Dr. Hartmann's hypothetical considerations. Thus, the mitotic figure of Acanthocystis is really not an ordinary mitotic figure, but a composite figure composed of two nuclei which simulate one. It may be noted, however, that the interpretation of monoenergid nuclei as consisting of two components is, in reality, merely a variant of Dr. Hartmann's former binuclearity hypothesis, become more complex by the introduction of polyenergid nuclei.

The relation of protozoan nuclei to metazoan nuclei and the constitution of the latter, is only briefly and hesitatingly considered. Dr. Hartmann thinks that all the chromosomes of a univalent protozoan nucleus are homologous with only one chromosome in a metazoan nucleus. Chromosomes in the former correspond with chromioles in the latter. Metazoan nuclei are, for the most part, polyenergid—the chromosomes being nuclei (or energids in Hartmann's sense). "Only the simple monoenergid atypical amœbæ and similar forms can be considered as elementary organisms in the sense of the cell theory." The union of the ovum and spermatozoon in Metazoa is not homologous with the conjugation of two protozoan gametes: for the latter are monoenergid, the former polyenergid.

Dr. Hartmann's ideas are discussed at some length in numerous special cases in the Protozoa, with the aid of figures copied from other works. There are several misprints in the text, and I may point out that "Herr Newin" referred to on page 18 is my friend and former pupil Mr. K. R. Lewin. His conclusions are at present indefinite, and do not warrant what Dr. Hartmann says of them.

Whether Dr. Hartmann's speculations will turn out to be well-founded or not, future work will determine. For our own part, we by no means agree with all his interpretations. But they will, no doubt, give rise to further discussion and analysis of a difficult problem, and thereby perhaps lead eventually to a better understanding of the nuclei of the Protista.

C. Clifford Dobell.

CYCLONES AND SUGAR-CANES.

The Sugar Industry of Mauritius: a Study in Correlation. Including a Scheme of Insurance of the Cane Crop against damage caused by Cyclones. By A. Walter. Pp. xvi+228. (London: A. L. Humphreys, 1910.) Price 12*s.* 6*d.* net.

MAURITIUS, situated just within the tropics and on an edge of the southern anticyclonic system, is in certain circumstances visited by tropical cyclones. Occasionally great damage to the growing sugar crops is done by such visitations, and though extremely violent storms are exceptional, yet the fact that they may and do occur makes the cyclone season one of dread and anxiety in the island. In the year 1892, for example, about one-half of the total crop was destroyed, to say nothing of damage to buildings, and other losses. True, this storm was one of quite unusual severity; but fear of a similar calamity tends, nevertheless, to have a paralysing effect upon the sugar industry. "Behind every attempt at improvements and every fresh outlay of capital, hovers the spectre of the 1892 disaster."

In these circumstances the question of insurance becomes one of primary importance. With a view to obtaining some rational basis for proposals of insurance the investigation described in the volume before us was undertaken: it is an attempt to determine quantitatively the relative effects of rainfall, temperature, and cyclonic wind-velocity upon the amount of the sugar-crop.

Obviously the problem is a complicated one. The author attacks it by a study of the climatic statistics for a number of years, in correlation with the crop harvested in each of those years. By successive approximations, after allowing for exceptional influences, it has been found possible to evaluate the effects of the several climatic factors upon the crop.

Taking first the question of rain, the changes in the amount of crop were found to follow in a general sense those of the rainfall, but the ratio *crop/rainfall* varied considerably from year to year. There is, however, not merely the total quantity of rain to be considered; the number of rainy days was soon seen to be as important as the total rainfall. From an agricultural point of view a month in which five inches of rainfall was distributed over twenty days would be a wetter month than if the whole had fallen in one day. Hence in order to obtain the combined effect of quantity and chronological distribution, the idea of "degree of wetness" for each month was introduced by means of the expression $R.t^1/t$, where R is the total rainfall for the month, t the number of days, and t^1 the number of rainy days. But further, in excessive falls a part of the rain is non-effective, and it was necessary to eliminate this portion, partially at least. The method adopted depended upon the consideration that if it were possible to determine the depth of soil to which a given fall penetrated, the amount which passed beyond the limit of the cane roots might be rejected. Increase of temperature in the soil at certain depths was taken as a guide to the points beyond which the fall penetrated.

The effect of high wind velocity on the cane is regarded as falling under one or all of the following heads:—(*a*) Tearing of the leaves; (*b*) bending of the stem about its weakest part; and (*c*) loosening and rupture of the roots. The magnitude of the effect (*a*) depends upon the pressure P of the wind, the duration h of the high velocity, and the epoch t in the plant's growth at which it occurs, since the riper the cane the greater the damage; effects (*b*) and (*c*) depend also on the amount of change θ in the direction of the wind, the greatest damage being caused when the cane is bent in directions differing by 180°. Whence the total effect on the crop is deduced to be expressible by the formula $\kappa P^2 h(2+\sin\frac{1}{2}\theta)\sin\frac{1}{2}t$. The value of the constant κ is obtained from the crop results given in three cyclone years, after eliminating the rainfall and temperature effects. This formula is suggested as a basis for determining the loss due to a cyclone, the values of P, h, and θ being taken from the official observatory records. The practical application for purposes of insurance is explained in detail.

The work is an ingenious and interesting statistical study which may prove to have practical value. A prediction of the crop yield for 1908, based on the methods explained, turned out to be correct within 3 per cent. There seems no reason why, if circumstances demanded it, the methods should not be applicable to other crops than sugar.

C. S.

IRRIGATION ON THE INDUS.

Punjab Rivers and Works. By E. S. Bellasis. Pp. vii+65+47 figs. (Allahabad: printed at the Pioneer Press, 1911.)

THE author presents this work as a treatise setting forth the general rules and principles on which the inundation canals and flood embankments of the Punjab are designed and maintained, since no such work has hitherto existed. This we may take as equivalent to saying that the regulations and practice of the Punjab Irrigation Service have not yet been systematised and brought into book form, since the present volume deals with this aspect of the subject, and does not, unfortunately, cover the wider field of the hydrography of the Indus in its bearing on the utilisation of its water.

While the first chapter deals very briefly with the rivers of the Punjab and their physical characteristics, the next three discuss in considerable detail the inundation or flood canals, the flood embankments, and the river-training works; the last chapter and seven appendices deal with the ordinary procedure, and give certain regulations, orders, and specifications as issued for the work of the Service. The information relating to canals deals with their maintenance, silt deposit, erosion, their section, alignment, and the various modifications which have to be adopted in dealing with the water of a river which has a high seasonal flood and carries a heavy silt load. These characteristics also necessitate flood embankments to control the river flood and protect certain areas in time of the inundation; while no less important are the river-training works to restrict the erosive action of the river on its banks at points where it may damage existing distributing works and towns or villages.

The information so brought together should be of much interest to irrigation engineers, and would have been valuable to a wider circle if fuller material had been provided for those not personally conversant with the Punjab. The case of the gradual destruction of the town of Dera Ghazi Khan on the west bank of the Indus by the gradual erosion of its right bank furnishes an interesting case of river action by the annual flood, and is illustrated by a series of ten plans showing the disposition of the river at this point from 1882 to the present time.

Elsewhere general statements and descriptions are in the majority, and we should have welcomed more quantitative treatment of some of the interesting points which are raised. The regimen of a part of a river cannot be properly understood without some knowledge of the whole, and the lack of this is especially apparent in the first chapter, where a general map of the basin, some information regarding its size, form, relief, structure, &c., would have given a valuable setting to the study of the utilisation of its water which follows. The subjects of rainfall and discharge are dealt with in two brief paragraphs, while we look in vain for maps showing the distribution of the rainfall or diagrams explaining the variations of discharge at different points and at different seasons. A number of plans and diagrams illustrate the report, but in only one case is the scale of the former indicated on it, though in some other cases it can be found from the text. References to other works on the Indus would have been a useful addition. H. G. L.

ELEMENTARY STATISTICS.

An Introduction to the Theory of Statistics. By G. Udny Yule. Pp. xiii+376. (London: C. Griffin and Co., Ltd., 1911.) Price 10*s.* 6*d.* net.

OF all the works a man may set himself to write, the most difficult must surely be an elementary text-book on statistics. The writer of a text-book on almost any scientific subject has to face the difficulties resulting from a recent rapid development of the science of which he is writing, but in statistics he has the further difficulty that many practical methods have been reached by mathematical analysis that is unsuitable for an elementary text-book. Nor is this all, for the subject appeals to so many diverse interests that points simple or useful to one student are merely troublesome or inconsequent to another.

Mr. Yule has made an attempt to explain some of the methods used in practice, without demanding much mathematical knowledge of his readers. This course explains the advantages as well as the limitations of his work, for it has enabled him on one hand to display his natural facility of explanation, and, on the other, it has debarred him from giving more than a sketch of some of the most important parts of the subject; it has even led him to avoid giving certain formulæ and methods that are of almost everyday use.

The book is divided into three parts, the first of which deals with the theory of attributes. We confess that this type of statistical work does not greatly appeal to us, for while good may be done with these methods by a statistician of Mr. Yule's ability, we are doubtful if the notation and formulæ he gives are of real help to a student. To most minds statistical errors in reasoning, for instance, are best explained arithmetically, and many of Mr. Yule's examples in part i. will help his readers more than his algebra or letterpress. The second part deals with the theory of variables, "ideal frequency distributions," averages, standard deviations, and correlation coefficients. There is a chapter on partial correlation which should be helpful to many readers, but we wish room had also been found for an account of some of the most recently discovered methods of calculating correlation coefficients. The last part of the book deals with the theory of sampling, and is mainly concerned with probable errors.

Possibly because of the mathematical work involved, Mr. Yule does not deal with the fitting of curves to statistical data, but a student who has proceeded so far as to study partial correlations and the correlation surface should, we think, have some idea how to do this. The gap will perhaps be filled in a future edition, and revision in some other respects will, we think, also be wanted. For instance, on p. 38 a formula is given for measuring the degree of association, and if it is applied to the example of imbecility and deaf-mutism on p. 34, the value is 0·9, indicating a high degree of association. On p. 213, instead of giving the ordinary formula for working out coefficients of correlation from fourfold tables, Mr. Yule gives a simple expression which he implies can be used in some cases. Unfortunately, in the particular case mentioned above to which a student might be tempted to apply it, the value, instead of being about 0·9, is only 0·02, and gives quite a wrong impression. It was, we think, a great mistake to give the formula on p. 213, as it is open to considerable criticism.

Another example of a case where readers might be misled occurs on p. 67, where a student might easily misunderstand Mr. Yule's discussion of isotropic distributions, and think that they affected the calculation of a coefficient of contingency.

While we are very ready to admit that, within the limitations he has placed on himself, Mr. Yule has given much that is of interest and value, we also feel that there is much in his work which lends itself to criticism—more, in fact, than one would expect to see in an elementary text-book. The two cases that we have given above are merely examples of this, but although we have felt it necessary to criticise, it is a pleasure to add that we have been much interested in reading Mr. Yule's work, and have throughout appreciated his numerous arithmetical examples and the trouble that must have been taken to arrange the book in so clear a form and to supply it with such excellent diagrams.

OUR BOOK SHELF.

Leitfaden für das mikroskopisch-zoologische Praktikum. By Prof. W. Stempell. Pp. iv+84. (Jena: Gustav Fischer, 1911.) Price 2.80 marks.

THE medical practice of teaching histology in a separate section of the course is, we regret to see from the author's preface, becoming adopted in biological teaching; and to this circumstance Prof. Stempell refers for the origin of his book, since he has adapted its contents to meet the requirements of beginners who wish to traverse rapidly a course in comparative microscopy apart from the dissections, museum work, and naked-eye observations with which microscopic work has been hitherto so usefully associated.

At first all is smooth sailing. A lucid introduction on apparatus paves the way to five lessons on protozoa. The methods of obtaining, examining, and preparing the material are admirably explained. The paragraphs are numbered, so that references to procedure can be made at once, and the most instructive and accessible members are dealt with before those which present greater difficulties. A few pages later, however, we find Anthozoa, Ctenophora, Turbellaria, and Trematodes dealt with in a single section, which we must suppose represents three to four hours' work. On the other hand, far more attention is given to the Nematoda than is usual in an elementary course. The section devoted to vertebrate histology is very incomplete.

The illustrations have a special value, since they are in every case photographic reproductions of actual preparations, but as no attempt is made to explain what they show such figures cannot be said to be useful to the student. The chief use of the book lies in the methods which it suggests for the collection and preservation of material. In this respect it will be of considerable service, but as an attempt to present a working course in comparative histology, we should be sorry to see Prof. Stempell's recommendations carried out without considerable modification.

F. W. G.

Early Essays on Social Philosophy. Translated from the French of Auguste Comte by H. D. Hutton. A new edition with additional notes, and with an introduction by Frederic Harrison. Pp. 352. (London: George Routledge and Sons, Ltd.; New York: E. P. Dutton and Co., n.d.) Price 1s. net.

THESE six essays, written by Comte between the ages of nineteen and twenty-one, appeared in vol. iv. of the "Positive Polity," published in 1877. Their special interest is that they prove the unity of their author's life-work—the coherency and consistency of his scientific philosophy and his social polity—as against the view of Littré, that the two are disparate, the later work a backsliding from the principles of the earlier.

The third essay is the longest and the most important. It contains in exact and decisive form the famous Law of the Three States, which "all subsequent thinkers have regarded as Comte's triumphant discovery," and is the basis and the justification of Positivism. From the nature of man's intellect each branch of knowledge in its development is necessarily obliged to pass through three stages—the theological, the metaphysical, and the scientific or positive.

The fourth and fifth essays give a *résumé* of the entire system of the "Positive Polity" as meaning a social and religious reorganisation of society based upon a scientific study of human nature.

Mr. Frederic Harrison supplies an excellent little introduction to this new edition.

Technique de Psychologie Expérimentelle de Toulouse, Vaschide et Piéron. By Ed. Toulouse and H. Piéron. Second edition, tome i., pp. xii+303; tome ii., pp. xvi+288. (Paris: Octave Dion et Fils, 1911.) Price 10 francs the two volumes.

THIS edition, now expanded to double the former size and comprised in two volumes, is virtually a new book. Far more space is devoted to the description of apparatus than formerly. Pieces of apparatus are illustrated, many of which are quite unknown in the psychological laboratories of this country. Not only for this reason, however, is the work likely to be of little value to elementary students of the subject on this side of the Channel. The authors err in laying no stress whatever on an acquaintance with the psycho-physical methods, and on the importance of obtaining introspective data in psychological experiment. It appears to be their object merely to "describe apparatus," much as the authors of a book on experimental physics would do, leaving on one side methods of procedure as if they could be picked up haphazard in the laboratory, and neglecting the introspective data obtainable from the subject of the experiment as if they did not exist! For the instructor or the advanced student, however, the work is of considerable interest. The apparatus, unfamiliar in this country, is excellently described; and there are several novel experiments which appear to have promising value.

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.*]

Rainless Thunderstorms.

FROM the letter signed "E. G." in your issue of August 31, it would appear that the Meteorological Office has not abandoned the ion condensation theory of the origin of atmospheric electricity. Now, there are many difficulties in accepting that theory. For instance, before condensation can take place on ions, there must first be dustless air; otherwise the necessary supersaturation cannot take place; and one naturally asks, Has anyone ever found dustless air in our atmosphere? So far as records go of air up to 10,000 feet, this has not yet been found, and it does not seem likely that it ever will be found, as the hot air carrying up the aqueous vapour to form clouds always carries up with it plenty of dust to act, if one may use the simile, as the return ticket to bring the water back to the surface of the earth. As much of this dust is very fine, only falling a few centimetres in a day at low level, it is likely to go wherever the moist air goes—in even the more rarefied regions of the upper clouds. Further, there is the constant supply of fine dust from the upper regions due to the disintegration of meteors, so that the air at cloud levels is likely always to have plenty of dust and condensation on ions seems impossible.

Another difficulty of importance is, Has anyone ever shown that it is possible for a cloud to form on ions under the conditions in which condensation takes place in the atmosphere? It is true that clouds can be formed on ions under experimental conditions; but in these the expansion must be made with explosive quickness, because if the expansion is made slowly only a few ions become centres of condensation, and these rapidly grow to the size of raindrops in the highly supersaturated air; and these drops in falling relieve the supersaturation of the air some distance round them all along their path, so preventing other ions becoming centres of condensation, and only rain, not cloud, is produced. It would appear that these and other difficulties are worth considering before accepting the ion condensation theory of the electrification of clouds.

With regard to rainless thunderstorms, though no rain falls, is that a proof that no rain has been formed? May not rain have fallen from the clouds, but evaporated before reaching the earth? One sometimes sees after dry weather clouds passing overhead from which rain seems to be falling, yet not a drop reaches the earth. If the thunder clouds be high and the lower air very dry, such as we have lately experienced, we can easily see that raindrops will undergo evaporation while falling and may be dried up before reaching the earth; and as the horizontal direction of the movement of the thunder clouds is generally different from that of the lower air, the falling rain may not get a chance of saturating the lower air, even though the storm may continue some time.

For the benefit of those who may make a study of thunderstorms, it may be of interest to record, as illustrating the influence of the geographical situation of a place on the formation of thunderstorms, that the district round Falkirk has a strange exemption from such storms. So far as I can remember, there has only been one good thunderstorm within my memory, and that goes back a long way, and on that occasion the storm covered a great part of the country. Once or twice in a year a few distant peals may be heard; and once this year we had a storm which lasted half an hour, with about six peals and some lightning, but that storm was an exception. With the one exception above mentioned, there are no great storms in that district such as are experienced in most parts of the country. It should be mentioned that Falkirk lies in the shallnw valley connecting the Firths of Forth and Clyde, through which it is proposed to cut the low-level canal, and that there are no high hills near.

John Aitken.

Loch Awe Hotel, Loch Awe, Argyllshire, September 5.

A Pseudo-Aurora.

The explanation which Sir Lauder Brunton calls for in No. 2183 of Nature seems to be very simple indeed. On the evening of August 21, which he mentions, thunderstorms of extreme violence came over the region of Lugano and its environs. That region is due south-east of Beatenberg, as is also the Mönch. The flashes seen were most certainly those of lightning, and the auroral appearance is very easily explained. Anybody may, in a mountainous country, whenever there is a slight haziness in the atmosphere, remark the shadows thrown on the mist by a light —sun or moon—when still behind a mountain top, *i.e.* rather low down in the sky. Such was the case with the storm over Italian Switzerland, and the intense lightning on August 21 was noticed as far away as the Canton de Vaud. The flashes, lighting up the sky through the gaps between the mountains, with the corresponding dark rays of the shadows, following in uninterrupted succession, may well have given an impression of seeing auroral rays.

J. S. Grey.

Gryon-sur-Bex, Canton de Vaud, September 4.

The Destruction of Kingfishers near London.

I have just received a letter from a man who has been very busy amongst the kingfishers that visit his grounds within ten miles of the Bank of England. I enclose the original letter, and now quote therefrom:—"I have caught sixteen quite lately [apparently since the middle of August]. Six went to —— alive; the others I have skinned. Would you make me an offer for nine?" Since receiving this letter I have been given three carcases, and understand that these birds were supplied alive to a dealer by my correspondent; this brings the total up to nineteen birds, *at least*, removed from the bird-population of the London district by one man. A disagreeable fact is that all appear to have been killed not illegally.

The weapon employed was, of course, the deadly "kingfisher net"; and my chief reason in writing this note is to suggest that steps might well be taken to prohibit both the use and the possession of this instrument. It is practically useless for everything except the capture of kingfishers; and so simple is it to buy, or make, or use, and so secret and so certain in its action, that by its means a man destitute of the elements of woodcraft could, and frequently does, utterly clear a stream of its chief feathered ornaments. I do not know of any fowling engine more effective against its proper quarry than the kingfisher net, nor can I think of one that needs less actual supervision. This latter point explains why it is so often in the hands of the unprivileged collector and the poacher, and I have heard of it being used while its owner and operator was actually under the constant eye of a keeper—of course, one unaware of the intentions of his suspect.

I cannot think that I exaggerate if I say that the kingfisher is the most defenceless of British birds, for no bird is easier to kill. This is with the net; without the aid of a net an organised kingfisher hunt would be unremunerative, if not quite impossible, for many destructive men do not dare to use a gun. Freed from the danger of the net, the kingfisher would be in a peculiarly secure position, and would certainly increase until perhaps common enough to be familiar by sight to all who have the desire to see one alive. Its food consists of small fishes and other aquatic animals, and the pisciculturist is the only person who would suffer from the increase of the bird. No good can come of attempting to ignore the fact that in and about fish hatcheries the kingfisher is an intolerable nuisance, and its destruction becomes at times an economic necessity, for it is not always possible to protect the fish by wire netting. But the prohibition of the net need not prevent the killing of the birds, for the keeper could easily use a gun. The kingfisher provides a simple target, although, fortunately, its habits protect it largely from the casual or wandering gunner. Without loading this letter (which is no more than a hint or a suggestion) with other details, I must end by saying that I have often considered the matter in all its aspects, and I believe that the total prohibition of the kingfisher net would lead at once to an increase in numbers of this ornamental bird, and that this prohibition would entail no hardship on the pisciculturist, who is the only person likely to be affected by the increase of the kingfisher. Perhaps something could be done in this matter by those who have the leisure to occupy themselves with the laudable work of active bird protection.

Stepney Borough Museums. Fredk. J. Stubbs.

A Bright Meteor.

Walking northwards on Saturday evening, September 2, I was looking towards the constellation of Cassiopeia when a bright meteor appeared at a point a few degrees west of η Perseus, and moved slowly westwards, gradually increasing in brightness until its disappearance at a point near α Canes venatici.

Its maximum brilliancy was about four times that of Jupiter, and its colour almost pure white.

The time occupied in its transit was between six and seven seconds, and a bright golden trail persisted for about two seconds more.

The time of the phenomenon was 20h. 27m. (G.M.T.).

Wilfred C. Parkinson.

The Observatory, Eskdalemuir, Langholm, Dumfriesshire, September 4.

Non-Euclidean Geometry.

I owe sincere apologies for carelessness in the latter portion of my letter in last week's issue of Nature.

In hyperbolic space, the area of a circle of very large radius R appears as

$$2\pi K^2\left(\cosh\frac{r}{K}-1\right),$$

i.e. practically

$$\pi K^2 e^{\frac{R}{K}},$$

which is an *exponential* infinitude.

On the other hand, the area of a regular N-gon inscribed therein appears as something less than

$$\pi K^2 N,$$

which is a *linear* infinitude.

Is not hyperbolic infinity paradoxical?

W. B. Frankland.

Examinations.

SIR WILLIAM RAMSAY's outspoken criticism on the value of examinations will be welcomed by many, but it is uncertain whether the general public could tolerate the present educational system in their absence.

When the chemical department becomes the department of chemical research, and the student realises that he is receiving a training in such practice, examinations as conducted in the majority of cases may possibly lose their present-day significance.

While practical training remains based upon text-book instruction, which hardly calls for anything more than observation on the part of the student, examinations are necessary. There is no other method of testing the student's memory.

Observation has been defined as "the performance of what is prescribed." It is the chief factor in a system of empiricism, but it cannot be expected to occupy this position for all time in a programme dealing with experimental investigation. It may be that a correct method of instruction has yet to be devised.

Examinations lose their chief value when they fail to supply the student with an estimate of the value of his personal qualifications, enabling him to confirm his original intention or change the direction of his life's work while there is yet time. W. P. DREAPER.

September 6.

Habits of Dogs.

I CANNOT answer Miss Everett's questions on this subject, but would like to "ask another." Is it known to be a common thing for dogs to carry hedgehogs in their mouths? I have a fox-terrier who amused himself in our garden by making life a burden to a hedgehog until the latter disappeared. He would not only roll the hedgehog about with his paws, but must have carried it a certain distance in his mouth, for one evening I found him in triumph at the back door of the garden with his lips all marked with pricks and bleeding, and the hedgehog lying in a ball at the top of three rather steep stone steps twenty or thirty yards from the summer-house where he lodged. If this is a usual form of play with dogs, it is a curious one. WALTER KIDD.

Heatherdown, Alum Bay, I.W., September 5.

Miniature Rainbows.

YOUR correspondent Mr. W. E. Hart may be interested to know that magnificent rainbows, which appear to be within easy reach, may often be observed inside water-cooling towers, the necessary conditions being a fairly heavy shower of the cooled water and an opening at one side of the tower sufficiently high to let the sunlight stream in over the observer's head. B. P. H.

Newcastle-on-Tyne.

Underpayment of Teachers.

MR. HODGSON's letter on p. 315 directs attention to a case of underpayment of teachers in collegiate institutions. Possibly the City of Bradford Education Committee would argue that, as universities generally offer about 150*l.* a year to lecturers, judging by the advertisement columns of NATURE, 60*l.* a year, with the privilege of earning a little more in the evenings, is sufficiently liberal for the work that they require.

150*l.* is a good stipend for a youth for the first few years after leaving college, or as a retaining fee for a man who has private means; but is it fair to expect men with high university qualifications, years of teaching experience, and a record of original work, to struggle to make both ends meet for the best part of their lives?

Twenty years ago, a lecturer might reasonably expect to become a professor or to branch out into technical work; but at the present time there are not enough professorships to divide among the many highly specialised men who have taken up university teaching during the past ten years, and a technical career must be commenced on leaving college.

The prospects of secondary teachers, though poor, are better; those of elementary teachers are better still; while none of them are so good financially as those of the boy who leaves school at sixteen or seventeen and enters a bank or an insurance office.

Since for university teaching a man needs a long and expensive training, must be a graduate with first-class honours, and must be capable of original work, and since many cannot hope to obtain professorships and the like, the remuneration offered to such men is woefully insufficient, and is likely in the future to cause students of ability to avoid university teaching as a career.

E. R. MARLE.

"Omori," Bitterne, Hants, September 8.

RUBBER.[1]

THE Rubber and Allied Trades Exhibition and the International Rubber Congress, held conjointly and recently concluded, are doubtless responsible for the simultaneous appearance of four books on rubber. One of these is a welcome attempt, as its title implies, to cover the whole range of the subject, and

FIG. 1.—Jelutong Tree, showing improved method of tapping. From "Rubber."

Mr. Philip Schidrowitz is to be congratulated on having produced a volume which should rank as a standard work for some time to come.

The first nine chapters, half the book, are of special interest to the lay reader, and are based, as the author points out in his preface, upon six lectures delivered by him in 1910 at Finsbury Technical College. The historical sketch in chapter i., and the two following chapters on production and consumption, and the general nature of the rubber industry, will be found most useful. The notes on wild, and what the author terms industrial rubbers, such as Guayule, Jelutong, and Madagascar vine rubbers, suffer somewhat from his lack of personal acquaintance with the actual

[1] "Rubber." By Dr. P. Schidrowitz. Pp. xv+303. (London: Methuen and Co., Ltd., 1911.) Price 10*s.* 6*d.* net.

conditions abroad. For instance, in dealing with bark crushing no distinction is made between the East African scrub vines with semi-fluid latex, and the larger dense forest vines in which the latex is thin and watery; nor are the paragraphs dealing with *Castilloa elastica* and *Funtumia elastica* free from misconceptions.

The chapter on the plantation industry is a book in itself, and will be read with the greatest interest. While laying no claim to being able to treat this truly extensive subject "in encyclopædic fashion," the author is to be congratulated upon the way he has singled out for mention, in few and telling words, the salient points under each of his headings. Under that of "Competition from other Sources," we read: "The first rubber to go will undoubtedly be that which is not prepared in a cleanly fashion. 'Africans' as we know them now will be a thing of the past, and that very shortly. It does not, however, follow that the rubber forests of Africa will no longer furnish their quota to the world's supply. On the contrary, it seems to me that the system of rationally working forest areas on semi-plantation lines . . . is likely to be extended."

Mr. Schidrowitz is very well known as a rubber chemist, and in the second half of the book he finds himself, as it were, on more congenial soil. In dealing with the chemistry of rubber, theory of vulcanisation, manufacture of rubber goods, substitutes and waste-rubber disposal, much new matter is introduced which is likely to be invaluable, not only to the general reader, but to the manufacturer and the chemist. The importance of the waste rubber industry is emphasised, and in this connection the author says: "If we assume that the crude rubber employed in the manufacture of goods in the British market yearly amounts to 12,000 tons, and this reappears in the shape of finished rubber articles, containing on the average perhaps not more than 30 per cent. of rubber, it is plain that there must be something like 30,000 to 40,000 tons of waste rubber annually. Of this, perhaps, one-half is recoverable, the remainder actual waste."

The chemical analysis of both vulcanised and raw rubbers, mechanical tests, and kindred subjects are also dealt with at length, while at the end of the book is an appendix of ten pages dealing with the wording of contracts and specifications which might also be described as interesting reading, which says much for the author's happy style of literary construction.

On p. 140 the reader with planting interests at stake will find: "The manufacture of synthetic rubber on a commercial scale will only be possible if a suitable low-priced raw material, capable of transformation at a low cost and with a high yield, can be found. So far these conditions do not appear to have been fulfilled."

With the Middle East and its Hevea plantations just now so prominent in rubber finances one is apt to forget that the sources of rubber are many and various. Trees, vines, shrubs, tubers, rhizomes, &c., belonging botanically to different classes of plants and growing in different continents, all appear in the list of productions of this commodity. This being so, and without implying that the book under review would have been more successful in any other form, it is clear that future publications on rubber will be likely to attain the greatest measure of utility if confined to one or other branch of this already stupendous subject.

FIG. 2.—Three-year-old rubber trees. From "Rubber."

Mr. Schidrowitz's book is excellently written, and is illustrated largely from photographs taken by him during a tour in Malaya and Sarawak (Borneo).

THE LIVES OF BRITISH BIRDS.[1]

THE third and fourth sections of this pleasant work on popular British ornithology comprise the dipper, the thrush family, the warblers, the hedge sparrow, the starlings, the golden oriole, and the waxwing. The work is professedly and necessarily very largely a compilation, and a vast amount of most interesting and valuable information has been gathered together from widely scattered and often very inaccessible sources. This is carried out in a manner deserving all praise, the more so that a reference is always given to the publication from which the information is gleaned. Nevertheless, we sometimes miss, in the accounts of some of our more familiar species, the charm often found in a first-hand narration, and in the case of some of the articles, *e.g.* that on the dipper, we do not find impressed upon a good many field naturalists whose acquaintance with the species in question has been of some duration. What is alluded to here as the lesser whitethroat's "loud rattling call" is usually regarded as the final portion of the bird's song, analogous to the bright, clear, piping notes with which the blackcap—though not invariably—concludes its strain.

In the excellent article on the marsh warblers—full of most interesting and valuable information—the author shows that he is remarkably at home with the subjects of his essay.

Many people must have noticed the habit the robins have in winter of keeping closely to one part of the garden, homestead, fields, or woodland, where they mean to live through the cold weather. Mr. Kirkman has gone into this matter closely, and gives in section iii. an interesting account of the result of his in-

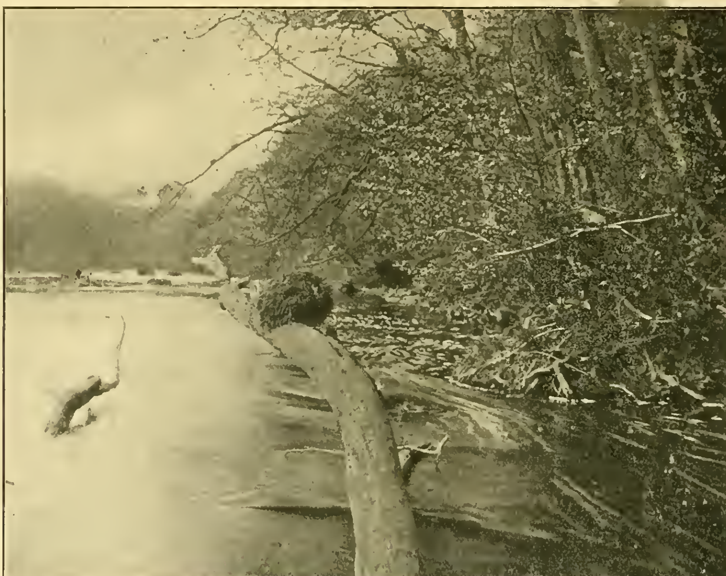

Photo.] [*Riley Fortune.*
FIG. 1.—Dipper's nest on a trunk projecting from the water. From "The British Bird Book."

them, or expressed by them, as much evidence of a personal acquaintance with the subject thereof as we might perhaps expect from those who undertook to write such accounts of well-known British species.

Again, one author writes, "I have not heard the song of the black redstart." This is a pity, because he has to fall back upon Naumann, who must surely have been prejudiced against the bird; and consequently no justice has been done to one of the most charming of bird songs.

In the article on the whitethroats, blackcap, and garden warbler, the author writes: "Difficult as it may be to distinguish between the songs of these four warblers. . . ." This implied statement will surprise

vestigations. He writes: "The robin, unlike any other British winter species that I know of, is found from about the end of August to the middle of February in solitary possession of a more or less well-defined feeding area, from which all others of his own species are excluded. Pressure of cold weather may sometimes force him to associate with his fellows in order to share the crumbs put out by the charitable, but he can hardly be said to suffer them gladly. He is happy only when alone. Hence the old saying, that 'one bush will not harbour two robins.'" From August to March he kept the robins about a farm under observation, and he was able at last to map out their adjoining estates—a plan of which is given. The boundaries of these estates, it is seen, are nearly everywhere imaginary lines, and they overlap, but every robin clearly recognised to within a

[1] "The British Bird Book." Edited by F. B. Kirkman. Section iii., pp. 297–449; Section iv., pp. 169. (London and Edinburgh: T. C. and E. C. Jack, n.d.) Price 10s. 6d. net each part.

yard or two the position of his boundary, and made the fact quite clear to any other robin who did not. Moreover, the author found that it was not easy to drive them out of their own little estate, to which they invariably returned immediately.

The intention of making life habits the chief feature in the work is fully carried out in the last two sections. A notice inserted in the last part informs readers that in order to render the notes on Distribution more complete, the range of each species outside its breeding area will be briefly indicated.

Mr. A. W. Seaby's pictures are as charming,

Photo] [*W. Farren.*
FIG. 2.—Reed-warbler feeding its young. From "The British Bird Book."

spirited, and lifelike as ever—quite the most original and refreshing bird pictures we have seen for long—and there are excellent plates of the rosy pastor, golden oriole, and waxwing by some of the other artists who contribute to the work.

A MONUMENT TO JANSSEN.

AN influential committee has been formed to raise to the memory of Janssen a durable monument which shall recall to the minds of those who see it the enormous and brilliant services rendered to astronomy by the great French *savant.*

A man of rare breadth of mind, it was not simply to any one branch of the oldest science that Janssen turned his attention, but he will be remembered chiefly for his fruitful researches in astronomical physics. That brilliant discovery, shared by Lockyer, in 1868, will probably be the *lucida* of his labours, the method of observing solar prominences, of drawing and measuring those enormous solar flames, without waiting for the rare and uncertain seconds of a total solar eclipse. Only those whose work it is to observe and to study solar phenomena know how much of our present knowledge is due to the timely discovery of this method. By this have the labours of the discoverers, of Respighi, of Young, of Tacchini, Ricco, Hale, and Deslandres, and of many others become productive. Janssen from India and Lockyer from West Hampstead sent messages to the French Academy which arrived almost simultaneously, and immediately a new era in the rapidly expanding knowledge of the sun's physical and chemical attributes was opened.

Janssen also studied with great assiduity and marvellous results the laws of the absorption and transmission of light travelling through gaseous media, and thereby laid foundations on which have since been erected wonderful superstructures. As an organiser he was in the forefront. His photographs of the solar surface were magnificent and have never been excelled. It is to Janssen that we owe the establishment of the solar observatory on Mont Blanc, whither, in spite of his lameness, he made many ascents.

All this will count as an imperishable monument to those who know aught of astronomical physics. We heartily sympathise with the aims of the committee which has charged itself with receiving subscriptions to this end, and below give the names of those who have already joined:—MM. Armand Gautier, président de l'Académie des Sciences; G. Lippmann, vice-président; G. Darboux, secrétaire perpétuel; Ph. Van Tieghem, secrétaire perpétuel; C. Wolf, doyen de la Section d'Astronomie; Henri Poincaré, de l'Académie Française; G. Bigourdan, de l'Institut; J. Violle, de l'Institut; B. Baillaud, directeur de l'Observatoire de Paris; Prof. Chauveau, de l'Institut; De Selves, préfet de la Seine; Daumet, de l'Institut; Edmond Perrier, directeur du Muséum; Prof. Bouchard, de l'Institut; Alfred Grandidier, de l'Institut; Prof. Lannelongue, Sénateur; Dr. Roux, directeur de l'Institut Pasteur; R. Radeau, de l'Institut; G. Lemoine, de l'Institut; H. Deslandres, directeur de l'Observatoire de Meudon; M. Hamy, de l'Institut; P. Puiseux, astronome à l'Observatoire de Paris.

PIERRE ÉMILE LEVASSEUR.

BY the death of Pierre Emile Levasseur both geography and economic science in France have sustained a severe loss. Born on December 8, 1828, Prof. Levasseur devoted his energies during a long life to demonstrating the importance of a right appreciation of geography in its application to man and of economic science. As early as 1863 he published a "Précis d'Histoire de France" and a "Précis de Géographie," and throughout many years of active work in economic geography he always aimed at the highest precision in his studies with the view of building up a truly scientific type of geography and insisting upon the educational value of the subject when so treated. He especially directed his efforts towards a thorough understanding of the economic geography of France, but he also travelled widely in order to study economic conditions occurring in other lands; a journey to the United States in 1853 resulted in an important work, "L'Ouvrier Américain," and the same line of investigation, followed up both historically and economically, produced important studies on the working classes in France up to the time of the Revolution, and a later work dealt with their condition under the Third Empire. Working in such fields, his attention was early directed to statistics, and in his important work "La Population Française" he not only treats of the geographical aspects of the question, but deals with it statistically and points out the importance of the proper use of statistics in all questions of applied geography. In all that relates to human geography, the definiteness which we meet in physical geography is only attained with difficulty, and by the careful and prudent use of the best statistical material available. In this direction Levasseur's work furnishes many examples of the highest value as giving a truly scientific form to investigations which, from the numerous factors involved, are too often treated superficially.

H. G. L.

THE BRITISH ASSOCIATION AT PORTSMOUTH.

As we went to press last week, the concluding meeting of the British Association at Portsmouth was being held; and the thanks of the Association were being expressed to the local authorities for the work they had done and the trouble they had taken to make the visit to Portsmouth pleasant and memorable. Everyone agrees that the Portsmouth meeting was most enjoyable; and well it might be, considering that it was held at a seaside resort during the season when "sunny Southsea" is full of attractions. In spite of great difficulties, the Mayor (Alderman T. Scott Foster) was able to arrange for the accommodation of the secretaries and other officials in the best hotels, and to provide hospitality for distinguished visitors. There was little private hospitality, and the grant of 3500*l.* made to the Mayor by the Corporation of Portsmouth for the entertainment of the visitors can scarcely have covered the expenses involved.

The best thanks of the world of science are due to the Mayor and the Corporation for the public spirit they have shown in making provision for the meeting, in spite of a certain amount of local opposition to the necessary expenditure. The actual work of local arrangements has, of course, fallen largely upon the shoulders of the local secretaries, namely, the town clerk (Mr. G. Hammond Etherton) and the medical officer of health (Dr. Mearns Fraser). Only those who have had to be responsible for the organisation of a meeting such as that concluded last week can understand how well the thanks received by the local secretaries are merited. The total attendance at the meeting was 1,241.

Of the attractions provided for the entertainment of the visitors, the naval display, which was viewed from the battleship *Revenge*, was most impressive; and it will long remain in the memories of the large party privileged to see it. The Association owes this distinctive feature to the Commander-in-Chief, Admiral Sir William Moore, who, in acknowledging the vote of thanks to him and the officers and men of the Royal Navy for the display, paid a generous tribute to the work of science. "When I am at sea," said Sir William, "Lord Kelvin's compass and sounding-line make me think of him with gratitude twenty times a day"; and, referring to Sir William White, who proposed the vote of thanks, he remarked, "He has given us the greatest essential in the design of our ships, namely, a steady gun-platform."

On account of the naval display, it was impossible for the Committee of Recommendations to decide upon the grants for scientific purposes on the Monday, so the subjoined list, which was adopted by the General Committee on Wednesday afternoon, was not available for publication last week. The total is 40*l.* less than last year.

GRANTS OF MONEY APPROPRIATED FOR SCIENTIFIC PURPOSES BY THE GENERAL COMMITTEE AT THE PORTSMOUTH MEETING.

	£
Section A.—Mathematical and Physical Science.	
Seismological Observations	60
Upper Atmosphere	30
Magnetic Observations at Falmouth	25
Establishing a Solar Observatory in Australia	50
Grant to the International Commission on Physical and Chemical Constants	30
Tabulation of Bessel Functions	15
Section B.—Chemistry.	
Study of Hydro-aromatic Substances	20
Dynamic Isomerism	30
Transformation of Aromatic Nitro-amines	10
Electroanalysis	10
Plant Enzymes	30
Section C.—Geology.	
Erratic Blocks	5
Palæozoic Rocks	10
Composition of Charnwood Rocks	2
Igneous and Associated Sedimentary Rocks of Glensaul	15
List of Characteristic Fossils	5
Sutton Bone Bed	15
Benbridge Limestone	20
Section D.—Zoology.	
Index Animalium	75
Table at the Zoological Station at Naples	30
Belmullet Whaling Station	20
Secondary Sexual Characters in Birds	10
Section E.—Geography.	
Equal Area Maps	20
Calculation of Areas on the Spheroid	25
Section G.—Engineering.	
Gaseous Explosions	60
Section H.—Anthropology.	
Glastonbury Lake Village	5
Age of Stone Circles	15
Anthropological Notes and Queries	40
Artificial Islands in Highland Lochs	13
Physical Character of Ancient Egyptians	40
Excavations in Easter Island	15
Anthropometric Investigations in British Isles	5
Section I.—Physiology.	
The Ductless Glands	35
Table at the Zoological Station at Naples	20
Anæsthetics	20
Calorimetric Observations	40
Section K.—Botany.	
Structure of Fossil Plants	15
Experimental Study of Heredity	35
Survey of Clare Island	20
Jurassic Flora of Yorkshire	20
Section L.—Education.	
Mental and Physical Factors	5
Overlapping	5
Industrial and Poor Law Schools	10
Influence of School Books on Eyesight	5
Corresponding Societies Committee.	
For Preparation of Report	25
Special Grant.	
Collections to illustrate Natural History, &c., of the Isle of Wight	40
Total	1050

SECTION G.

ENGINEERING.

OPENING ADDRESS BY PROF. J. H. BILES, LL.D., D.Sc., M.INST.C.E., PRESIDENT OF THE SECTION.

IT has happened during recent years that accidents have happened to ships and they have mysteriously disappeared. The complete disappearance without leaving any trace has led to the assumption that the vessel has capsized. The circumstances of such cases obviously preclude the existence of any direct evidence. The only subjects of investigation can be (1) the condition of the ship prior to the accident, and (2) the probability that such a condition could be one which in any *known possible circumstances* could lead to disaster. The first is determinable by evidence in any particular case. The second involves a consideration of the whole question of the behaviour of ships at sea. What is the effect upon any given ship of a known series of waves? What waves is a ship likely to meet?

This subject has occupied the attention of scientific engineers, and it may be said to have been considered a solved problem. We have thought that if a ship has a certain metacentric height and a certain range of positive stability she is quite safe from the action of a series of waves of any kind which we know to exist. If, however, a known ship (and perhaps more than one) has these safety-ensuring qualities and mysteriously disappears, it may be desirable to review the grounds of our belief to see whether any *known possible combination* of circumstances may cause disaster.

Let us then first briefly review the grounds of our belief. Fifty years ago Mr. Wm. Froude showed that the large angles occasionally reached in rolling are not due to a single wave-impulse, but are the cumulative effect of the operation of successive waves. The period T of a small oscillation of a ship in water free from wave disturbance and resistance is $\pi\sqrt{\frac{k^2}{gh}}$, where k is the radius of gyration and h is the metacentric height (*i.e.*, the height of the metacentre above the centre of gravity). The period T of a wave is $\sqrt{\frac{2\pi l}{g}}$, where l is the length of the wave and g is the acceleration due to gravity. The line of action of the resultant of the supporting pressures acting on a ship in undisturbed water is the vertical through the centre of gravity of the volume of the water displaced by the ship. In wave-water it is in the normal to the effective wave-slope (which is approximately the wave-surface). The oscillation of this normal as the waves pass causes a varying couple tending to incline the vessel. If the vessel is very quickly inclined by this couple she will place herself in or near the normal and the inclining couple will be of zero value. If, however, her movements are very slow, the normal may make one or more oscillations before any appreciable effect is produced on the vessel. The tendency to incline in one direction caused by the normal acting on one side of the vertical is checked by the rapid oscillation of the normal to the other side of the vertical. It is, therefore, evident that the relation between the period of the ship and that of the wave normal is a dominating feature in the resulting movement of the ship. Mr. W. Froude's mathematical solution of this relation is the basis of our belief that we understand the behaviour of a ship in the *uniform* system of waves when the vessel is placed broadside on to the waves. To obtain this solution he assumed that within the limits considered, the moment of stability varied as the angle of inclination. In the curve of righting levers of a ship, usually known as a curve of stability, this condition holds generally for angles up to about 10°. The curve usually reaches a maximum value at about 30° to 40° and vanishes at 60° to 80°, so that for large angles of roll the assumption does not hold. On this assumption, however, he showed that the motion of a ship amongst such a system of waves is the same as for still water plus a motion composed of two sine terms. The amplitude of this latter motion depends upon the maximum slope of the waves and the ratio $\frac{T}{T_1}$ (the period of the ship in undisturbed water to the period of the wave). If the ship starts from rest in the upright, θ is the maximum angle of inclination of the ship and θ_1 the maximum wave-slope; then

$$\theta = \theta_1 \frac{1}{1 - \frac{T^2}{T_1^2}}$$

He considered several solutions of the equation of motion:—

(1) $T = T_1$; this is synchronism and the angle of inclination gradually increases. Each wave-impulse adds something to the ship's inclination and without any resistance to rolling the vessel would capsize.

(2) $\frac{T}{T_1} = 0$; this is the case of the ship's period being very small compared with that of the wave. θ will then be positive and equal to θ_1. In other words, the ship will place herself normally to the wave-slope. The maximum amplitude will only be the maximum wave-slope.

(3) $\frac{T}{T_1} < 1$. In this case the wave-period is greater than that of the ship and θ is always positive and greater than θ_1. The vessel always inclines away from the wave-slope. If

$$\frac{T}{T} = \tfrac{1}{4},\ \theta = \frac{16}{15}\theta_1. \quad \text{If } \frac{T}{T_1} = \tfrac{1}{2},\ \theta = \frac{4}{3}\theta_1. \quad \text{If } \frac{T}{T_1} = \tfrac{3}{4},\ \theta = \frac{16}{7}\theta_1$$

The nearer $\frac{T}{T_1}$ is to unity the larger is the maximum amplitude.

(4) $\frac{T}{T_1} > 1$. In this case the wave-period is less than that of the ship, and θ is always negative. The vessel inclines towards the wave-slope.

$$\text{If } \frac{T}{T_1} = 1{\cdot}1, \text{ then } \theta = -4{\cdot}76\,\theta_1;$$
$$\frac{T}{T_1} = 1{\cdot}26, \text{ then } \theta = -\theta_1;$$
$$\frac{T}{T_1} = 2{\cdot}0, \text{ then } \theta = \frac{1}{3}\theta_1;$$
$$\frac{T}{T_1} = 2{\cdot}235, \text{ then } \theta = \tfrac{1}{4}\,\theta_1.$$

This shows the advantage of having T greater than T_1.

He showed that the ship goes through a cycle of changes and considered the effect of variations of $\frac{T}{T_1}$ upon these cycles. He showed that $\frac{T}{T_1} = \frac{5}{4}$ is better than $\frac{T}{T_1} = \frac{4}{5}$, so that it is better to lengthen T rather than to shorten it. Similar results for $\frac{T}{T_1} = 2$ and $\frac{1}{2}$ respectively gave better results by lengthening than shortening T. In each of the cases $\frac{T}{T_1} = \frac{5}{9}$ and $\frac{T}{T_1} = \frac{9}{5}$ the results show baulked oscillations in which, while the vessel swings towards the vertical, she does not reach it but swings back again. The lengthened value of T here also gave better results than for shortening it. The results given above are greater than would be obtained in practice, because resistance has been neglected. Later he determined the effect of resistance upon rolling in still water free from waves. He determined the law of resistance and found it to vary partly as the angular velocity and partly as the square of it. He rolled a ship, and after she was allowed to roll free from disturbance he measured the angle of inclination at the end of each roll. These showed the rate of extinction of the rolling due to the resistance. The loss of extreme angle of roll between one roll and the next represented the work done by the ship in rolling. It is possible to calculate the work done in inclining the vessel to any angle, and the difference between the amount of work thus done in two different angles represents the difference in work necessary, and therefore work done in resistance to bring the ship to these angles of inclination. Hence the work done by resistance between the two consecutive rolls can be actually measured by measuring the extreme angle of inclination in successive rolls.

Having determined the resistance in terms of angles of roll and time, it was easy to determine the law which represented the resistance in terms of the angular velocity.

In applying this to waves, all that is necessary is to take account of the fact that the position of equilibrium about which the ship oscillates is the normal to the effective wave-slope. This normal has a definite oscillation about a fixed vertical. It is, therefore, possible to determine the angle of inclination in terms of time.

As these angles of roll may be considerable, the assumption upon which the general solutions for unresisted rolling, already given, were based will not hold. The actual moments of stability depend upon the form of the ship and the position of its centre of gravity, and as these vary in different ships it is only possible to obtain the relation between inclination and time by a special investigation in each case. A solution by a method of graphic integration was devised by Mr. W. Froude and has been applied to a very small number of cases. The information necessary to obtain a solution in any one case is as follows:—

(1) A curve of righting levers in terms of angle of inclination. This is called a curve of statical stability.

(2) The form and period of the wave on which the ship is supposed to be placed broadside on.

(3) The constants which determine the actual value of the resistance moment in terms of the angular velocity. These can be obtained by rolling the ship in still water and observing the rate of extinction of rolling when that extinction is due to resistance only. The form of the curve of extinction can be obtained by rolling a model of the ship, but the actual ordinates of the curve for an actual ship can only be obtained by experiment on the ship herself, or by inference from a similar ship of approximately the same size, form, and arrangements.

A consideration of these three necessities for the solution of one particular case shows that a considerable amount of work is necessary for determining the angle of inclination in terms of time. Even this solution can only be made for one assumed maximum angle of inclination as a starting condition. For instance, in any case where a ship is assumed to start with a maximum inclination of 20° it is only possible to obtain one solution of angles of inclination in terms of time. If we take another maximum angle of inclination, another complete solution is necessary. The work of each solution is considerable.

For ships which vary much in draught and condition of loading it is evident that for each ship the work of complete investigation for all the conditions of loading of different waves and different angles of maximum inclination is very great. For this reason the investigation of rolling by the Froude graphic method has only been made for a very small number of cases, and our knowledge of the actual angles of inclination of ships obtained by this method is very small.

The curve of statical stability is worked out for many ships in a few conditions of draught and position of centre of gravity. These curves are of little practical value, because they only serve as comparisons between ships. It is assumed that if a ship has a fair range of statical stability, *i.e.*, that the angle of vanishing statical stability is not less than, say, 60°, and the maximum righting lever is not unlike some previous ship which "has been to sea and come home again" safely, this ship will be safe. This assumption is based on the belief that only what has happened to previous ships will happen to the one in question; that is, that the contingencies of waves will be the same in all cases. But when we find that occasionally ships are missing we are compelled to ask ourselves the question—is it possible that some occasional contingencies of sea or ship, or both, may exist which will produce a dangerous and perhaps fatal roll?

Mr. W. Froude's investigations were made for a uniform system of waves. He showed that in unresisted rolling a ship initially at rest and in the upright position is acted upon by a uniform series of waves such that $\frac{T}{T_1} \, \frac{p}{q}$ where p and q are the smallest whole numbers which express this ratio, then the rolling of the ship will be in cycles, the maximum inclination in each roll gradually increasing, and again gradually diminishing, and so on. The period of occurrence of the maximum of maxima will be $2q$T. The number of times the ship passes through the upright in each complete cycle is $2p$ or $2q$, whichever is the smaller. The ship is upright at the middle of the cycle, and on either side of this middle there is an equal maximum which is approximately $\theta_1 \frac{q}{q-p}$, and never exceeds this value (where θ_1 is maximum wave-slope). If T is much larger than T_1, and therefore p is much larger than q, then the value of $\theta_1 \frac{q}{q-p}$ approaches $\theta_1 \frac{q}{p}$ and is less than the wave-slope. If T is much smaller than T_1, then the value of $\theta_1 \frac{q}{q-p}$ approaches θ_1. If T is nearly equal to T_1, then $\theta_1 \frac{q}{q-p}$ approaches a high value.

From this it is seen that our investigations in unresisted rolling may be over a very wide field, but would produce no definite result in the matter of finding cases of large angles of roll in practice. We can only obtain valuable results when resistance is included.

Mr. R. E. Froude in 1896 was led to deal with the subject of non-uniform rolling of ships in an assumed uniform system of waves which did not synchronise with the ship, such as is dealt with above for unresisted rolling, and he dealt with the effect of resistance in such a case. He pointed out that there is a particular phase-relation between the ship and the wave which will produce uniform rolling, just as there is in the case of a synchronous system of waves. If at any stage for any reason the rolling is of the cyclic character considered in non-resisted rolling, then the resistance must gradually introduce uniformity, because the rolling is made up of two seas of oscillations—

(1) That due to the rolling relatively to the water-surface, such as would occur in undisturbed water.

(2) That due to the oscillation of the water-surface itself, caused by the passage of the wave.

We have already seen that the resisted oscillation in undisturbed water gradually decreases when the vessel is left free to oscillate, but takes place in practically uniform time T. The oscillation of the water-surface is forced on the ship and causes a simple harmonic oscillation of the ship in time T_1, in algebraic addition to that due to the free resisted oscillation. When the maximum angle of a roll due to the free oscillation coincides with the maximum angle due to the forced oscillation of the wave, we shall have a maximum extreme inclination which is the sum of that due to the free and the forced. When they are in opposition we shall have a minimum extreme oscillation which is the difference of these two. At stages between coincidence and opposition we shall have extreme angles varying between maximum and minimum. As time goes on the extreme angle due to the free oscillation gradually decreases under resistance, and the sum and the difference referred to above approximate to each other, and the rolling becomes that due to the wave alone. We have seen that in the case of unresisted rolling where the wave and the ship synchronise there is an addition to the angle of inclination for each passage of the wave, and were it not for resistance these accumulated increases would cause the vessel to upset. But in the case of resisted rolling each increase of extreme angle of roll causes an increase in the work done upon the resistance of the ship, and when the increase in work done in increasing the angle of heel by each passage of the wave equals the work done in increasing the resistance incurred in swinging through this greater angle, then we shall have a balance of condition and a uniform angle of roll. The angle at which this balance takes place depends on the period and maximum slope of the wave and the coefficients of resistance between the ship and the water. For instance, with a maximum wave-slope of 3° and with a ratio of ship to wave-period of 1·1 the value of the angle of ultimate uniform rolling in the case of H.M.S. *Revenge* was found to be 13·0° without bilge-keels and 10·8° with them. In the case of synchronism of the ship and the wave, the rolling is uniform always and reaches a maximum of 41·1° without and 14·85° with bilge-keels. The nearer the wave and ship are to synchronism, the larger is maximum inclination reached before uniform rolling sets in and during uniform rolling. Resistance is of much more importance in the case of synchronism. If the ratio of ship to wave-period be 1·3, the maximum angle before uniform rolling is reached is 8·25° without and 6·6° with bilge-keels, while that due to uniform rolling is 4·35° without and 4·24° with. We see, therefore, the important part that the near approach to synchronism plays in creating large angles of roll and the value of bilge-keels in reducing the rolling in conditions approaching synchronism. When on waves of smaller period, when small angles of roll may be expected, the bilge-keels give but small advantage. The assumption in these cases is that the vessel starts from rest in the upright in the mid-height of the wave, and that the rolling is caused by the assumed uniform swell. The vessel will go through the cyclic change already described and will reach a maximum inclination of not more than double that which she reaches when uniform rolling has set in.

A later investigator, Colonel Russo, of the Italian Navy, found by experiment that by varying the assumption as to starting condition of the ship, by letting the wave-action begin to operate first when the vessel is upright and at rest on the crest of the wave, the maximum angle before uniform rolling sets in can be more than four times that due to uniform rolling if the time of the ship is greater than that of the swell. There is an infinite number of solutions of rolling amongst waves because there is an infinite number of initial circumstances, but, whatever these may be, the rolling in a uniform swell will always soon degenerate into a series of uniform forced oscillations in the wave-period.

From this discovery of Colonel Russo's, we see that the region of investigation of possible causes of upsetting is removed from that of uniform rolling even in a non-synchronous sea. The following table shows for the *Revenge* with bilge-keels the variation in maximum angle of inclination before and during uniform rolling in terms of the period and length of the swell:—

Period of swell in seconds...	8	10	12	13·3	15	17	19
Length of swell in feet ...	328	512	738	910	1153	1481	1850
Maximum angle in degrees before uniform rolling ...	6·3	8·0	14·7	21·4	17·1	13·0	11·0
Maximum angle in degress during uniform rolling ...	2·5	4·2	12·6	21·4	15·4	11·0	8·7

The period of free rolling of the *Revenge* through small angles for a double roll was about 16 seconds. The foregoing shows that the maximum rolling (which occurs at synchronism) took place at a period of swell of 13·3 seconds. The period of roll was less at large than small oscillations. The above figures are for waves varying from $\frac{1}{37}$th to $\frac{1}{64}$th of their length in height. The length of wave which corresponds to maximum inclination is 910 feet and height is about one-fiftieth. The maximum wave-slope for such waves is 3·6°. We are in the habit of dealing with waves of one-twentieth of their length in height for strength calculations. Observers have recorded waves in the open ocean of 600 to 800 feet in length and of 30 to 45 feet in height, so that we know that the slope of the waves assumed by Colonel Russo is much less than may be encountered at sea. A wave the length of which is twenty times its height has a maximum slope of 9°. Records of waves having a ratio of height to length of as great as one-thirteenth have been published. The maximum slope of wave corresponding to these proportions is 14°. If it is admissible to take much larger angles of wave-slope we may expect to get much larger angles of maximum inclination both before uniform rolling sets in and when it does. In a case given by Mr. Froude in which the maximum inclination in the *Revenge* before uniform rolling was 12·0°, he showed by calculation that the corresponding maximum wave-slope must have been 5·09°. For 20° maximum inclination the wave-slope was 10·3°. Both these cases were for periods of ship and wave of 16 and 13 seconds respectively. For similar periods of 16 and 14·6 seconds the wave-slope to produce 20° maximum before uniform rolling is only 7°. These figures give some idea of the effect of the wave-slope on the maximum inclination. It is to be remembered that these are the maximum angles obtained by Mr. Froude; but if we take Colonel Russo's maximum angles, which in some cases are double those obtained by Mr. Froude, it is easy to see that large wave-slopes may produce very large angles of roll.

Summarising, we see that:—

(1) With wave-slopes of 3·6° the angles of maximum roll obtained by them in the *Revenge* with bilge-keels may be taken at 22°.

(2) This roll takes place when synchronism exists between the wave and the ship, when the wave is 910 feet long and 18½ feet high and has a wave-slope of 3·6°.

(3) Waves exist which are of this length, but which may have a height of 50 feet, and possibly more, and a wave-slope of 10°.

(4) In such steeper waves we should expect to get much larger angles of roll.

(5) Each ship has peculiarities of rolling due to its form as well as to its lading and bilge-keels, &c.

(6) These peculiarities and the effect they have upon rolling, and the effect different waves will have upon the rolling of the ship, can best be studied experimentally.

It was my intention when you appointed me as your President to have placed before you the results of an experimental study made on lines somewhat similar to those carried out by Colonel Russo, but extended to a wide range of types of ship, waves, and resistance.

The machine for carrying out these experiments is practically complete, but having met with an accident at the end of April last which incapacitated me for some time, I was prevented from being able to do anything to this subject since then. I am, therefore, obliged to ask you to be content with the general *résumé* of the subject which has been given.

I think enough has been said to show what a field of investigation is open to the experimenter. The little that has been done and published by Colonel Russo is only for three battleships of about the same size. For the great bulk of the ocean wayfarers nothing has been done. If it is possible to determine the kind of rolling which is likely to take place under stated conditions it seems to be desirable to do so.

In all that has been said it will be seen that it is possible to determine experimentally the kind of rolling which will take place in a ship which is snug and seaworthy. But it is also possible to study the effect of loose water in a ship under the same set of conditions as to waves, lading, and form of ship. This part of the subject has not received any experimental treatment except in a very limited number of full-sized ships. It is quite conceivable that some conditions of loose water associated with some conditions of sea may produce large angles of inclination.

The subject has been treated as one in which it is probable that the kind of waves met with at sea will be uniform in size and period. That this is not so is a fact with which we are all more or less familiar. The effect of a uniform system of waves is to rapidly induce a condition of uniform rolling. But any deviation from uniformity of sea immediately introduces non-uniformity of rolling, and generally greater extreme angles of roll. Any experimental study of the action of waves upon a ship must include a variation in the character of the waves. The field of investigation is thereby widened and the search for large angles of inclination made more laborious. But the work is of a kind which can be done by many people, and can be done fairly rapidly, so that there seems to be no insuperable objection to doing it. The details of the apparatus need not be described, but the study of the objects attained may be of interest.

(1) Wave-motion is simulated by the revolution about parallel axes of two parallel cranks of different lengths. The line joining the ends of the arms of the cranks is always in the line of the normal to the wave-surface, and a line perpendicular to it is therefore parallel to the wave-surface.

(2) From the form of the ship are determined curves which are the shape of rollers which roll on a straight line parallel to the wave-surface. The form of these rollers is such that the model of the ship in rolling maintains the position in relation to the wave-surface (*a*) which cuts off constant volume of displacement at any angle of inclination; (*b*) in which the perpendicular to the straight line parallel to the wave-surface through the point of contact is the line of the resultant of the water-pressures acting on the vessel.

(3) The resistance to rolling is obtained by (*a*) electro-magnets, the current to which is generated by the motion of the model, (*b*) secondary electro-magnet, the current for which is in the first magnet. (*a*) represents the resistance due to the angular velocity, (*b*) represents the square of that velocity.

The variations in the lengths of the cranks and the speed of revolution give the variation in the wave-form assumed. The variation in the electric current by resistances in the circuit gives the variation in the resistances to rolling of the ship. For instance, the current necessary to represent the resistance of a ship with bilge-keels is very different from that for one without.

It is hoped that sufficient has been said to direct attention to the possibility of extended study of the rolling of ships at sea, so that some valuable work may be done in this important subject.

SECTION H.

ANTHROPOLOGY.

OPENING ADDRESS BY W. H. R. RIVERS, M.D., F.R.S., PRESIDENT OF THE SECTION.

The Ethnological Analysis of Culture.

DURING the last few years great additions have been made to our store of the facts of anthropology—we have learnt much about different peoples scattered over the earth, and we understand better how they act and think. At the same time we have, I hope, made a very decided advance in our knowledge of the methods by means of which these facts are to be collected, so that they may rank in clearness and trustworthiness with the facts of other sciences. When, however, we turn to the theoretical side of our subject, it is difficult to see any corresponding advance. The main problems of the history of human society are little if at all nearer their solution, and there are even matters which a few years ago were regarded as settled which are to-day as uncertain as ever. The reason for this is not far to seek; it is that we have no general agreement about the fundamental principles upon which the theoretical work of our science is to be conducted.

In surveying the different schools of thought which guide theoretical work on human culture, a very striking fact at once presents itself. In other and more advanced sciences the guiding principles of the workers of different nations are the same. The zoologists or botanists of France, Germany, America, our own and other countries, are on common ground. They have, in general, the same principles and the same methods, and the work of all falls into a common scheme. Unfortunately, this is not so in anthropology. At the present time there is so great a degree of divergence between the methods of work of the leading schools of different countries that any common scheme is impossible, and the members of one school wholly distrust the work of others, whose conclusions they believe to be founded on a radically unsound basis.

I propose to consider in this address one of the most striking of these divergencies, but, before doing so, I will put as briefly as possible what seem to me to be the chief characters of the leading schools of different countries. To begin with that dominant among ourselves. The theoretical anthropology of this country is inspired primarily by the idea of evolution founded on a psychology common to mankind as a whole, and further, a psychology differing in no way from that of civilised man. The efforts of British anthropologists are devoted to tracing out the evolution of custom and institution. Where similarities are found in different parts of the world it is assumed, almost as an axiom, that they are due to independent origin and development, and this in its turn is ascribed to the fundamental similarity of the workings of the human mind all over the world, so that, given similar conditions, similar customs and institutions will come into existence and develop on the same lines.

In France we find that, as among ourselves, the chief interest is in evolution, and the difference is in the principles upon which this evolution is to be studied. It is to the psychological basis of the work of British anthropologists that objection is chiefly made. It is held that the psychology of the individual cannot be used as a guide to the collective actions of men in early stages of social evolution, still less the psychology of the individual whose social ideas have been moulded by the long ages of evolution which have made our own society what it is. It is urged that the study of sociology requires the application of principles and methods of investigation peculiar to itself.[1]

About America it is less easy to speak, because it is unusual in that country to deal to any great extent with general theoretical problems. The anthropologists of America are so fully engaged in the attempt to record what is left of the ancient cultures of their own country that they devote little attention to those general questions to which we, more unfortunately situated with no ancient culture at our doors, devote so much attention. There seems, however, to be a distinct movement in progress in America which puts evolution on one side, and is inclined to study social problems from the purely psychological point of view, the psychological standpoint, however, approaching that of the British school more nearly than that of the French.[2]

It is when we come to Germany that we find the most fundamental difference in standpoint and method. It is true that in Adolf Bastian Germany produced one who was thoroughly imbued with the evolutionary spirit, and the *Elementargedanke* of that worker forms a most convenient expression for the psychological means whereby evolution is supposed to have proceeded. In recent years, however, there has been a very decided movement opposed to Bastian and the whole evolutionary school. In some cases this has formed part of that general revolt, not merely against Darwinism, which is so prominent in Germany, but it seems even against the whole idea of evolution. In other cases the objection is less fundamental, and has been not so much to the idea of evolution itself as to the lines upon which it has been customary to endeavour to study this evolution.

This movement, which by those who follow it is called the geographical movement, but which, I think, may be more fitly styled "ethnological," was originated by Ratzel, who was first led definitely in this direction by a study of the armour made of rods, plates, or laths which is found in North America, northern Asia, including Japan, and in a less developed form in some of the islands of the Pacific Ocean.[3] Ratzel believed that the resemblances he found could only be explained by direct transmission from one people to another, and was led by further study to become an untiring opponent of the *Elementargedanke* of Bastian and of the idea of independent evolution based on a community of thought.[4] He has even suggested that the idea of independent origin is the anthropological equivalent of the spontaneous generation of the biologist, and that anthropology is now going through a phase of development from which biology has long emerged.

The movement initiated by Ratzel has made great progress, especially through the work of Graebner[5] and of P. W. Schmidt.[6] It has resulted in an important series of works in which the whole field of anthropological research is approached in a manner wholly different from that customary in this country.[7] I must content myself with

[1] I refer here especially to the work of the "sociological" school of Durkheim and his followers. For an account of their principles and methods see "L'Année sociologique," which began to appear in 1898; Durkheim, "Les Règles de la Méthode Sociologique," Paris; and Lévy-Bruhl, "Les fonctions mentales daos les sociétés inférieures," Paris, 1910.

[2] See especially A. L. Kroeber, "Classificatory Systems of Relationship," Journ. Roy. Anthr. Inst., 1909, xxxix., 77; and Goldenweiser, "Totemism: An Analytical Study." Journ. Amer. Folk-lore, 1910, xxiii.

[3] *Sitzber. d. Akad. d. Wiss. München*, Hist. Cl., 1886, p. 181.

[4] See especially "Anthropogeographie," 1891, Th. ii., 795, and "Die geographische Methode in der Ethnographie," *Geograph. Zeitsch.*, 1897, iii., 268.

[5] See especially "Methode der Ethnologie," Heidelberg, 1911, and "Die melanesische Bogenkultur und ihre Verwandten," *Anthropos*, 1909, iv., 726. The annual "Ethnologica," edited by W. Foy, is devoted to the illustrations of this school of thought.

[6] See especially "L'origine de l'Idée de Dieu." *Anthropos*, iii.–v., 1908–10, and "Grundlinien einer Vergleichung der Religion u. Mythologie der austronesischen Völker," *Denksch. d. Akad. d. Wiss. Wien*, Phil.-hist. Kl., 1910, liii. Schmidt differs from Graebner in limiting the application of the ethnological method to regions with general affinities of culture. Otherwise he remains an adherent of the doctrine of independent origin. (See 'Panbabylonismus und ethnologischer Elementargedanke," *Mitt. d. anthrop. Gesellsch. in Wien*, 1008, xxxviii., 73.)

[7] It must not be understood from this account that all German anthropologists are adherents to the ethnological school. There are still those who follow the doctrines of Bastian, which have undergone an interesting modification through the adoption of the biological principle of Convergence.

one example to illustrate the difference of standpoint which separates the two schools. Few subjects have attracted more interest in this and other countries than the study of primitive decoration. In the decorative art of all lands there are found transitions from designs representing the human form or those of animals and plants to patterns of a purely geometrical nature. In this country it has been held, I think I may say universally, that in these transitions we have evidence for an evolutionary process which in all parts of the world has led mankind to what may be called the degradation and conventionalisation of human, animal, or plant designs, so that in course of time they become mere geometrical forms.

To the modern German school, on the other hand, these transitions are due to the blending of two peoples, one possessing the practice of decorating its objects with human, animal, or plant designs, while the art of the other is based on the use of geometrical forms. The transitions which have been taken to be evidence of independent processes of evolution based on psychological tendencies common to mankind are by the modern German school ascribed to the mixture of cultures and of peoples. Further, similar patterns, even one so simple as the spiral, when found in widely separated regions of the earth, are held to have been due to the influence of one and the same culture.

I have chosen this example because it illustrates the immense divergence in thought and method between the two schools; but the difference runs through the whole range of the subject. In every case where British anthropologists see evolution, either in the form of material objects or in social and religious institutions, the modern German school sees only the evidence of mixture of cultures, either with or without an accompanying mixture of the races to which these cultures belonged.

It will, I think, be evident that this difference of attitude of British and German workers is one of fundamental and vital importance. When we find the chief workers of two nations thus approaching their subject from two radically different and, it would seem, incompatible standpoints, it is evident that there must be something very wrong, and it has seemed to me that I cannot better use the opportunity given to me by the present occasion than in devoting my address to this subject.

The situation is one which has an especial interest for me in that I have been led quite independently to much the same general position as that of the German school by the results of my own work in Oceania with the Percy Sladen Trust Expedition. With no knowledge of the work of this school, I was led by my facts to see how much, in the past, I had myself ignored considerations arising from racial mixture and the blending of cultures, and it will perhaps interest you if I sketch briefly the history of my own conversion.

Much of my time in Oceania was devoted to survey work, in which I collected especially the systems of relationship of every place I visited, together with such other facts concerning social organisation as I was able to gather. I began my theoretical study by a comparison of the various forms of these systems of relationship, disregarding at first the linguistic nature of the terms. From the study of these systems I was able to demonstrate the existence, either in the present or the past, of a number of extraordinary and anomalous forms of marriage, such as marriage with the daughter's daughter and with the wife of the father's father,[1] all of which become explicable if there once existed widely throughout Melanesia a state which is known as the dual organisation of society with matrilineal descent, accompanied by a condition of dominance of the old men which enabled them to monopolise all the young women of the community. Taking this as my starting-point, I was then able to trace out a consistent and definite scheme of the history of marriage in Melanesia from a condition in which persons normally and naturally married certain relatives to one in which wives are purchased with whom no relationship whatever can be traced, and I was able to fit many other features of the social structure of Melanesia into this scheme. So far my work was of a purely evolutionary character, and only served to strengthen me in my previous standpoint.

[1] These terms are used in the classificatory sense.

I then turned my attention to the linguistic side of the systems of relationship, and a study of the terms themselves showed that these fell into two main classes: one class generally diffused throughout Oceania, while the terms of the other class differed very considerably in different cultural regions. Further, it became clear that the terms of the first class denoted relationships which my comparative study of the forms of the systems had shown to have suffered change, while the terms which varied greatly in different parts of Oceania denoted relationships, such as those of the mother and mother's brother, which there was no reason to believe had suffered any great change in status. From these facts I inferred that at the time of the most primitive stage of Melanesian society of which I had evidence there had been great linguistic diversity which had been transformed into the relative uniformity now found in Melanesia by the incoming of a people from without, through whose influence the change I had traced had taken place, and from whose language the generally diffused terms of relationship had been borrowed. It was through the combined study of social forms and of language that I was led to see that the change I had traced was not a spontaneous evolution, but one which had taken place under the influence of the blending of peoples. The combined morphological and linguistic study of systems of relationship had led me to recognise that a definite course of social development had taken place in an aboriginal society under the influence of an immigrant people.

I turned next to a Melanesian institution, that of secret societies, concerning which I had been able to gather much new material, and it soon became probable that these societies belonged properly neither to the aboriginal culture nor to that of the immigrants, but had arisen as the result of the interaction of the two; that, in fact, these secret societies had had their source in the need felt by the immigrants for the secret practice of the rites they had brought with them from their former home. A comparison of the ritual of the secret societies with the institutions of other parts of Oceania then made it appear that the main features of the culture of these immigrants had been patrilineal descent, or at any rate definite recognition of the relation between father and child, a cult of the dead, the institution of taboo, and, lastly, certain relations with animals and plants, which were probably allied to totemism, if they were not totemism itself in a fully developed form.

Further study made it clear that those I have called the immigrant people, though possessing these features in common, had reached Melanesia at different times and with several decided differences of culture, but that probably there had been two main streams: one which peopled Polynesia and became widely diffused throughout Melanesia, which was characterised by the use of kava; another which came later and penetrated much less widely, which brought with it the practice of chewing betel-mixture. Traces of a third stream, the earliest of all, are probably to be found here and there throughout Melanesia, while still another element is provided by recent Polynesian influence. It became evident that the present condition of Melanesian society has come into being through the blending of an aboriginal population with various peoples from without, and it therefore became necessary to ascertain to which of the cultures possessed by these peoples the present-day customs and institutions of Melanesia belong, always keeping in mind the possibility that some of these institutions may not have belonged to any one of the cultures, but may have arisen as the result of the interaction of two or more of the blending peoples.

I must be content with this brief sketch of my scheme of the history of Melanesian society, for my object to-day is to point out that if Melanesian society possesses the complexity and the heterogeneous character I have indicated, and is the resultant of the mixture of three or four main cultures, it cannot be right to take out of the complex any institution or belief and regard it as primitive merely because Melanesian culture on the whole possesses a more or less primitive character. It is probable that some of the immigrants into Melanesia had a relatively advanced culture, possibly even that the institutions and ideas they brought with them had been taken from a culture higher still, and, therefore, when we bring forward any Melanesian institution or belief as an example of primitive thinking or acting, our first duty should be to inquire to which stratum of Melanesian culture it belongs.

To illustrate my meaning, I have time for only one example. No concept of Melanesian culture has bulked more largely in recent speculation than that of *mana*, the mysterious virtue to which the magico-religious rites of Melanesia are believed to owe their efficacy. This word now seems on its way to enter the English language as a term for that power or virtue which induces the emotions of awe and wonder, and thus provides a most important element, not only in the specific mental states which underlie religion, but also plays much the same part in the early history of magic. In recent speculation the idea of *mana* is coming to be regarded as having been the basis of religious ideas and practices preceding the animism which, following Prof. Tylor, we have for long regarded as the earliest form of religion, and *mana* is thus held to be not only the foundation of pre-animistic religion, but also the basis of that primitive element of human culture which can hardly be called either religion or magic, but is the common source from which both have been derived. If I am right in my analysis of Oceanic culture, the Melanesian concept of *mana* is not a suitable basis for these speculations. It is certain that the word *mana* belongs to the culture of the immigrants into Melanesia, and not to that of the aborigines. It is, of course, possible that though the word belongs to the immigrant culture, the ideas which it connotes may belong to a more primitive stratum; but this is a pure assumption, and one which I believe to be contrary to all probability. At any rate, we can be confident that even if the ideas connoted by the term *mana* belong to or were shared by the primitive stratum of Melanesian society, they must have been largely modified by the influence of the alien, but superior, culture from which the word itself has been taken. I believe that the Melanesian evidence can legitimately be used in favour of the view that the power or virtue denoted by *mana* is a fundamental element of religion. The analysis of culture, however, indicates that it is not legitimate to use the Melanesian evidence to support the primitiveness of the concept of *mana*. This evidence certainly does not support the view that the concept of *mana* is more primitive than animism, for the immigrants were already in a very advanced stage of animistic religion, a cult of the dead being certainly one of the most definite of their religious institutions.

Further, I believe that the use of the term *mana* in Melanesia in connection with magic, as a term for that attribute of objects used in magic to which they owe their efficacy, is due to an extension of the original meaning of the term, and that it would only be misleading to use the Melanesian facts as evidence in favour of the concept of *mana* as underlying primitive magic. Here, again, I do not wish to deny that a concept such as that denoted by *mana* may be a primitive element of magic; all that I wish to point out is that the Melanesian evidence cannot properly be used to support this view, for the use of the term in connection with magic in Melanesia is not primitive, but secondary and relatively late.

The point, then, on which I wish to insist is that if cultures are complex, their analysis is a preliminary step which is necessary if speculations concerning the evolution of human society, its beliefs and practices, are to rest on a firm foundation.

I have so far dealt only with Melanesia. It is obvious that the same principle that analysis of culture must precede speculations concerning the evolution of institutions is of wider application; but I have time only to deal, and that very briefly, with one other region.

No part of the world has attracted more attention in recent anthropological speculation than Australia, and at the bottom of these speculations, at any rate in this country, there has usually been the idea, openly expressed or implicitly understood, that, in the culture of this region, we have a homogeneous example of primitive human society. From the time that I first became acquainted with Australian sociology, I have wondered at the complacency with which certain features of Australian social organisation have been regarded, and especially the combination of the dual organisation and matrimonial classes with groups closely resembling the totemic clans of other parts of the world. This co-existence of two different forms of social organisation side by side has seemed to me the fundamental problem of Australian society, and I confess that till lately, obsessed as I see now I have been by a crude evolutionary point of view, the condition has seemed an absolute mystery.[1] A comparison, however, of Australia and Melanesia has now led me to see that probably we have in Australia, not merely another example of mixture of cultures, but even another resultant of mixture of the same or closely similar components as those which have peopled Melanesia, viz. a mixture of a people possessing the dual organisation and matrilineal descent with one organised in totemic clans, possessing either patrilineal descent, or at any rate clear recognition of the relation between father and child. This is no new view, having been already advanced, though in a different form, by Graebner[2] and P. W. Schmidt.[3] If further research should show Australian society to possess such complexity, it will at once become obvious that here also ethnological analysis must precede any theoretical use of the facts of Australian society in support of evolutionary speculations.

It may be objected that we all recognise the complexity of culture, and, indeed, in the study of regions such as the Mediterranean, where we possess historical evidence, it is this complexity which forms the chief subject of discussion. Further, where we possess historical evidence, as in the cases of the Hindu and Mohammedan invasions into the Malay Archipelago, all anthropologists are fully alive to the complexities and difficulties introduced thereby into the study of culture; but where we have no such historical evidence, the complexity of culture is almost wholly ignored by those who use these cultures in their attempts to demonstrate the origin and course of development of human institutions.

I have now fulfilled the first purpose of this address. I have tried to indicate that evolutionary speculations can have no firm basis unless there has been a preceding analysis of the cultures and civilisations now spread over the earth's surface. Without such analysis it is impossible to say whether an institution or belief possessed by a people who seem simple and primitive may not really be the product of a relatively advanced culture forming but one element of a complexity which at first sight seems simple and homogeneous.

Before proceeding further I should like to guard against a possible misconception. Some of those who are interested in the ethnological analysis of culture regard it not only as the first, but as the only, task of the anthropology of to-day. I cannot too strongly express my disagreement with this view. Because I have insisted on the importance of ethnological analysis, I hope you will not for a moment suppose that I underrate the need for the psychological study of customs and institutions. If the necessity for the ethnological analysis of culture be recognised, this psychological study becomes more complicated and difficult than it has seemed to be in the past, but that makes it none the less essential. Side by side with ethnological analysis there must go the attempt to fathom the modes of thought of different peoples, to understand their ways of regarding and classifying the facts of the universe. It is only by the combination of ethnological and psychological analysis that we shall make any real advance. To-day, however, time will not allow me to say more about this psychological analysis, and I must continue the subject from which I have for a moment turned aside.

Having shown the importance of ethnological analysis, I now propose to consider the process of analysis itself and the principles on which it should and must be based if it in its turn is to have any firm foundation. In the analysis of any culture a difficulty which soon meets the investigator is that he has to determine what is due to mere contact and what is due to intimate intermixture, such intermixture, for instance, as is produced by the permanent

[1] I may note here that Mr. Lang, after having considered this problem from the purely evolutionary standpoint ("Anthropological Essays presented to E. B. Tylor" p. 203), concludes with the words, "We seem lost in a wilderness of difficulties."

[2] *Zeit. f. Ethnol.*, 1905, xxxvii., 28, and "Zur australischen Religionsgeschichte," *Globus*, 1909, xcvi., 341.

[3] See especially *Zeitsch. f. Ethnol.*, 1909, xli., 340.

blending of one people with another either through warlike invasion or peaceful settlement. The fundamental weakness of most of the attempts hitherto made to analyse existing cultures is that they have had their starting-point in the study of material objects, and the reason for this is obvious. Owing to the fact that material objects can be collected by anyone and subjected at leisure to prolonged study by experts, our knowledge of the distribution of material objects and of the technique of their manufacture has very far outrun that of the less material elements. What I wish now to point out is that in distinguishing between the effects of mere contact and the intermixture of peoples, material objects are the least trustworthy of all the constituents of culture. Thus in Melanesia we have the clearest evidence that material objects and processes can spread by mere contact, without any true admixture of peoples and without influence on other features of the culture. While the distribution of material objects is of the utmost importance in suggesting at the outset community of culture, and while it is of equal importance in the final process of determining points of contact and in filling in the details of the mixture of cultures, it is the least satisfactory guide to the actual blending of peoples which must form the solid foundation of the ethnological analysis of culture. The case for the value of magico-religious institutions is not much stronger. Here, again, in Melanesia there is little doubt that whole cults can pass from one people to another without any real intermixture of peoples. I do not wish to imply that such religious institutions can pass from people to people with the ease of material objects, but to point out that there is evidence that they can and do so pass with very little, if any, admixture of peoples or of the deeper and more fundamental elements of the culture. Much more important is language; and if you will think over the actual conditions when one people either visit or settle among another, this greater importance will be obvious. Let us imagine a party of Melanesians visiting a Polynesian island, staying there for a few weeks, and then returning home (and here I am not taking a fictitious occurrence, but one which really happens). We can readily understand that the visitors may take with them their betel-mixture, and thereby introduce the custom of betel-chewing into a new home; we can readily understand that they may introduce an ornament to be worn in the nose and another to be worn on the chest; that tales that they tell will be remembered, and dances they perform will be imitated. A few Melanesian words may pass into the language of the Polynesian island, especially as names for the objects or processes which the strangers have introduced; but it is incredible that the strangers should thus in a short visit produce any extensive change in the vocabulary, and still more that they should modify the structure of the language. Such changes can never be the result of mere contact or transient settlement, but must always indicate a far more deeply seated and fundamental process of blending of peoples and cultures.

Few will perhaps hesitate to accept this position; but I expect my next proposition to meet with more scepticism, and yet I believe it to be widely, though not universally, true.[1] This proposition is that the social structure, the framework of society, is still more fundamentally important and still less easily changed except as the result of the intimate blending of peoples, and for that reason furnishes by far the firmest foundation on which to base the process of analysis of culture. I cannot hope to establish the truth of this proposition in the course of a brief address, and I propose to draw your attention to one line of evidence only.

At the present moment we have before our eyes an object-lesson in the spread of our own people over the earth's surface, and we are thus able to study how external influence affects different elements of culture. What we find is that mere contact is able to transmit much in the way of material culture. A passing vessel, which does not even anchor, may be able to transmit iron, while European weapons may be used by people who have never even seen a white man. Again, missionaries introduce the Christian religion among people who cannot speak a word of English or any language but their own, or only use such European words as have been found necessary to express ideas or objects connected with the new religion. There is evidence how readily language may be affected, and here again the present day suggests a mechanism by which such a change takes place. English is now becoming the language of the Pacific and of other parts of the world through its use as a *lingua franca*, which enables natives who speak different languages to converse not only with Europeans, but with one another, and I believe that this has often been the mechanism in the past; that, for instance, the introduction of what we now call the Melanesian structure of language was due to the fact that the language of an immigrant people who settled in a region of great linguistic diversity came to be used as a *lingua franca*, and thus gradually became the basis of the languages of the whole people.

But now let us turn to social structure. We find in Oceania islands where Europeans have been settled as missionaries or traders perhaps for fifty or a hundred years; we find the people wearing European clothes and European ornaments, using European utensils, and even European weapons when they fight; we find them holding the beliefs and practising the ritual of a European religion; we find them speaking a European language, often even among themselves, and yet investigation shows that much of their social structure remains thoroughly native and uninfluenced, not only in its general form, but often even in its minute details. The external influence has swept away the whole material culture, so that objects of native origin are manufactured only to sell to tourists; it has substituted a wholly new religion and destroyed every material, if not every moral, vestige of the old; it has caused great modification and degeneration of the old language; and yet it may have left the social structure in the main untouched. And the reasons for this are clear. Most of the essential social structure of a people lies so below the surface; it is so literally the foundation of the whole life of the people that it is not seen; it is not obvious, but can only be reached by patient and laborious exploration. I will give a few specific instances. In several islands of the Pacific, some of which have had European settlers on them for more than a century, a most important position in the community is occupied by the father's sister.[1] If any native of these islands were asked who is the most important person in the determination of his life-history, he would answer, "My father's sister"; and yet the place of this relative in the social structure has remained absolutely unrecorded, and, I believe, absolutely unknown, to the European settlers in these islands. Again, Europeans have settled in Fiji for more than a century, and yet it is only during this summer that I have heard from Mr. A. M. Hocart, who is working there at present, that there is the clearest evidence of what is known as the dual organisation of society as a working social institution at the present time. How unobtrusive such a fundamental fact of social structure may be comes home to me in this case very strongly, for it wholly eluded my own observation during a visit three years ago.

Lastly, the most striking example of the permanence of social structure which I have met is in the Hawaiian Islands. There the original native culture is reduced to the merest wreckage. So far as material objects are concerned, the people are like ourselves; the old religion has gone, though there probably still persists some of the ancient magic. The people themselves have so dwindled in number, and the political conditions are so altered, that the social structure has also necessarily been greatly modified, and yet I was able to ascertain that one of its elements, an element which I believe to form the deepest layer of the foundation, the very bedrock of social structure, the system of relationship, is still in use unchanged. I was able to obtain a full account of the system as actually used at the present time, and found it to be exactly the same as that recorded forty years ago by Morgan and Hyde, and I obtained evidence that the system is still deeply interwoven with the intimate mental life of the people.

If, then, social structure has this fundamental and deeply seated character, if it is the least easily changed, and only changed as the result either of actual blending of

[1] There are definite exceptions in Melanesia; places where the social structure has been transformed, though the ancient language persists.

[1] See "Folk-Lore," 1910, xxi., 42.

peoples or of the most profound political changes, the obvious inference is that it is with social structure that we must begin the attempt to analyse culture and to ascertain how far community of culture is due to the blending of peoples, how far to transmission through mere contact or transient settlement.

The considerations I have brought forward have, however, in my opinion, an importance still more fundamental. If social institutions have this relatively great degree of permanence, if they are so deeply seated and so closely interwoven with the deepest instincts and sentiments of a people that they can only gradually suffer change, will not the study of this change give us our surest criterion of what is early and what is late in any given culture, and thereby furnish a guide for the analysis of culture? Such criteria of early and late are necessary if we are to arrange the cultural elements reached by our analysis in order of time, and it is very doubtful whether mere geographical distribution itself will ever furnish a sufficient basis for this purpose. I may remind you here that before the importance of the complexity of Melanesian culture had forced itself on my mind, I had already succeeded in tracing out a course for the development of the structure of Melanesian society, and after the complexity of the culture had been established, I did not find it necessary to alter anything of essential importance in this scheme. I suggest, therefore, that while the ethnological analysis of cultures must furnish a necessary preliminary to any general evolutionary speculations, there is one element of culture which has so relatively high a degree of permanence that its course of development may furnish a guide to the order in time of the different elements into which it is possible to analyse a given complex.

If the development of social structure is thus to be taken as a guide to assist the process of analysis, it is evident that there will be involved a logical process of considerable complexity in which there will be the danger of arguing in a circle. If, however, the analysis of culture is to be the primary task of the anthropologist, it is evident that the logical methods of the science will attain a complexity far exceeding those hitherto in vogue. I believe that the only logical process which will in general be found possible will be the formulation of hypothetical working schemes into which the facts can be fitted, and that the test of such schemes will be their capacity to fit in with themselves, or, as we generally express it, "explain" new facts as they come to our knowledge. This is the method of other sciences which deal with conditions as complex as those of human society. In many other sciences these new facts are discovered by experiment. In our science they must be found by exploration, not only of the cultures still existent in living form, but also of the buried cultures of past ages.

And here is the hopeful aspect of our subject. I believe our present store of facts, at any rate on the less material sides of culture, to form but a very small part of that which is yet to be obtained, and will be obtained, unless we very wilfully neglect our opportunities. Waiting to be collected there is a vast body of knowledge by means of which to test the truth of schemes of the history of mankind, not only of his migrations and settlements, but of the institutions and objects which have arisen at different stages of his history and developed into various forms throughout the world.

And this brings me to my concluding topic. I have tried to show that any speculations concerning the history of human institutions can only have a sound basis if cultures have first been analysed into their component elements, but I do not wish for one moment to depreciate the importance of attempts to seek for the origin and early history of human institutions. To me the analysis of culture is merely the means to an end, which would have little interest if it did not show us the way to the proper understanding of the history of human institutions. The importance of the facts of ethnology in the study of civilised culture is now generally recognised. You can hardly take up a modern work dealing with any aspect of human thought and activity without finding reference to the customs and institutions of savage or barbarous peoples. It is becoming recognised that a study of these helps us to understand much that is obscure in our own institutions or in those of other great civilisations of the present or the past. Further, there can be no doubt that we are only at the threshold of a new movement in learning which is being opened by this comparative study.

It is a cruel irony that just as the importance of the facts and conclusions of ethnological research is thus becoming recognised, and just as we are beginning to learn sound principles and methods for use both in the field and in the study, the material of our science is vanishing. Not only is the march of our own civilisation into the hitherto undisturbed places of the earth more rapid than it has ever been before, but this advance has made more easy the spread of other destroying agencies. In many parts of such a region as Melanesia, it is even now only from the old men that any trustworthy information can be obtained, and it is no exaggeration to say that with the death of every old man there and in many other places there goes, and goes for ever, knowledge the loss of which the scholars of the future will regret as the scholars of the past regretted such an event as the disappearance of the library of Alexandria. There is no other science in the same position. The nervous system of an animal, the metabolism of a plant, the condition of the South Pole, for instance, will a hundred, or even a thousand, years hence be essentially what they are to-day, but long before the shorter of those times has passed, most, if not all, of the lower cultures now found on different parts of the earth will have wholly disappeared or have suffered such change that little will be learnt from them. Fortunately, the need for ethnographical research is now forcing itself on the attention of those who have to deal with savage or barbarous peoples. Statesmen have begun to recognise the practical importance of knowledge of the institutions of those they have to govern, and missionary societies are beginning to see, what every wise missionary has long known, that it is necessary to understand the ideas and customs of those whose lives they are trying to reform. Still, we must not be content with these more or less official movements. There is ample scope, indeed urgent need, for individual effort and for non-official enterprise. It is not all who can go into the field and do the needed work themselves, but there are none who cannot in some way help to promote ethnographical research. We have before us one of those critical occasions which must be seized at once if they are to be seized at all: the occasion of a need which to future generations will seem to have been so obvious that its neglect will be held an enduring reproach to the science of our time.

SECTION I.

PHYSIOLOGY.

OPENING ADDRESS BY PROF. J. S. MACDONALD, B.A., PRESIDENT OF THE SECTION.

THE special difficulties of physiology are well known to a large section of my audience, but it may be permissible to illustrate them by reference to an individual case. Take for example those small capsules which are found in the kidneys at the very summit, so to speak, of the problem of renal secretion. These small bodies each occupy a space of less than two thousandths of a cubic millimetre. Within their interior they contain several different kinds of blood-vessels that represent the structures of greatest mechanical interest when dealing with the circulatory system, omitting, of course, the heart. This almost complete sample of the circulatory mechanism, itself formed of a congeries of parts and unitary mechanisms, is enclosed by two or three thousand cells of specific glandular function. Every one of these cells again is a complex of mechanisms about which we cannot rightly think until we reduce our conceptions to the level of molecular dimensions. Enclosed then in this minute space, within a mass that weighs two thousandths of a milligramme, lie quite a series of the problems in which physiology is interested.

The difficulties occasioned by this minuteness of parts, and by the manner in which they are complexly mixed together, render direct investigation of single problems possible only in the very simplest cases, as, for instance, the red blood corpuscle and the nerve-fibre.

A consideration of the dynamic properties of the red blood corpuscle is perhaps the simplest task in physiology. By the aid of the centrifuge these bodies can be obtained free from the embarrassing presence of other cells, may even be washed and immersed in definite solutions of known value. In addition, these compressed discs—the study of the forces normally compressing them open to research by variations in the quality of the surrounding solutions—contain no nuclear reactions, and but the one material of primary dynamic importance.

Everyone knows, however, that even in this case the dynamic conditions are being investigated largely in an indirect fashion. The material of primary importance, hæmoglobin, is stable except with regard to the one well-defined reaction with oxygen to which it owes its utility. This material may readily be obtained pure and its properties examined in homogeneous solutions, and these properties may again be studied after adding to this solution such secondary substances, lipoids and inorganic salts, as are also present in the red blood corpuscle. In the hands of members of this section such studies are not only increasing our knowledge of the properties of hæmoglobin, but are also rapidly leading to a knowledge of those very dynamic conditions with which it is surrounded when present within its microscopical site in the red blood corpuscle. In this very simple instance, the parts of the mechanism being known, it is possible to arrange them in such a fashion as to limit our conceptions of the way in which they are actually arranged within the body.

In cases of greater complexity, where no doubt in course of time the same method of indirect attack will be adopted, in preparation for this event, the necessities of the moment largely confine our attention to a discovery of the various parts present in these mechanisms. In fact, the first requirement is a knowledge of the micro-chemistry of these more complex structures, that is to say, a precise knowledge of the chemical materials distributed in minute spaces of microscopical dimensions. It is well known that my predecessor in this honourable post, Prof. Macallum, of Toronto, has contributed largely to our knowledge of these matters, and that he further assisted us to a right conception of the forces in action between these minute masses of material by his excellent Presidential Address to this Section.

Thinking of the body as no more than a collection of chemical reactions, this elaborate separation of parts in a multiplicity of extremely small spaces protects the individuality of a certain large number of reactions, whilst at the same time securing a rich maintenance of contact with supplies of raw material and a ready means for separating the end-products of reactions from the materials in reaction at each point. Every nucleus, surrounded by its constellation of secondary chemical reactions, is thus given certain limits of size, surface, territory, and environment. These are physical necessities of arrangement possible within the conditions of solution met with in the body, and no doubt largely due to physical states developed by each reaction—that is to say, that the products of each reaction exert a physical influence and produce characteristic physical arrangements. It is not without interest to realise that cell-growth, and the increase in nuclear surface with which it is attended in cell-division, is apparently initiated at every centre by what is doubtless a physical process, and what, as Loeb has shown us, may be accelerated by definite physical change. Such effects of growth are best studied in those early days of enormous expansion when the ovum increases to one thousand million times its original weight, and it is at this time that these separative physical consequences of chemical reactions are most apparent.

During this primary expansion not only have the reactions of nuclear matter been extended to occupy some hundred million times more mass, but it is also true that they have been modified in a very large number of ways, and doubtless this as the consequence of special conditions, extrinsic conditions, existing at the time of formation of each separate part. These modifications are largely shown by differences in appearance and structure, and are each attended by some difference in the function of typical groups of cells. A singular persistence in the similarity of structure and function exhibited by successive generations of similarly placed cells is no doubt sometimes due to the maintenance of those special extrinsic conditions which occasioned their initial modification. In these cases reversion to an original type may occur on immersion in formerly pre-existent conditions, and indeed a whole series of different structures make their appearance as the conditions are further variously modified, as is sometimes seen in the regeneration of parts.

There is, however, seen in some cases a greater degree of persistence, studied, for example, in malignant growths, which is largely retained even when the extrinsic conditions are greatly modified; and in such cases there has doubtless occurred some elimination and refinement—that is to say, rather an abstraction than an addition of character—as the consequence of the initial modification.

In certain places in the adult, physical conditions due to the modification and acceleration of chemical reactions are still frequently provocative of nuclear growth and subdivision: thus in the tonsils, follicles, patches, and lymphatic structures generally, that are embedded in the surface of the alimentary canal. These structures, characterised by their great wealth of nuclear material, experience great nuclear change, to which they are largely stimulated by chemical substances derived from foreign organisms. Specifically affected by each chemical substance, they are probably the site of manufacture of specific neutralising substances that are driven from these sites of activity into the portal system almost as soon as the substances exciting their appearance are driven in from the absorbent surface of the alimentary canal.

In other places in the adult, however, such conditions never recur after a certain date in development. In these places the nuclear material has been so refined as to be irresponsive to conditions that accelerate and modify the reactions of nuclear material in other parts. Permanent sites of monotonous nuclear activity are formed and maintained in such places until the moment when some unusually extreme condition still further limits their activity and terminates their existence. It is significant, too, that this may happen when the condition is not sufficiently extreme similarly to cut short the reactions of other parts.

Now the latter case is typically illustrated by reference to the nervous system, which is thus seen as the site of a severely limited quality of chemical activity. That it is also restricted in amount may be further emphasised by reference to the relatively minute quantity of nuclear material which is present in this system. Thus it is probable that if a direct comparison between the cells of the nervous system and the lymphoid cells to which I have alluded were possible, the essential difference found would be a difference between the stability of certain chemical material in the one case, and a frequently modified wealth of chemical reaction in the other; so that of the two, the nervous system would be the more comparable with the red blood corpuscle.

Thus, if when reviewing the wide array of function in which the nervous system participates, we are led to foresee for each of its cells a great variety of chemical change, or, if when surveying the great differences in function of the organs of the body we are led to expect typical chemical differences between those several parts of the central nervous system with which they are individually associated, we are arrested by this clear evidence of a universally distributed monotony of simple chemical state.

It is true that certain drugs affect some groups of cells within this system more readily than others. None of these instances are, however, of such a kind as to demand the inference that there was any essential difference between different groups of cells. In most cases, indeed, it is probable that differences in relative quantity, and in such simple factors as relative state of solution, are responsible for these effects. Thus there is nothing to refute the statement that all the cells of the nervous system contain chemical materials of an exactly similar kind. Just as every liver-cell is like every other liver-cell in its general chemical character, so in the nervous system are all the cells chemically alike.

Glancing from the liver-cell to the nerve-cell, however, there is at once seen a marked difference of a kind we have not yet considered. The chemical experiences of the liver-cell are multifold, but in the main alike for each cell, and it is thus not surprising that the chemical reactions are in the main the same in every cell, no matter how multifold they may be. The physical experiences of the liver-cells are similarly the same for each cell, and we are not surprised that in physical appearance there is as monotonous a similarity between all the cells in the liver as there is a monotonous chemical similarity between all the cells in the nervous system. In the nervous system, however, there is no monotony in the physical character of the cells. It is a notable physical fact that the cells of the nervous system have diverse shapes and sizes, and still more so that these are such as to bring them into a kind of physical relationship observed in no other epithelial organ. It is a notable physical fact that cells originally separated by considerable distances are brought into close contact by a growth of processes, and that they are in this way arranged into chains forming definite paths for the transmission of physical influence through this system.

Before attempting to explain the manner in which physical conditions give rise to this arrangement, I must briefly sketch the differences in physical state which may be met with in these cells. Thus there are the states of excitation, of rest, and of inhibition. I may simplify matters by saying that there are reasons for considering excitation as associated with an increase in pressure, either due to a temporary increase of particles in motion within the solutions of the cell or to some acceleration in the motion of particles initially present. In rest these particles are in their normal quantity and have their normal motion. During inhibition the particles are decreased in number, or have a retarded motion. Associating excitation with an increase, inhibition with a diminution, and rest with normal degrees of molecular activity, we shall not be far away from the facts.

Everyone is aware that increased molecular activity is associated with a tendency to break bounds, or when taking place behind resistant but distensible bounds with a tendency to expand the region of activity. Thus it happens that the excited cell tends to grow in size, whereas, on the other hand, the inhibited cell tends to diminish, and the resting cell to remain unaltered. These several proceedings are possible so long as the surface membranes of the cells, or of structures within them, which form bounds resistant to the pressure of molecular activity, are at the same time porous to water molecules; and this we know is within limits true—namely, that the cell is enclosed by such semi-permeable membranes. Thus when the excited nerve-cell grows in size, and the region of molecular activity is thus increased, the materials within the cell are diluted by an admission of water.

Attention is now directed to the probability that there is some kind of material in solution within the cell which takes no part in this increase of molecular activity; is, on the other hand, retarded in its motion by agglutination into colloidal clusters, and may finally be precipitated. I, for my part, have no hesitation in saying that there is every probability that this is indeed the primary phenomenon of excitation, this precipitation. Leaving that point, however, alone, it is probable that this tendency towards precipitation occurs. This material, precipitated and diluted, thus loses some of that mass-action formerly holding in check its formation by the particular chemical reaction that is always tending to produce still more of it. More of this material is thus produced within the excited cell, and is in turn precipitated, and still more and more. We may therefore think of these excited cells as laying down a structure which I will ask your permission to describe as a cuticle. The nerve-fibre is the cuticle of the nerve-cell. Once give it such a name, as is in part justifiable, and no one will be surprised that these structures are pushed out to an extraordinary distance from their parent cells, and that their length is measured not like other details of cell-structure in thousandths of millimetres, but sometimes in metres, and therefore on a scale with units one million times larger than usual.

If we entertain this idea, that nerve-fibre growth is proportional to excitation, we are prepared for the statement that the physical characters of the cells within the nervous system and their relations to one another are all due to their relative experience of incidents of excitation. We face the fact that their chemical work is of a universally monotonous type, a drearily slow and respectable type, and that their physical features and arrangements are capable of very simple explanation.

Now structure is everywhere the outcome of function, and those functional developments that lead to the growth and differentiation of structure contain the most interesting and most fundamental problems of physiology. If it is thought that the main relationships of parts within the nervous system are fixed from an early date of development, it would then seem that to the physiologist the nervous system is a place of very limited interest. But this is by no means the case, the relationship of parts is by no means a fixture within the nervous system. In so far as it is fixed, it is the sign of the orderly action of circumstance upon the structures of the body, and the result rather than the cause of the monotony of existence. There is, however, no need to labour this point or to debate our interest in this system. One portion of the nervous system is the seat of the mind, a fact to which I will return later. The whole of it is the very essence of the unity of the organism containing it. It is the rapid transmission of physical states through its individual nerve-fibres, and the modifications in transmission determined by passage into its constituent cells, which serve to weld the actions of the several parts of the body into that phase of common action which is suited to the necessities of the moment.

That there is no moment during life when there are not many paths through the central nervous system engaged in this business of transmission is a statement of commonplace realised by all. There are not, however, in my opinion, a sufficiently large number of persons sufficiently impressed by that greater truth, discovered and analysed by Sherrington: that no path is thus busy without there being at the same time some other path maintained in a condition of enforced rest. Whenever the system is excited at one part it is also inhibited at another, and it is this phenomenon that lies at the root of the harmonious effects produced by this system, and forms the means whereby action suspends antagonistic action.

When considering the influence of states of excitation upon the growth and arrangement of structures within this system, it follows then that I cannot afford to omit some proper consideration of the manner in which this phenomenon of simultaneous inhibition may be explained, and of its influence on the growth and arrangements of structures. To get a clearer view of this process we must think in detail of the probable nature of the structures involved in the simplest case of transmission through the system. It is indeed a simple thing to form a picture of the track entering the system, the structure called the afferent neurone. Here we have a long length of cuticle, or nerve-fibre, stretching right from the surface where it is liable to stimulation by change in circumstance, or—more complicated case, but very usual one—by the maintenance of circumstance. This afferent neurone is mainly cuticle. It is true that its cell-body is placed like a hump somewhere on its back, but this is no more than an index that it is never inhibited. Thus from the site of change of circumstance right into the nervous system transmission is of the simplest kind, since all we know of this nerve-fibre is that it transmits most of the excitations it receives at a rapid pace and without loss from one end to the other. We can therefore see the excitation planted by it into every cell with which it comes in contact within the system. By some of its branches it plants this excitation into nerve-cells, whose nerve-fibres pass out to reach the site of action. It is a simple matter again to picture this first set of efferent neurones as receiving an excitation which they then transmit. That there is a certain complexity in the process is a fact with which we are not at present concerned.

But now, what about the site of antagonistic action, the parts that are held in a state of enforced rest? To them also lead perfectly similar efferent neurones, incapable of producing any other effect in the site of antagonistic action than that of exciting it or transmitting excitations towards it. We must therefore conclude that it is this second set of efferent neurones that are inhibited and maintained in a condition of enforced rest. How then does the change transmitted into the several branches of the afferent neurone, having the same character as it invades every branch, succeed in causing diametrically opposite conditions in two groups of perfectly similar efferent neurones? There is but one answer to this question, namely, that transmission into the second group must be through some intermediate mechanism which reverses the character of the change. Now I have no hesitation in naming definite structures in the nervous system as being alone those to which we can impute this reversal, namely, certain intermediate neurones which have a way of being interpolated between afferent and efferent neurones. Such neurones are seen in the cord sometimes sending their main nerve-fibre towards efferent neurones placed on the other side of the cord, and in the cerebellum the large cells of Purkinje are seen to be approached by afferent nerve-fibres in this double fashion; one set reaching them directly, the other set indirectly through intermediate neurones. We shall then picture neurones with short nerve-fibre processes as placed in these paths that are inhibited, and as sometimes responsible for this singular reversal of the transmitted excitation.

In this connection, too, we must deal briefly with another fact observed by Sherrington, that certain drugs, tetanotoxin and strychnine, affect these intermediate mechanisms in such a way that they lose their power of reversing the character of change transmitted through them. When these drugs are applied to any part of the nervous system action and antagonistic action are simultaneous consequences, and the stronger wins. Of the greatest interest, too, is the fact that this disturbance of the process of reversal may be obtained in a graduated manner by the application of such drugs in varied strengths of solution. It is thus clear that there is nothing peculiar about the nerve-fibre portion of these intermediate neurones, since when given excitations to transmit they transmit them, although it is so frequently their normal business to transmit inhibitions. Clear, too, that their cell-bodies frequently inhibited like those of the efferent neurones may also with a slight modification of condition tend towards excitation, or, as a matter of fact, be excited, again like the efferent neurones. There is no difference discoverable here between these two sets of cells other than a difference of degree. The one salient fact demanding explanation is this difference under normal conditions in which the efferent neurones are seen as excited by identically the same character of transmitted change that inhibits the intermediate neurones.

Now it would be a simple matter to show that all these points might be dealt with adequately on the assumption that nerve-cells invariably contained a mixture of two materials, existing in different proportions in different cells, each of which was forced into a diametrically opposite physical state to the other as the result of changes in physical conditions of the kind transmitted by nerve-fibres.

It is of interest then that there is definite reason to suppose that within nerve-cells there are always two substances which seem to have their states diversely affected by different conditions. One of them is the characteristic constituent of what I have been irreverently terming the cuticle, the nerve-fibre; and the other a complex material which apparently represents the primary product of nuclear activity, and is spoken of as the material of Nissl. It may seem a weak point in my use of the term that this cuticle-stuff is found within the cell-body. Perhaps so, but perhaps also not so; the point is not worth discussing.

The point really worth discussion is as to whether it is true that these substances are affected in diametrically opposite ways by the same change, just as if, for example, one of them was possessed of acid and the other of basic characters; so that the basic was precipitated, and the acid dissolved by the addition of an alkali: since if they exhibit any opposite behaviour in the presence of the transmitted excitation, then it is indeed probable that their admixture is responsible for many of the orderly vagaries of transmission through nerve-cells. I am proceeding as if this is really true to a consideration of its influence on the development of nerve-cells.

Imagine a developing afferent neurone in contact with two other neurones, but by different extents of its surface, so that it transmits a larger quantity of change to the one than to the other. In both cases it affects an algebraical sum of opposing properties, and we might think of it as effecting a compression and an expansion. Now let there be the slightest difference in the forces required to compress and to expand, and it might readily happen that the effect of a minimal dose might be to produce an algebraical sum in favour of compression, whilst a maximal created a general effect of expansion. One of these cells then might be habitually excited and grow a cuticle traversing considerable distances in the central nervous system; whereas the other is inhibited until the accumulation of charges previously received add up to the dose required to tip the algebraical sum in favour of excitation, and then first commences the growth of a short nerve-fibre.

This, however, involves the assumption that these cells of both classes store up all the transmitted energy they receive, that they do not leak, do not transmit, and thus grow their nerve-fibres from the effects of accumulation. Within certain limits this supposition is sound, since we are familiar with that summation which is a leading feature in nerve-cell conduction. Below a certain definite quantity of charge they do not leak, and are found by a second impulse arriving some little time after an apparently ineffectual predecessor in a new state, so that the new-comer is effectual. Now if no new-comer arrives in time we must suppose the energy due to the first as having affected the growth of the cell in one direction or another—that is to say, in one direction if it produced the change characteristic of excitation, and the other if producing to a minimal degree the change characteristic of inhibition. It is legitimate, too, to suppose these limits as set by the capacity and extent of excitable contacts. The larger the extent of contact the sooner and the more effectual must be the leakage. Thus we may readily picture the excited neurone as growing more and more cuticle until this growth is checked by the number, extent, and capacity of the excitable contacts made in course of growth. When a certain measure of growth has occurred we may suppose that residual charges below the margin of leakage are now only just sufficient to maintain the district of cuticle that has been laid down. We have therefore encountered the limits of growth of the nerve-fibre.

As for the second cell, which we have considered as mainly inhibited. In it the mass-action of the products of nuclear change is diminished and we must think of it as enlarging its cell-body by an increased nuclear activity; possessed of a short cuticle but an extending cell-body, possessed of no more than a short nerve-fibre and an extensive set of dendritic processes. As each new dendritic process makes contact with a new branch of the excited afferent neurone its growth will be more and more limited. We have here, then, encountered the limits of growth of the nerve-cell.

There is no difficulty other than that due to the short time at my disposal in compounding these statements so as to cover the whole scale of differential cell-growth, and within each cell of the relative growth of its several parts, that is observed within the nervous system. I may perhaps be permitted this abrupt closure to a development of the probabilities underlying the following expression of opinion.

I hold it as probable that all the individual structures of the nervous system, and so in the brain, have just so much difference from one another in size, in shape, and in function, as is the outcome of that measure of purely physical experience to which each one of them has been subjected; and that the physiological function of each one of them is of the simplest kind. The magnificent utility of the whole system, where the individual units have such simplicity, is due to the physically developed peculiarities of their arrangement in relation to one another, and to the receptive surfaces and motor-organs of the body.

To relieve the monotony of this discussion, let us turn away for a moment to the consideration of certain physical mechanisms found in the body, external to the central nervous system; mechanisms that are placed, so to speak, upon the front of that system so that they are capable rather of affecting it than of being affected by it, and this to such a degree that we must suppose them as rather assisting in the development of the central nervous system than as being assisted to their development by the central nervous system. There are, for example, the lens systems of the eyeball and the sound-conducting and resonant systems of the ear. Now, in dealing with the central nervous system, the suggestion was made that it was developed by just such physical conditions as are transmitted through it in its adult form. In dealing with the eyeball, it is clear that an admission of this sort is not easy. During the evolution associated with natural selection the eyeball is formed by light. It must be so. The eye is as perfect an optical instrument as could be made with a full knowledge of the part played by matter and special arrangements of matter in reflecting, refracting, and absorbing light. Long prior to the development of man, who at a later date acquired sufficient knowledge of these properties to aid him in the formation of crude lenses, there was to be found upon the general surface of the animal world lenses of very great perfection, in fact, complete cameras. Had the first optician then known what was in him he would have been saved infinite pains. Had he indeed known even the lens systems formed on the leaves of plants. Surely there is no escape from the statement that either external agency cognisant of light, or light itself, has formed and developed to such a state of perfection this purely optical mechanism, and that natural selection can have done no more than assist in this process. The influence of natural selection depends upon the frequency of variations, and it is important that there is no variation that has not behind it some cause. In this special case of variation in physical arrangements, it is indeed probable that the most frequent cause of variation would be exerted by physical conditions, since in this case the factors that are thus introduced by variation are not distinguished by any chemical peculiarity. Thinking of the few possible physical causes of variation, there can be little doubt that light itself would produce some change in this optical instrument, and that the variations produced by light would be just those more likely to be adapted to the subsequent traverse of light than such as were accidentally produced by some other physical cause. Accepting such a statement, we may say that in the course of development light formed the eye by its action upon such tissues as those of which the general surface of the body is composed. Now in just the same way there can be little doubt but that sound formed the sound-conducting and resonant portions of the ear. We may perhaps go further than this statement, and say that not only has this mechanism placed in front of the central nervous system been formed in this fashion, but that the parts of the central nervous system behind it have been formed by physical effects transmitted from the ear through this keyboard where sound is transformed into nervous impulses. Thus also, when thinking of the semicircular canals, representing as they do the portion of the surface of the body that is still normally excited by just such changes as affected the whole surface of the animal when its habitat was the sea, there is no need to doubt the view that the structures found there were formed by fluid friction; and that the cerebellum was formed as a consequence of the stimuli which have been transformed by these surface organs into nervous impulses.

But if this was the case during the evolution which led up to man, what occurs in the development of the individual? We can afford to admit the possibility that sound may approach the embryo and that fluid friction is responsible for effects observed, but light is obviously no factor in this process. Here there is no doubt that the eyeball is developed into a very perfect optical instrument in the absence of light, and we must ask: What is the force that in this case imitates the action of light? Some force must be held as arranging the several parts of the eyeball in front of the developing retina, and it is probable that before discovering it we should have to refer to the properties of the retina for an answer. We might indeed say that since the retina is a portion of the central nervous system generally characterised by the undoubted possession of electrically charged surfaces, it is always possible that this cause is of an electrical nature. Leave the statement general and it takes the form that the optical mechanisms of the eyeball are formed in the absence of light by some other definite physical cause or series of causes. Place it temporarily in the form where I would like to leave it, both on general grounds and on the evidence that its development is modified by the addition or subtraction of electrolytes: in the absence of light it is probable that orderly electrical forces arrange the developing parts of the eyeball. Now this is really not a surprising statement, since light may probably, even in the first case, be transformed into some other form of energy such as electrical energy when primarily shaping these surfaces. In any case, however, this is the view, that the individual eyeball is an instrument formed probably by some simple set of physical conditions from which light is absent, and that it is used, after a certain abruptly occurring date, by light, a force that has, up to this time, had no access to it, and yet finds it most beautifully formed for its special use.

Now development after all is rather a retrograde affair. Consider the fertilised ovum and its possibilities. A physical condition determines an increase in the chemical activity of the nucleus. At the same time an addition is made to the chemical material of the nucleus. The nucleus then divides and forms an ever-increasing site of modified chemical activity. Each new portion of this extending site is surrounded by cell bodies subjected to different sets of physical conditions, and in touch with different qualities and quantities of states. We may take it as certain that not any of the many extraordinary events which take place happen without definite cause. For example, this must be true of every single cell division. Any particular cause bearing similarly on successive generations of cells, or, as we may say, allowed to prolong its action upon a special mass of changing nuclear reaction, must finally produce states of an almost irreversible kind, eliminating possibilities of variation. Thus we might describe the ovum as a possible source of countless variations, whereas it is probable the cells of formed tissues are greatly limited in this possibility. Early in these processes, it is true, a portion of still fairly aboriginal material is shut off, and through some cause protected from changes leading to violent modification; and to this share there still appertains much of the variable character of the original ovum. Part of the remainder, perhaps the whole of the remainder, is under the heavy grip of circumstances which differ widely in different cases, and is step by step slowly driven into something of that deadly monotony of condition which is so evident in the red corpuscle, in the nerve-fibre, and in a somewhat less degree in the nerve-cell. Knowing this, then, we shall only with difficulty be induced to credit any particular kind of subordinate cell with any special character. When, for example, it is stated that the mind is, so far as the evidence will permit the statement, associated with the brain, and with no other part of the central nervous system, we can hardly get behind this statement. Mind, in man, is associated with the brain. It is conceivable that in animals it may be associated with parts of central nervous systems so simple in arrangement that we single out nothing from them as the brain. It is conceivable that there is something of the kind, indeed, in humble uni-cellular organisms. But in man mind is associated with the brain.

There is also the point that even in the case of the brain, such phenomena as sleep and deep anæsthesia familiarise us with the fact that the mind is not necessarily always associated with the brain, but only with this when in a certain condition.

Now there is no scientific evidence to support or to rebut the statement that the brain is possibly affected by influences other than those which reach it by the definite paths proceeding from the sense-organs and from the different receptive surfaces of the body. It is still possible that the brain is an instrument traversed freely, as the ear, by sound, by an unknown influence which finds resonance within it. Possible, indeed, that the mind is a complex of such resonances; music for which the brain is no more than the instrument, individual because the music of a single harp, rational because of the orderly structure of the harp. Consider such a possibility, and the analogy which I have prepared in dealing with the eyeball is seen to have some meaning, inasmuch as an instrument shaped in the embryo by a certain set of conditions may in due course of time become the play of some new influence which has taken no immediate part in fashioning it. I will not dwell upon the point behind this statement, that I find it difficult to refrain from using the word "soul."

If, however, such a view is considered, it must be said that there is no evidence that any individual physico-chemical phenomenon is developed within the brain that is not developed within other parts of the nervous system, and in a more confused manner, indeed, within the limits of every living cell. It is some special arrangement of dynamic states that must be held to form the special characteristic of the waking brain, and it should be possible in time to define the peculiarities of those special arrangements whereby we are assuming that the mind is, so to speak, caught.

It is true, too, that there are great difficulties offered to the expanded presentation of a statement which suggests a mysterious influence provocative of mind as possessed apparently of something of the nature of a physical force, since it is held to be constrained in certain peculiarities of physical environment to behave in a special way. It is, indeed, almost clear that this influence must be held to affect those physical surroundings, since there is little doubt that mind, *per se*, affects human conduct and animal behaviour, just as it is impossible to conceive mind, where present, as exerting no influence in natural selection. This, although the risks of the environment must always play the greater part in natural selection, and the influence of the mind be conceived as only secondarily affecting the organism through the intervention of the nervous system, or through mechanisms that are substituted for that system. Admitting these facts, we should in this case be obliged to regard mind resonating amongst the distributed dynamic states of the brain as influencing them in a way that might possibly be demonstrable in any physical apparatus closely imitating those states and their distribution.

Then, again, one of the main objections to a suggestion of this kind is that the condition might involve a transformation of energy which should have been discovered as an otherwise unexplainable quantity in the energy equations of the body. There may, however, be no real necessity to conclude that any transference of energy would be involved in such a process. The distribution of dynamic states in the central nervous system which are suggested as playing the part of resonators is, as I have already related, a distribution of opposite states. If we consider how these opposite states, excitation and inhibition, are arranged in any given case, it is seen that the installation of an equal number of excitations where inhibitions were present, and of inhibitions where excitations were present, will give rise to a new pattern of a very different meaning. Now such a change in the distribution of states might entail either no more than the transmission of nervous impulses, a process in which exceedingly small quantities of energy are dissipated, or, indeed, an actual cessation in the transmission of certain nervous impulses, since it is one of the curious features in these states that the one tends to recoil into the other. We might, indeed, make the assumption that an alteration in the setting of the instrument, such as was attended with a change in consciousness, was always attended by this cessation of nervous impulses, so that a brilliant display of mind might be associated with no increase in the transformation of physical energy, but actually with a diminution in the transformation. Under cover of such an assumption it might be held that this mysterious influence of which I have spoken absorbed instead of contributing energy to the system, or that it diverted energy without loss from one part of the system to another.

Now, in my opinion, there is no one at the present time who is in a position to discuss the energy transformation of the central nervous system. Further, there is certainly no one capable of dealing with such peculiarities as might arise in the energy transformation of that part of it, the brain, which is associated with the mind. There are many points to be cleared up, as, for instance, the extraordinary relationship of the central nervous system to the general muscular system, upon which I might be allowed for a moment to dwell. The fibres of skeletal muscle form the largest site of energy transformation from the oxidation of food or fuel, a site in which apparently no such transformation takes place without a coincident exhibition of characteristic muscle function and the performance of some mechanical work, and are dominated in this transformation by impulses discharged from the ventral portion of the central nervous system. This exhibition of function is invariably the cause of a dispatch of nervous impulses into the central nervous system again, along the nerve-fibres passing into its dorsal portion. Now, since the energy set free in muscle is out of all proportion to the small sum of energy transmitted from the nervous system, it is capable, amongst other things, of dispatching back again to the central nervous system a compensating or even an additional sum of energy. The musculature might then be supposed to reinforce the nervous system. Until such points are given their due importance, it would be ridiculous to dogmatise about the energy equations of the central nervous system, and to discuss the amount of energy expended in the performance of movements, or stored in the absence of movements, within this system.

I will not labour these points, upon which I can throw no light, but put forward this expression of belief rather than opinion to explain an attitude revealed in the remainder of this address, and not as based on evidence or in any way a statement of demonstrated or demonstrable fact. The essential point for the moment is this—that there is some loophole for the view that mind is not directly associated with life or living matter, but only indirectly with certain dispositions of dynamic state that are sometimes present within certain parts of it. It is a point of view not without interest to physiology, since it would leave that science free to consider all phenomena present in such forms of life and living matter as carry no suggestion of an association with mind, as nothing more or less than physico-chemical phenomena, which, when thoroughly investigated, would be completely translatable into scientific terms. Then, too, when there is evidence of mind, the view is that it represents a force acting from without upon what is still no more than matter involved in certain chemical and physical states. Incidents of function would, in such a view, pass straightway into the realms of physical and organic chemistry, requiring special methods of investigation alone, because of the localisation of processes and punctate states in minute microscopical parts not readily removed from their surroundings into selected experimental surroundings of the same value.

We are at liberty, then, to deal with this series of physico-chemical experiments, boldly giving each observed difference in circumstance a possible importance in the determination of observed differences of character, and each difference in character a probable explanation in terms of simple differences in circumstance; we may boldly consider the causation of variations, and use the term "natural selection" as equivalent to the physico-chemical limits to the successful maintenance of each experiment. Let us, for example, begin with the blood.

It is at once legitimate, in the first place, to ask how this blood tissue has arisen from variation in the chemical reactions of nuclear material. The argument runs that some ascertainable cause must have produced a material variation which has been preserved by natural selection, and quite probably, too, by the persistence of the cause over some long period in the history of nuclear material. There is no harm for the moment in surveying causes and temporarily fixing upon one that seems to possess greater appropriateness than any other. Therefore I suggest that we take this main characteristic of nuclear material in the blood tissue, that it is engaged in the production of a pigment, and that the most efficient cause determining pigment production is the action of light. Remembering that we are probably dealing with nuclear matter in general from which this particular material has been split off and set aside by subsequent causes, we can admit this postulate. The pigment-forming propensity of blood is thus taken as probably due to the initial action of light upon nuclear material placed near the surface of the body, and there exposed to the action of light.

Our next step is to discover any probable fact which, favoured by natural selection, might drive into the interior of the body nuclear matter that had been so modified by light that it persisted in the formation of pigment; in other words, Why should any pigment-forming reaction ever be removed from the direct influence of light, and a valuable transformer of radiant energy be thus driven into a position of disadvantage within the interior of the body?

Now let us consider the value of those particular instances of pigment formation which have been allowed by natural selection to persist upon the surface of the body. These successes represent experiments that have not been detrimental to the general mass of chemical reactions which form collectively what we call the organism, and we are entitled to ask, In what way are these successes likely to differ from the failures? If we take the possibility that some pigments convert all the light which they absorb into heat, and receive per unit of surface a share of solar radiation measured as seven thousand horse-power per acre, we have a picture that the body surface might thus be exposed at any one time to the transformation of an excessive amount of energy. The square metre of surface which might in the human body be exposed at one time to the sun would, provided with such pigment, absorb in one hour as much heat as is produced by the whole body in twelve hours, and the temperature of the body might be raised a further 20° C. by this means in one hour. It must, then, be an important matter in which the risks of life maintenance have certainly acted along the lines of natural selection, that such pigments, transforming the total energy they receive into heat, must be driven from any place they have temporarily occupied on the surface of living matter. As in the plant, in successful cases this energy must be largely diverted into chemical work. It would not, then, be surprising that certain modes of pigment formation have been eliminated, and that certain other modes, finding a utility of some other kind, have been retained by natural selection in seclusion within the interior of the body. Let us take it that blood-pigment represents such a mode of reaction, and that its influence is mainly to convert light into heat, and, secondarily, in some degree to determine the separation of oxygen from certain compounds, thus also performing some chemical work when under the influence of light.

Now since it is also part of the general line of argument that it was inefficient in this chemical aspect, and on that account driven from the surface of the body, it must be held as incapable of separating oxygen from more stable compounds; and we find an explanation for the fact that it is engaged upon unstable compounds of oxygen, not absorbing much energy in the process of reduction nor liberating much on oxidation.

Since, in regard to all such chemically dynamic pigments, with a utility dependent upon their constant association with some molecular group in which a corresponding reduction process can be effected, it will never be surprising to find this group actually forming a constituent part of the molecule. It is, then, not surprising to find these two qualities, pigment and unstable oxygen compound, present in hæmoglobin, nor to find in this special case that the secondary process has assumed the position of major importance, and that hæmoglobin is no longer of use as a pigment so much as an unstable compound of oxygen. Following this line of reasoning, there is nothing extraordinary in the discovery that such pigments, utilised as "oxygen carriers" within the interior of the body, are found in other situations than in blood—for instance, in the nerve-cells of certain animals and commonly in skeletal muscle. Blood tissue represents a special set of nuclear reactions possessed of this persistent quality in marked degree.

If it seems strange that the initial formation of blood in the embryo and its maintained formation in the adult persist in the absence of light, let us return to the instance of the eyeball. Of that instrument it was said that, although it was originally formed by light, yet in the mammalian embryo its formation was continued in the absence of light. Here it was necessary to think of some replacement of one cause by another, and not difficult to adopt such a suggestion, since even in the initial process it was probable that light produced its effects subsequent to transformation into some other form of energy, such as electricity. In that particular case this idea of forces, and substituted forces, in action, is capable of being formulated in fashion readily understood, because of the ease with which we can think of arrangements in gross parts being determined by such forces. Here in this new case we are, however, thinking of parts of a different order of magnitude, a fact which I can best illustrate by reference to a single red blood corpuscle occupying a one-tenth millionth of a cubic millimetre, and containing in a one-hundredth part of that space as many molecules of hæmoglobin as there are present red blood corpuscles in one cubic millimetre of blood—that is to say, five millions.

Now there is, in reality, no difficulty in considering some electrical agency as limited in its action to the minute dimensions in which each pigment-forming reaction is in process; some electrical machine such as, for example, might be energised by electrons derived from the dissolved molecules of a pigment-salt; such a machine as might be capable of transforming both light and heat into electrical energy, and which would maintain a process in the absence of light at the cost of energy obtained in the form of heat.

When thinking of the persistence of such reactions as this, initiated in this way by the action of certain primary causes that are then subsequently removed without any cessation of the reaction, we are concerned with one of the fundamental properties of living matter. Everywhere in living matter numerous instances of this property are being discovered, as in the study of immunity and of protection from infection. Nor is there reason to believe that this persistent quality of such variations will not finally be explained in terms of physical chemistry. The main characteristic of living matter is that it contains machines formed by electrolytes distributed upon the complex surfaces of matter in a state of colloidal solution and in the presence of competitive solvents, and that such machines are multiplied within it. Some of these mechanisms are arranged and perfected by the action of physical conditions operative on the surface of living matter, as, for instance, light. Some by energy derived from internal sources, but in a form that embodies conditions originally derived from the surface. Some are primarily due to internal disturbances in the equilibrium of these complex solutions produced by those chemical reactions which take place there.

Now, returning to the grosser characteristics of blood, we find it possessed of other characters curiously reminiscent of the surface of the body, and especially of glandular invaginations from the surface. Thus it is everywhere confined by cells spread upon its surface, the endothelium, which limit its relationship to the general mass of the interior. Its new-formed cells are again passed into an internal core covered by these surface cells, and from this situation, except as a result of violence, they do not pass. We might, in fact, compare the blood to a gland in which the red blood corpuscles were seen as a secretion occupying a lumen which represents the original external surface of the body. I do not wish to lay any emphasis on this point except in so far as it renders clearer this thought: that blood covered by its endothelium represents a single tissue which tends, like any gland, to grow into every interstice of the body, where the conditions of mechanical pressure permit. I shall render the point clearer by saying that the blood capillaries are no more and no less than blood-tissue.

In its early days this blood-tissue, or, if you will, this capillary network, is pushed into each portion of the body by pressure due to its growth. In its later stage the tissues surrounding it, which form the muscular coat of the heart and the walls of the blood-vessels, are arranged into an external mechanical system providing a new pressure, which still further tends to push the blood-tissue into every available space, a process such as, for example, takes place in tumour development and in the granulation tissue present in wounds.

It is a general postulate that cells long exposed to constant conditions may come to be stamped by those conditions. Special change takes place from the time when the blood grew onward by pressure of its own growth to the time when this movement is more clearly determined by the mechanism of the circulatory system, and divergent results occur in different localities of the blood-tissues which can be attributed to the differences in these causes of onward motion. Thus where growth is the leading cause of this progressive motion, as, for example, in the development of bone, the blood-tissue is later found occupying spaces that are cut off from the general mass except by lines of communication too small to transfer a full share of pressure from the circulatory mechanism. In this isolated space the blood-tissue preserves to a greater degree powers of intrinsic growth than in those places where the tissue bears the brunt of new forces. It is true that other factors induced by the new motion given to the fluid core of this tissue complicate this matter. This notwithstanding, it is, however, clear that certain definite differences in circumstance, and those principally of a purely mechanical kind, leave the blood-tissue in one district possessed of aboriginal properties which are in a large degree lost elsewhere.

As to that other tissue, which forms the circulatory system and embraces the blood-tissue, there is here little room for doubt that the structures found are the result of special local conditions acting upon originally similar cells, and little room for the suggestion that samples of several different kinds of special formative cells are driven into these positions by destiny and not by mechanics. This is an old theme, well extended and illustrated by exact observation, especially by Thoma; that in every blood-vessel the arrangement of structures is an almost immediate guide to the conditions of pressure met with in that vessel. Let us proceed through the structures in the walls of a small artery, giving a definite mechanical origin to each tissue. The elastic tissue first met with in the inner coat of the vessel is the result of periodical or intermittent pressure. In the large arteries, where intermittent pressure is the main phenomenon, and where its influence is felt right through the thickness of the wall, this elastic tissue has the major share in forming the structure of the wall. In the small artery, where the total quantity of the causative phenomenon is small, the innermost structures are affected most. This inner zone, formed under the influence of intermittent pressure, protects from intermittency the tissue formed by constant pressure, involuntary muscle. Both with regard to this tissue and with regard to the elastic tissue, it is to be remembered that the conformation of the material embracing the cylindrical mass of blood-tissue is such as to convert incidents of internal pressure into tension as well as pressure. Thus we may say that elastic tissue varies in quantity with the value of intermittent, involuntary muscle with the value of constant, pressure, and tension. On the outer surface of this case, still more protected by the mechanical value of the structures internal to it, but submitted to the traction and friction of surrounding tissues, comes white fibrous tissue. Again, when windows have been cut in the outermost case of large vessels, leaving the inner case intact, and thus destroying the tensile character of the mechanical conditions and permitting the internal pressure to hammer through these windows, they have been found closed in by plaques of cartilage, and even by true bone. It is true that the explanation offered for such results has been different from that here inferred, it being held that cells specially formative of cartilage and bone have been admitted to this new situation by the brusque strokes of operating instruments. True, too, that the complete ligature of vessels has been followed by developments of bone in unexpected places beyond the walls of the blood-vessels, as in the pelvis of the kidney; but how can you make a better internal hammer and better provide for its constant use than, for example, by tying the renal artery? Let me state it as probable that white fibrous tissue, involuntary muscle, and elastic tissue are produced by tension, whereas bone and cartilage are formed by pressure. If we credit the main statement that they are first formed from originally similar cells by circumstances special to each case, and that the difference lies in the circumstances and not in the cells, together with the statement illustrated in former paragraphs that modifications tend to persist when once introduced, we shall probably get near to the truth of the matter. Now it is impossible to leave this special case of the circulatory system—special because here there is no doubt that mechanical conditions are operative from the earliest days of development and from the first beat of the heart—without touching upon two points: the origination of the heart itself and the formation of valves.

Picture the blood-tissue in its earliest form as a lacery of networks distributed in a layer throughout the embryo, protected better by the greater thickness of material covering the central longitudinal axis than at the edges. In the absence of this protection the peripheral parts are subjected to incidents of compression which set pressure-waves travelling along the meshes of this blood-tissue in all directions from the point primarily affected. Since these waves will tend to be reflected within the tissue, we can think of the disturbance caused by them as possessed of a certain periodic recurrence of rhythm determined in its time-relations by the dimensions of the tissue, and as undergoing a tendency to modification as these dimensions are increased. In the earliest stages, whilst the distance from edge to edge is less than one millimetre, giving these waves the very slow rate of one metre per second, we can imagine these periodic changes in pressure exerting their influence upon the tissues enveloping the blood with a frequency of one thousand per second. It is again not difficult to imagine that the protection afforded to the central axial portion, through which each wave must pass in transit from edge to edge, allows us to think of the tissue there as more pressed upon than pressing, so that in this place our attention is directed to the enveloping tissue-cells receiving this rapidly recurring stimulation and being especially affected in the process into a formation of cardiac muscle. Since cardiac muscle resembles so closely in many minute particulars skeletal muscle, which is developed mainly under the influence of electrical discharge from the central nervous system, we must, if consistent, suppose that here, too, the same force is in action. In this, however, there is no difficulty, since it is a simple matter to explain how mechanical pressure may give rise to electrical change, as, for instance, when a nerve is excited by mechanical pressure. There is, however, probably this distinction between skeletal and cardiac muscle, namely, that the electrical stimulus provocative of the latter is of a high frequency and approximates nearer to what I might describe as a constant electrical current. The heart is not by any means the only site of formation of rhythmical contractile tissues, and in these other cases, so far as I am acquainted with them, a similar state of formative conditions may be described. Thus at those points where the conical apices of that second network, the lymphatic system, are forced by pressure of external parts to flow towards certain points in this blood-tissue, rhythmical lymph-hearts are described as developed in these protected sites prior to the final penetration of the blood-tissues, and the forced commingling of lymph with the fluid core of the blood.

Now give the agency that I have described a certain direction, crediting it with a graduated qualitative influence in different parts in correspondence with the date of their formation and with the altering dimensions of the blood-tissue as a whole, and the peristaltic character of the movement subsequently performed by the contractile tissue may be completely explained. Let us, then, suppose that such a peristaltic contractile mass is formed in these enveloping tissues, and consider how it will affect the blood, again enveloped by its own endothelial cells. When driven forward away through this site, the endothelial covering, which at first will slip upon the enclosing heart, later will acquire some attachment by the precipitation of fibrous tissue due to repeated friction. The movement of the endothelial cells is now only partial. They have become describable no longer completely as the surface cells of blood-tissue, and are in a measure the internal covering of the heart, its "tunica intima." With each pulsation this intima is dragged onwards to some slight degree behind the blood column to which it originally belonged. There is no difficulty whatever in thinking that valves are necessarily formed at every point where the conditions are such as tend to break up the blood column into separate parts. Indeed, we may look particularly at every place where valves are found in the blood-vessels and see similar factors at work. In the arterial system there is no projection forwards of interrupted columns of blood, nor is this the case in any of those veins in which no valves are found, as notably in those veins that are protected from partially distributed results of external pressure by the rigidity or by some other incident in the conformation of the framework in which they are found.

And now let us turn to the main function of this developing system, which is to drive the blood in continual sequence past tissues that contribute to it and tissues that abstract from it certain chemical materials, and let us select the main incident, namely, the carriage of oxygen from the lungs to other parts. That this is a main incident is clearly shown by the fact that the red corpuscles which form so important a feature in the structure of blood are formed in a number directly equivalent to this demand, that the blood should be capable of transferring a certain quantity of oxygen. Thus if these structures are lost by hæmorrhage, or rendered less efficient by the presence of carbon monoxide, or when circumstances for the acquisition of oxygen are peculiarly difficult, as on high altitudes, their formation is proportionally accelerated. That negative pressure of oxygen governs blood-production is a statement which will bear some inspection.

Now here we have a function which for its perfect performance is dependent upon another machine, the respiratory mechanism, which in its turn is governed by a different but correlated factor, namely, the carbonic-acid pressure in the blood. In this case we may say that the positive pressure of carbonic acid dominates the quantity of the respiratory activity. It is well known now that this statement has been set on firm ground.

It is interesting, then, to observe how these two mechanisms are brought into exact correlation by the simple fact that the lung surface, a portion of the respiratory mechanism, is formed accurately to a measure provided by the volume of blood dispatched from the heart, and therefore probably by that second growth of blood-tissue which I have spoken of as due to pressure from the heart. The surface of the lungs is some eighty square metres. The heart at each stroke sends into the lungs somewhere about 100 cubic centimetres of blood containing red corpuscles within a total surface also of eighty square metres. Here, then, we have a mechanical link connecting these mechanisms that is obviously forged by an incident of use.

Within the central nervous system, where development mainly affects the shape and distribution of structures rather than their chemical quality, affecting thus what we might call the geography of the system, interesting geographical facts attest to the same forged linkage of mechanisms. Thus, for example, we have the so-called "sympathetic system," offering at first view a curious anomaly to the more usual, somewhat segmental, distribution of nerve-fibres, since from the region of the cord related to the trunk of the body nerves pass through this system to control tissues placed in the head and in the limbs. This anomalous geographical fact is, however, at once explained when we regard the part played by this sympathetic control in the several parts of the body as merely subservient to the interests of locomotion. Under its influence the eye is set for out-of-door, or, if I might say it, for out-of-cave, vision. The heart is accelerated. The glandular organs, with the exception of those useful in times of much exertion and heat production, like the sweat glands, are set at rest, or else the motor organs of special importance in their sphere of influence are quietened. Regarding the matter in this light, there is an obvious convenience of geographical fact in the situation of this instrument midway between those parts of the central nervous system that are swept at this very time by nervous impulses dominating the movements of the limbs, just as there is some convenience in the chemical linkage which has been discovered between the different parts of this sympathetic system that further tends to permit their unison of activity.

On the other hand, when the muscles are at rest and the condition of the body is of the indoor description, the eye is set for close vision, and various glandular organs are allowed to conduct their functions under the influence of nervous mechanisms placed at some distance from the disturbing centres of nervous activities that are used in locomotion.

Doubtless this useful distribution of parts within the nervous system must find an explanation in the same terms as must the dynamic anatomical relation to which I have drawn attention as linking up the respiratory and circulatory systems, namely, the fact that the heart sweeps past the surface of the lungs at each stroke red corpuscles that have the same extent of surface as the lungs. In both cases it is true that the right adjustment of the several parts of this machine has been arrived at as a consequence of use, and that these mechanical linkages are due to circumstances of a purely physical and chemical nature.

In conclusion, I might say that these instances have been selected to illustrate my opinion that some of the experiments of greatest interest to physiology are in process of conduction within the normal body, and are to be observed by records imprinted on its structures. In feeling for the keys whereby each set of records may be interpreted, it is necessary that someone should frankly attempt to assign a definite meaning to every incident of structure. That this attempt should be limited by precise thinking goes without saying, and I may be allowed the hope that my transgression outside the realms of precision have not been beyond the tolerance of this section of the British Association for the Advancement of Science.

NOTES.

A DEPARTMENTAL committee (consisting of Mr. Angus Sutherland, C.B., chairman, Mr. J. E. Sutherland, M.P., Mr. H. M. Conacher, Dr. T. Wemyss Fulton, and Mr. J. Moffatt) has been appointed by the Secretary for Scotland to inquire into and report upon the character and national importance of the inshore and deep-sea fisheries of Norway and other countries engaged in the North Sea fisheries, and the efforts made for the development of the fishing and fish-curing industry in all its branches, including (1) the systems of fishery administration, including the constitution and function of the local committees formed for this purpose in Norway and of any similar organisations in the other countries; (2) the facilities provided for research and for educating and training those engaged in these industries, by the establishment of technical schools, museums, laboratories, classes, or other special facilities; (3) the nature of the various means of capture employed and the methods (including any use of State credit) by which fishermen obtain the necessary capital to maintain the efficiency of their vessels and equipment; and to report in regard to each of the foregoing matters whether it would be advisable for similar action to be taken, with or without modifications, in the case of the Scottish fishing industry, and, if so, what means should be adopted.

REUTER messages from Catania state that frequent earthquake shocks, some of which were fairly severe, have been recorded at the Etna Observatory. The records in the seismic apparatus are reported to be almost continuous and very distinct. The volcano is throwing up dense clouds of smoke, and a rain of cinders is falling as far as Catania. There is also a broad stream of lava, which is destroying the vineyards in its path.

ON Saturday, September 9, the aërial post was inaugurated by Mr. Gustav Hamel, one of our most brilliant flyers, who carried a sack of letters in a Blériot monoplane from Hendon to Windsor in thirteen minutes. Starting at five minutes to five in the afternoon, he arrived at his destination, nineteen miles distant, at 5.8, so that his speed, the wind being behind him, was about 105 miles an hour. The other aviators who should have started were prevented by the thirty-mile wind, and no further deliveries took place until Monday, when Messrs. Greswell and Driver carried six mail-bags over in the early morning. M. Hubert, in an effort to follow, had a bad fall, damaging his machine and severely injuring himself. The affair has aroused great interest, so much so that it is as well to sound a word of warning and say that the aëroplane post is neither practical, useful, nor economical. Letters can be sent far more cheaply, trustworthily, and conveniently by train or motor-van, and it is to be expected that these conditions will continue for the next half-century at least. From a philanthropic point of view the post has been a success, large sums having been received by the sale of letters and postcards, which are to be devoted to charity; but from the aëronautical point of view it proves nothing and promises nothing. Besides, it is unthinkable for very many years to come that we should put good aviators to the menial task of carrying mails regularly.

The Zeppelin airship *Schwaben* made a successful non-stop flight on September 6 from Baden Baden to Gotha by way of Frankfurt-on-the-Main. It left Baden at 6.10, and descended at Gotha at 12.30, covering a distance of about 200 miles. It carried seven passengers in addition to the pilot. On September 9 it flew from Gotha to Berlin, and on September 12 it carried eight passengers from Gotha to Düsseldorf.

Particulars are given in *The Times* of the anthropological research expedition to the islands of Normanby, Fergusson, and Goodenough, in British New Guinea, funds for which are being provided out of the Oxford University common fund and by several of the colleges. The work has been undertaken by Mr. David Jenness, of Balliol College, who proposes, unaccompanied, to spend a year amongst people who are admittedly cannibals. Mr. Jenness started on his journey last week. It is stipulated by the University, in contributing to the expedition, that the University museum shall have the first offer of articles of interest which may be obtained. Assistance has been promised by the missionaries on Goodenough Island, including the use of a boat and native oarsmen. The first few weeks will be spent in cruising around the islands endeavouring to get on friendly terms with the people and in studying the trade relations, after which Mr. Jenness hopes to settle down for some time; later he will proceed on a mission boat to Rossell Island, at the eastern end of the Louisiade Archipelago, to study some ethnological problems concerning the relationships of Oceanic peoples. Mr. Jenness has been provided with the latest scientific instruments, including a phonograph for recording native songs and speech.

A preliminary announcement with reference to the eighth International Congress of Applied Chemistry, which is to be held in Washington, D.C., U.S.A., on September 4, 1912, and in New York on September 6 to 13, 1912, has been sent to us. We learn from it that the sections will be devoted to the following subjects:—(1) analytical chemistry; (2) inorganic chemistry; (3*a*) metallurgy and mining; (3*b*) explosives; (3*c*) silicate industries; (4) organic chemistry; (4*a*) coal-tar colours and dyestuffs; (5*a*) industry and chemistry of sugar; (5*b*) indiarubber and other plastics; (5*c*) fuels and asphalt; (5*d*) fats, fatty oils, and soaps; (5*e*) paints, drying oils, and varnishes; (6*a*) starch, cellulose, and paper; (6*b*) fermentation; (7) agricultural chemistry; (8*a*) hygiene; (8*b*) pharmaceutical chemistry; (8*c*) bromatology; (8*d*) physiological chemistry and pharmacology; (9) photochemistry; (10*a*) electrochemistry; (10*b*) physical chemistry; (11*a*) law and legislation affecting chemical industry; (11*b*) political economy and conservation of natural resources. Further particulars of the prospective arrangements of the congress may be obtained from the secretary, 25 Broad Street, New York City, U.S.A.

The autumn meeting of the Institute of Metals will take place at Newcastle-on-Tyne on September 20 to 22, and the reading of the undermentioned papers has been arranged for:—the corrosion of brass, with special reference to condenser tubes, by Mr. P. T. Brühl; further note on the nature of solid solutions, by Mr. C. A. Edwards; the electrical conductivity and constitution of alloys, by Dr. W. M. Guertler; volume changes in the alloys of copper with tin, by Mr. J. L. Haughton and Prof. T. Turner; non-ferrous metals in railway work, by Mr. G. Hughes; the failure of a brazed joint, by Prof. H. Louis; the mechanical properties of hard drawn copper, by Mr. D. R. Pye; the alloys of aluminium and zinc, by Dr. W. Rosenhain and Mr. S. L. Archbutt.

We learn from *Science* that the third National Conservation Congress will be held in Kansas City on September 25 to 27. It will be remembered that the general objects of the congress are to provide for the discussion of the resources of the United States as the foundation for the prosperity of the people; to furnish definite information concerning the resources, and their development, use, and preservation; to afford an agency through which the people of the country may frame policies and principles affecting the conservation and utilisation of their resources, to be put into effect by their representatives in State and federal Governments.

The third congress of the International Society of Surgery will take place in Brussels on September 25 to 29, and a lengthy programme of papers to be read and discussed has just been issued.

At the meeting of the Astronomical and Astrophysical Society of America, held at the Dominion Observatory, Ottawa, on August 23 to 25, Prof. E. C. Pickering was re-elected to the presidency and Prof. Hussey to the secretaryship. The next annual meeting is to take place in August next at the Allegheny Observatory, Pittsburg.

It is announced in *Science* that Mr. Arthur A. Allen, instructor in neurology and vertebrate zoology in Cornell University, is to spend next year in South America as chief of an expedition organised by the American Museum of Natural History. The expedition will go to Colombia, its immediate object being to explore ruins and collect antiquities.

The New South Wales Government, in consequence of the efforts of Prof. Edgeworth David, F.R.S., has granted the sum of 7000*l.* towards the cost of Dr. Mawson's Antarctic expedition. The amount subscribed locally has now reached 19,100*l.*

The sum of 500*l.* a year for two years has been given to the Sheffield City Council by Mr. Douglas Vickers to cover the cost of a trial of the tuberculin treatment for consumptives, and Dr. Chapman, formerly of the Sheffield Infirmary, has been appointed to superintend the treatment.

The twenty-sixth annual congress of the Incorporated Sanitary Inspectors' Association met at Yarmouth last week under the presidency of Sir James Crichton-Browne, F.R.S., who in his opening address made the following remarks on the subject of tuberculosis:—For all practical purposes the identity of human and bovine tuberculosis is established, and we can hold fast to the faith which had been unquestioned until Koch launched his thunderbolt—the explanation of which was afforded by the Royal Commission report. It was the difficulty he experienced in communicating human tuberculosis to calves, cattle, and pigs, whether by injection or feeding, that led Koch to conclude, too hurriedly, that human and bovine tuberculosis were specifically different. The fact of the comparative immunity of calves, cattle, and pigs to human tubercle bacillus enabled them to realise how much they were indebted to the labours of the Royal Commission. It misled Koch; it would have misled many less experienced investigators; and but for the appointment of the commission there would have been a series of repetitions of Koch's experiments under restricted conditions and an accumulation of testimony that he was quite right in declaring that bovine and human tuberculosis were distinct diseases, followed by a mischievous relaxation of the measures directed to prevent the communication of bovine tuberculosis to human beings and the loss of innumerable lives. The commission fulfilled its mission, and there is now irrefragable evidence that mammals and man can be reciprocally infected with tuberculosis, with the prospect of the introduction of stringent administrative measures for preventing the propagation of tuberculosis among human beings by means of food. Bovine animals are only comparatively, not completely, immune to the human tubercle bacillus, and human beings are notably susceptible to the bovine tubercle bacillus, which produces in them even the pulmonary forms of the disease. He went on to emphasise the necessity of general legislation, applicable to the whole country, to cope with the evil of tuberculous milk supply.

SEPTEMBER this year is proving exceptionally warm, and the record summer is extending its influence into the early autumn. On seven days out of the first twelve in September the shade temperature at Greenwich has exceeded 80°, which brings the total days with 80° and above to forty-four for the summer so far, which is four more than any previous record during the last seventy years. The average maximum temperature for the first eight days of the month is 2° higher than any previous record for the same period. The maximum temperature at Greenwich on September 7 was 92°, and on September 8 94°; the latter is 2° higher than any previous temperature so late in September. There have already been seven days during the summer with the temperature above 90°, and 1868 is the only other summer in the past seventy years with an equal number of hot days. The aggregate rainfall at Greenwich from July 1 to September 12 is 1·62 inches, which is 30 per cent. of the average, and rain has only fallen on twelve days. When a complete discussion is made of the very remarkable summer, it will be full of interest.

THE Parliamentary report of the Meteorological Committee for the year ended March 31 shows that the business has been exceptionally important; the office was transferred to South Kensington, where a museum of instruments and objects of interest, and a small physical laboratory, have been provided. The transfer to the committee of the administration of the Kew Physical Observatory and of the magnetic observatory at Eskdalemuir (to which we have before referred) was carried out. In addition to many useful official publications, we note that Dr. Shaw has completed a book (more particularly for the use of aëronauts) on "Forecasting Weather," which embodies the results of the work of the office in connection with dynamical meteorology during the last ten years. The reports of the operations of all the various departments exhibit great activity. Upwards of 3000 registers of various classes relating to the meteorology of the ocean were received. The information has been utilised in the preparation, *inter alia*, of the monthly meteorological charts of the North Atlantic and Indian Oceans (to which we have frequently referred). Considerable improvements have been made in the maps and tables of the Daily Weather Report; several stations in or near London are now included in a separate table. The usual forecasts have been supplemented by a "further outlook" giving the prospects for a longer period when practicable. The success of these and of the usual forecasts and storm warnings during the year was very satisfactory; wireless telegrams from the mercantile marine were generally received too late for the chart of the current day, but were nevertheless frequently of great assistance to the forecaster. The investigation of the upper air by kites and balloons has been regularly carried on; a systematic attempt was made to ascertain the effect of solar radiation on the instruments, &c. The result, so far as it goes, is said to show that distinctly higher temperatures are recorded while the sun is shining.

To the first part of the *Bergens Museums Aarbok* for 1911 Captain H. Negaard contributes a paper on the earliest population of the Hardanger Field district of south-western Norway, with descriptions and illustrations of their works, weapons, and implements. Among the former, the abundance of remains of Megalithic structures of the Stone age is specially noticeable. In a second paper Mr. J. A. Grieg records the vertebrate remains found among these "boplader," which include those of trout, ptarmigan, willow-grouse, plover, reindeer, and lemming.

DR. FLORENTINO AMEGHINO emphasises his views on early human development in South America in a paper entitled "La antigüedad del hombre en la República Argentina" (Atlántida, tomo iii., 1911). The stratigraphical studies of Wilckens are quaintly described as formed in the cabinet during "un acceso de ameghinofobia aguda." The paper is mainly an answer to the work of A. Mochi in the *Archivio per l'antropologia*, in which the age of the beds containing human remains is held to be in accord with what is known in Europe, while doubt is thrown upon the materials brought as evidence from underlying strata. Ameghino claims certain diminutive eoliths from the South American Eocene as having been fashioned by the precursors of man. His general position is that Argentina may be able to show what European stratigraphy fails to prove, and this, of course, no scientific geologist can overlook.

IN an article on the adaptation of the Primates, published in *The American Naturalist* for August, Prof. F. B. Loomis expresses the opinion that the group, of which the earliest known representatives are the Lower (Wasatch) Eocene Anaptomorphidæ and Notharctidæ, originated in the forest tract north of Hudson Bay, which then enjoyed a tropical climate. "From this ancestral centre the first Primates, along with other groups, migrated in all directions possible. . . . This opened three paths, one south into America, a second south-easterly into England and France, and a third south-westerly into Asia, thence ever southerly across China and India and along the Indo-Madagascar isthmus (or chain of islands) to Madagascar and Africa." At an early date the group became differentiated into fruit-eaters (Anaptomorphidæ, followed by the modern Tarsiidæ) and general feeders (Notharctidæ—giving rise to the tropical American Cebidæ—and the European Adapidæ, from which are derived modern Old World apes and monkeys, while a side-branch gave rise to lemurs). The Cebidæ probably reached their present home from the north during the Eocene, while the Old World Primates travelled from America *via* Bering Strait, and made their way south through eastern Asia to Madagascar and

Africa, reaching England in the Upper Eocene. "With the close of the Eocene the first adaptive radiation of the Primates was complete, and they had achieved an almost world-wide distribution. At the end of the period the North American contingent was extinct, the South American group was isolated, the Asiatic and African forms were scattered on islands and on the African continent, and the European contingent was located in central and southern Europe . . . and it is among these that the next act in the great primate drama took place." To follow the views of the author on this point would take too much space, but it may be mentioned that he adopts the opinion as to the Asiatic origin of the man-like apes and man, considering the Fayum forms described by Schlosser as being probably referable to the Cercopithecidæ. In conclusion, it may be observed that the views of Mr. Loomis differ essentially from those of Dr. Standing (Trans. Zool. Soc., 1908), who believes American monkeys and lemurs to have been differentiated in an equatorial continent connecting Africa with South America.

Vol. vi., No. 15, of the University of California Publications in Zoology contains a contribution (pp. 353–468, pls. 33–48), by Edna Earl Watson, on the unsegmented cestode Gyrocotyle, which is parasitic in the spiral valve of certain chimæroid fishes. The history, occurrence, and gross anatomy of the genus are considered, the distinctive characters of the four known species are pointed out, and the morphology and histology of the systems of organs described. The intermediate host and life-cycle of Gyrocotyle are still unknown. Interesting observations are presented on the functional orientation of this parasite. The acetabulum is directed anteriorly, and its exploratory function is strongly in evidence; it never acts as an organ of fixation. The rosette is posterior, and functions strictly as an organ of attachment. Near the acetabulum is a pair each of sensory pits and papillæ abundantly innervated from the neighbouring portion of the central nervous system, which the author regards as corresponding to the "brain" of a turbellarian. The rosette portion of the nervous system, developed in connection with the powerful posterior organ of attachment, is comparable with the posterior ring commissure in the posterior sucker of a heterocotylean trematode. The rosette of Gyrocotyle is a true scolex, in structure and function, and corresponds to that organ in the segmented tape-worms. On the basis of this and other evidence, the scolex of a cestode is regarded as a posteriorly situated organ of attachment, the "neck" or growing region as the ante-penultimate region, corresponding to the growing zone in annelids, and the proglottis as the intermediate region of the body. According to this view, the anterior end in the tape-worms has disappeared.

Part i. of vol. ii. of the entomological series of Indian Forest Memoirs, by Mr. E. P. Stebbing, contains a detailed account of the pests of the Deodar, and some sketches of the insects that have been observed to prey upon some of these pests, which should be extremely useful to forest officers of every grade. The number of pests, mostly from the Deodar forests of the N.W. Himalaya, which the author discusses, include fourteen species of beetles, six species of lepidopterous caterpillars, and two saw-fly caterpillars, the majority of which are specifically identified, those that are not named being sufficiently described and figured for recognition by the forest conservator. Among the injurious beetles, three species of Scolytus, which are regarded as destructive above all others in the area specified, are said to be quite peculiar to the Deodar. Of insects that attack some of the commoner of the pests, four parasitic Hymenoptera and three predaceous beetles are mentioned, and are duly extolled according to the modern optimistic fashion. The plan of the memoir is good. Each species, so far as the present state of knowledge allows, is described and figured in the several stages of its existence, in the more important phases of its activity, and in its local and constitutional effects upon the tree. Damages also are adjudged, and treatment is suggested.

In addition to giving an account of the work and progress of the society for the year 1910–11, the seventy-eighth annual report of the Royal Cornwall Polytechnic Society contains a short but excellent life, by Mr. F. H. Davey, of the later C. W. Peach, accompanied by a portrait. Peach, who did so much for the geology and natural history of Cornwall, as well as for other parts of the United Kingdom, was born in 1800 and died in 1886. Occupying an ordinary post in the coast guard service, and entirely self-educated, he is credited with having made during the first half of the nineteenth century probably more additions to the Cornish marine fauna than any naturalist except W. P. Cocks.

Pursuing Prof. Brandt's argument that the distribution of plankton is correlated with the activity of denitrifying bacteria, Mr. B. Issatschenko reports in the *Bulletin du Jardin Impérial Botanique*, St. Petersburg (vol. xi., part iii.), the results of cultivating bacteria from samples of water taken from the Black Sea. Two new species of Bacterium were thus obtained, the one an active denitrifying organism, the other only capable of decomposing nitrites. Similarly, Dr. Parlandt describes the action of three denitrifying species cultivated in water from the Baltic Sea.

A brief summary of the leading facts connected with graft hybrids is contributed by Mr. R. P. Gregory to *The Gardener's Chronicle* (September 2 and 9). Although the subject is discussed by Charles Darwin in "Animals and Plants under Domestication," the nature of these vegetative hybrids has remained obscure, and systematic attempts to produce other specimens failed until Prof. H. Winkler managed to raise composite forms from grafts of tomato and black nightshade. A striking feature of the hybrids thus obtained was the development, side by side on the stem, of the stiff hairs and divided leaves of the tomato with the smooth exterior and simple leaves of the nightshade, a phenomenon to which Winkler gave the name of "chimæra"; the explanation is found in the juxtaposition of meristematic tissues derived from each plant. Generally it has been observed that tissue development proceeds in parallel lines, *i.e.* periclinally; thus in *Crataego-mespilus Asnierii*—as illustrated—the epidermis is that of the medlar, while the internal tissue is that of Cratægus, and *Cytisus Adami* presents the appearance of *Laburnum vulgare* clothed in an epidermis of *Cytisus purpureus*.

Mr. E. F. Smith directs attention to the striking resemblances between "crown-gall," an affection of plants, and malignant animal tumours, especially sarcoma. It is inoculable on to healthy plants, reproducing the disease. In the "tumours," both primary and those obtained by artificial inoculation, a bacterial organism (*Bacterium tumefaciens*) is present, which can be isolated and cultivated, and the pure cultures reproduce the disease on inoculation (Circular No. 85, 1911, Bureau of Plant Industry, U.S. Department of Agriculture).

In *The Museums Journal* (vol. x., No. 12, June) Mr. E. E. Lowe, of Leicester, continues a description of models to show the optical properties of rock-forming minerals.

We should prefer to place the models illustrating the crystal-systems on a lower shelf, rather than to tilt some of them in order to show their lateral axes. The features of the optical indicatrix are well illustrated by hoops and wires. The explanations of the models serve as an introduction to the examination of mineral-slices with the polarising microscope; but we may prefer the generalised diagrams of Groth to those here given for a special case. There seems an arrow-head too many in one of the figures; and we doubt if Mr. Lowe's model has, as he states, the short diagonal of the analysing nicol "inclined towards the observer at an angle of 45° with the horizontal plane."

For several years past the Aire and Calder Navigation Company has been improving the navigation along the system of canals between Goole and Leeds by deepening and widening the water-way; and in consequence the traffic has been very largely increased, rendering Leeds an inland port on a small scale. Recently a steamer 80 feet long reached Leeds from the docks at Hull in nineteen hours.

An automatic stabilisator, recently invented by M. Doutre, has been used with partial success on a Farman biplane in France, where it has aroused considerable interest. It is designed solely for preserving fore-and-aft equilibrium, and one of its most interesting results is to give the machine to which it is fitted its best angle of glide independently of the pilot's control. The apparatus consists of two parts, an anemometer and what is termed an "accelerometer." The former is a plate placed normally to the air-flow, and backed by two springs of such a strength that the pressure on the plate, when the machine attains its mean speed, entirely compresses them. The forward motion of the plate resulting from any diminution of the wind-pressure depresses the elevator through the agency of a piston operating by compressed air. The "accelerometer" consists of two movable and relatively heavy cylinder-heads, each sliding on a rod placed end on to the flight-path, which move under inertia whenever the speed of the machine diminishes or increases, and operate the elevator in a similar way to the anemometer. These cylinder-heads are held at each end by springs, which return them to their initial position when the aëroplane progresses at a uniform speed, and also check their movement when the machine pitches without speed variation. Both the accelerometer and the anemometer have been combined in one instrument by the inventor, and experiments in calm weather proved that the machine could safely fly for several seconds uncontrolled.

An interesting article on engineering problems in Nicaragua, by Mr. T. Lane Carter, appears in *The Engineering Magazine* for August. As few countries have such a rainfall as one finds in Nicaragua, irrigation is not one of these problems. At Greytown, at the mouth of the San Juan River, the rainfall is about 300 inches per annum; in the mountains, where the gold mines are situated, the rainfall varies from 100 to 125 inches per annum. With rainfall and soil such as they have in Central America, it is not surprising that the vegetable growth is rapid. Two and a half crops of corn can be raised per year. Sugar-cane will produce there for seven or eight years, and does not need an annual planting, as in Louisiana. But the agricultural engineer will find a great deal to occupy his attention in Nicaragua. In the eastern part of the country agriculture is in as backward a condition as in the days of Columbus. Take, for instance, the usual method there of planting corn. A patch is selected in the forest, and the trees and bushes felled. No attempt is made to clear away the rubbish. A man goes round with a sharp, pointed stick, pokes holes in the ground wherever he can find a place amongst the débris, drops in a few seeds, and leaves the crop to nature's care. There is no hoeing or cultivating done. The corn must fight out its battle unaided by man. Strange to say, the crop is gathered in about eight weeks.

A leading article in *Engineering* for September 1 deals with the recent investigation on the stress distribution in a plate pierced with a hole and subjected to pull, which has been ably carried out by Dr. K. Suyehiro, of the Department of Naval Architecture, Tokio University. Strictly speaking, the solution appertains only to the ideal case of a plate pierced at the centre and extending to infinity in all directions; this is assumed to be subjected, in one direction only, to tension, the distribution of which is uniform at an infinite distance from the origin. Dr. Suyehiro then works out what the distribution of stress is in the immediate neighbourhood of the hole, and finds that the maximum value of the stress is no fewer than three times that of the average value. If there were any real analogy between stream-lines and stress-lines, the maximum stress, he points out, would be double the mean. Dr. Suyehiro also shows that local concentrations of stress have practically vanished at points distant from the centre of the hole by $1\frac{1}{2}$ radii; hence his result is applicable to quite narrow plates. He has also compared the results of his calculations with direct experiments on a strip of india-rubber, and finds remarkably close agreement. In view of the importance of the fact that a ship's deck is under push and pull alternately, a useful investigation might be made on the elastic breakdown and final rupture of a wide bar pierced with a hole and subjected to alternating stresses of push and pull. The original paper is reprinted in full in the issue of *Engineering* already quoted.

OUR ASTRONOMICAL COLUMN.

Kiess's Comet, 1911*b*.—No. 4522 of the *Astronomische Nachrichten* contains a new set of elements calculated by Dr. H. Kobold for comet 1911*b*, also a number of observations of the comet. The observations, made about the middle of August, are somewhat uncertain, owing to the difficulty of the object, and Senor Marisonza reports from Rio de Janeiro that during August 18–20 the brightness had rapidly decreased; he states that it could not be observed there after August 24. The ephemeris computed by Herr A. Kobold shows that the present magnitude should be about 8·6, and the position for September 14 is 18h. 15·3m., -45° 24·1′; the comet is now nearly stationary in Corolla, immediately north of α Telescopium.

Meridian Circle Observations.—From the Harvard College Observatory we have received vols. lxv. and lxvi. of the Annals, embodying the journal of the zones observed with the 8-inch meridian circle during the years 1888–90 and 1890–8 respectively. The observations were made and the volumes prepared by Prof. Searle in the preparation of a catalogue which is to appear in vol. lxvii. of the Annals; a previous publication, vol. lxii., part i., dealt with the fundamental stars employed in the same zone, viz. -9° 50′ to -14° 10′.

Brooks's Comet, 1911*c*.—The brightness of Brooks's comet, 1911*c*, continues to increase, and during the fine nights recently experienced at Portsmouth many British Association visitors who are not astronomers found no difficulty in distinguishing the comet from the surrounding stars merely by naked-eye observations. According to the supplement to No. 4522 of the *Astronomische Nachrichten*, Dr. Schiller reports that on August 29 the comet was about half a magnitude fainter than the Andromeda nebula. Its nucleus, formerly sharply stellar, had become diffuse, and in a bright red field was well seen. Dr. Ebell found that on August 26 the brightness of the comet was comparable with that of two 5·9-magnitude stars near to it, and on September 11 Mr. Rolston found that it was as conspicuous as ν Draconis.

From later observations, August 19, 21, and 24, Dr. Kobold has calculated improved elements and an ephemeris, which he publishes in the supplement named, and from which we take the following:—

Elements.

T = 1911 October 27·76235 (M.T. Berlin)

$$\left.\begin{array}{l}\omega = 152^{\circ}\ 44'\ 17.7'' \\ \Omega = 293^{\circ}\ 10'\ 6.1'' \\ i = 34^{\circ}\ 0'\ 2.8''\end{array}\right\} 1911.0$$

$\log q = 9.690358$.

Ephemeris 12h. Berlin M.T.

1911	α (true) h. m.	δ (true)	log r	log Δ	mag.
Sept. 13	17 14·2	+57 9·7	0·0396	9·7171	5·1
,, 15	16 48·1	+56 40·5			
,, 17	16 22·6	+55 50·5	0·0113	9·7136	4·9
,, 19	15 58·5	+54 42·1			
,, 21	15 35·8	+53 16·8	9·9808	9·7152	4·8
,, 23	15 14·6	+51 37·1			
,, 25	14 55·6	+49 44·7	9·9482	9·7214	4·7
,, 27	14 37·9	+47 41·9			
,, 29	14 21·8	+45 30·0	9·9132	9·7321	4·5

On the accompanying chart we show the approximate apparent path of the comet among the stars for the next month.

Apparent Path of Brooks's Comet, 1911*c*, September 13 to October 15, 1911.

From the ephemeris it will be seen that the comet is nearest to the earth about September 17, when its distance will be about 48 million miles. In calculating the magnitude, Dr. Kobold has taken 6·0 on August 26 as his fiducial point, and from opera-glass observations made on that date we believe that his figure probably errs in the direction of making the comet too faint, so that we may expect to see a fourth-magnitude object at the beginning of October.

VARIABILITY OF POLARIS.—Numerous observers have suspected α Ursæ Minoris to be a variable star, and several periods have been found for its variation, but a lack of agreement has left the question somewhat undecided. As a result of a very large piece of observational work, however, Dr. Ejnar Hertzsprung finds that the pole star is a variable of the δ Cephei type having an amplitude of 0.171 ± 0.012, and a period of 3·9681 days. The grating method described in *Astronomische Nachrichten* No. 4452 was employed, the first- and second-order images of Polaris being compared for density with the image of a neighbouring star. Observations were made on fifty nights, 418 plates being secured with four exposures on each, and the results are tabulated in the paper in No. 4518 of the *Astronomische Nachrichten*. Dr. Hertzsprung also shows that Polaris has other attributes of a Cepheid variable.

OBSERVATIONS OF MARS.—A telegram from Prof. Lowell, published in No. 4521 of the *Astronomische Nachrichten*, announces that photographs of the Martian canals were secured on August 30.

In the same journal M. Jarry Desloges makes some preliminary remarks concerning his observations of the planet during the present opposition. The seeing generally has not been good, although latterly he has been able to use a power of 500, and has had moments of absolute calm. The Mare Cimmerium, among other features, is still very pale and difficult to see during Martian morning. The gulf which formed on Zephyria in 1909 is still visible, and a bright area has been detected on its interior. Aonius Sinus is sharply outlined, but the whole region of the Solis Lacus, although well placed for observation, is lacking in colour; the lake itself is double, or greatly constricted across its median line, as in 1907 and 1909. A number of "canals" appear as broad bands with indefinite edges, and are quite easy to see despite the great distance of the planet; Cyclops, Cerberus, Læstrygon, Titan, Araxes, Coprates, and Bathys are among these, and the last named is more easily seen than in 1907, although the planet was much nearer then. Many bright spots, *e.g.* Elysium, Æolis, Zephyria, Memnonia, Tharsis, &c., are visible, but the southern polar cap is very small and at times difficult to distinguish, appearing as though it were veiled.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE University of Edinburgh has just instituted two degrees in veterinary science, viz. bachelor and doctor.

A STATE college of forestry has been established at Syracuse University, and the sum of 55,000 dollars has been appropriated for it.

DR. FRASER HARRIS, at present lecturer on physiology in the University of Birmingham, has been appointed professor of physiology in the Dalhousie University, Halifax, Nova Scotia.

MR. E. D. SANDERSON, dean of the college of agriculture at West Virginia University, has been appointed to succeed Mr. J. H. Stewart in January next as director of the experiment station. He will continue to fulfil the duties of dean.

ELEMENTARY courses of medical study, both theoretical and practical, have been arranged by the authorities of Livingstone College, Leyton, E., for those about to engage in missionary work. Particulars of the course, and the "Mrs. Bishop exhibition," can be obtained from the principal of the college. The session begins on October 2.

AT the jubilee celebration of the University of Christiania, the honorary degree of doctor was conferred upon the following British representatives:—Prof. Alfred Marshall; Sir Thomas Barlow, Bart., K.C.V.O., F.R.S.; Sir J. Rose Bradford, K.C.M.G.; Prof. Sir W. Osler, Bart., F.R.S.; Rev. Prof. A. H. Sayce; Dr. H. Sweet; Prof. Sir James Dewar, F.R.S.; Dr. H. A. Miers, F.R.S.; Sir John Murray, K.C.B., F.R.S.; Prof. Sir William Ramsay, K.C.B., F.R.S.; Prof. W. J. Sollas, F.R.S.; and Prof. Sir J. J. Thomson, F.R.S.

THE Board of Education has issued its regulations for scholarships, exhibitions, &c., in science for the year 1912. The awards for science to be made by the Board under these regulations are identical with those formerly made by the Board under the regulations for technical schools, 1909–10. The conditions for these awards in 1913 will be modified. The subjects of the competitive examination will remain the same, but the papers set will be of not more than two standards corresponding with those of the new scheme of general science examinations. The Board of Education is of opinion that further changes in the conditions of award of Royal scholarships, free studentships, and of Whitworth scholarships and exhibitions, may with advantage be made later, but such alterations will not be brought into operation without due notice being given.

IN the case of the Merchant Venturers' Technical College, Bristol, in which the faculty of engineering of the University of Bristol is provided and maintained, the new calendar shows that the complete arrangements made last year are to govern the work next session, and that the educational needs of every important industry of the city have been borne in mind. It is interesting to notice that several local firms have notified their willingness, other things being equal, to give a preference to students who have completed a course of work in the engineering department; and some firms are prepared to take students into their works at reduced premiums, or, in others, without premiums. Some firms, too, have agreed to allow their apprentices to present themselves at their works at 7 o'clock in place of at 6 o'clock on not more than two mornings a week during the college evening-class session provided they can produce a certificate from the college at the end of the session stating that they have attended a number of evenings equal to the number of cases on which they have availed themselves of the concession.

THE new calendar of the Battersea Polytechnic shows that in the Day Technical College full-time courses are arranged in mechanical, civil, electrical, and motor engineering, architecture and building, and chemical engineering. The courses cover a period of three years, at the end of which time students passing the necessary examinations are awarded the polytechnic diploma. Concurrently with the diploma courses, students can take the degree courses in science and engineering of the University of London. Several new developments have been arranged; in the mechanical engineering department a course of lectures on illuminating engineering will be held; in the electrical engineering department special attention will be given to electric traction, and new machinery and apparatus are being purchased so that the subject may be more thoroughly taught. Attention may also be directed to the chemistry course for sanitary inspectors, and to the arrangements which have been made for the provision of special lectures by trade experts in connection with the paper-making course.

AMONG the college calendars, providing information respecting the arrangements made for the forthcoming session, which have been received during the past week may be mentioned that of the Edinburgh and East of Scotland College of Agriculture, which affords evidence of the greatly increased activity in this branch of technical education. Particulars are given of the courses which may be taken at the central institution in the departments of agriculture, horticulture, and forestry. In horticulture, during the coming session a commencement will be made with the newly instituted two years' course leading up to a special certificate. It is hoped that this course, which has been established at the instance of the Scottish horticultural societies, will be taken advantage of by intending nurserymen, market and estate gardeners, and others. Under the new arrangements with the University of Edinburgh, the teaching in forestry subjects is to be shared between the University and the College, and details are given of the courses offered in the combined forestry school. Various experiments in the growing of field crops and in other branches of agriculture and horticulture are conducted under the advice of local committees of practical men, and are directed towards the solution of problems of importance in the business of the farmer and gardener.

THE celebration of the 500th anniversary of the foundation of St. Andrews University is now in progress, and the influx of distinguished visitors into the ancient city far exceeds anything of the kind in former years. The presence of Royalty alone is necessary to complete the scene. Almost all the visitors are the guests of the University staff, of the St. Andrews School for Girls, of the citizens of St. Andrews and Dundee, or of country houses in Fife and Forfarshire—within easy reach of the city by motor carriages. The cordiality with which all responded to the call for accommodation was a source of gratification to the executive. For the carrying out of the programme various committees dealing with the several departments have been at work about a year. Thus the publications committee has issued several memorial volumes, literary, scientific, and historical, and there is also a small quincentenary handbook of the city and the University of St. Andrews by the librarian. In the memorial volumes the zoological department and the Gatty Marine Laboratory do not bulk so largely as, for example, chemistry, since the history of the laboratory, with the list of publications up to date, forms an independent publication. A large temporary hall about 90 yards in length and 30 yards in breadth has been fitted with a spacious platform at one end and an orchestra at the other, the whole structure occupying the old archery butts to the north of the United College. This hall accommodates between three and four thousand people. Covered ways lead to several cloak-rooms, to the museum, and to the United College buildings generally. In the upper hall of the library in South Street is an exhibition of early and rare printed books and manuscripts. Everything has been done in the way of facilitating transit by railway from a distance and to Dundee, as well as arranging for local conveyances. Clubs for men and for women, a camp in the University park for students, a special post-office and a refreshment-room in the Town Hall are other features which have received attention. Never did the old grey and sea-girt city, with its parallel streets leading to the cathedral, look more charming, or its finely planted promenades and walks (under the fostering care of the Town Council) more enticing. To every graduate and student, as of old, the place appeals with an irresistible charm, and it is to be hoped that the distinguished visitors will be no less fascinated by their unique surroundings. Next week we hope to have an account of the celebration, which began with a reception by the Chancellor on Tuesday evening. Besides the men of science mentioned in NATURE of last week, the following will receive the honorary degree of LL.D.:—Dr. Berry, Dr. Byron Bramwell, Sir H. Butlin, Sir Hector Cameron, Prof. Caullery, Prof. Goebel, Prof. Gotch, Prof. Ludwig Graff von Paucsova, Prof. Holst, Dr. Horne, Prof. Keen, Sir J. Larmor, Prof. Leboucq, Prof. Sedgwick Minot, Prof. Nathorst, Prof. Nijland, Prof. E. E. Prince, Prof. Reddingius, Prof. Schaefer, Dr. Anthony Traill, Prof. Veit, Prof. Watts, and Dr. Smith Woodward.

CONTENTS.

THURSDAY, SEPTEMBER 21, 1911.

THE PROGRESS OF PHYSICS.

The Progress of Physics during Thirty-three Years (1875–1908). Four lectures delivered to the University of Calcutta during March, 1908. By Arthur Schuster, F.R.S. Pp. x+164. (Cambridge: University Press, 1911.) Price 3*s*. 6*d*. net.

IN the year 1908 Prof. Schuster during his visit to India gave to the University of Calcutta four lectures, which he has now incorporated into a book, dealing with the progress which had been made in his subject during his own active lifetime, namely from the year 1875 onward.

The scope of the book he thus explains:—

"It is my aim to trace the changes in our point of view, rather than to give an historical account of the sequence of the discoveries which make this period memorable. . . . I prefer to be frankly subjective, and warn you beforehand that my account will be fragmentary, and to a great extent reminiscent of those aspects which have come under my own personal view."

In his preliminary survey of the state of the science before 1875 he contrasts the endeavour at that time prevalent to get a clear idea of the mechanism underlying the various processes, with the "blinkers" which are in some quarters willingly accepted now, not only as inevitable but as praiseworthy instruments conducive to a rational philosophy. The one idea of Energy is now sometimes upheld as dominating the field, and rendering unnecessary all more picturesque inquiry into forces and motions and coordinates in detail.

It is true that ignorance of detail may often be a dominant feature in both methods of dealing with phenomena; but the modern treatment, as he says—"glorifies our ignorance, while the other accepted it as a regrettable necessity." . . . The "vagueness which used to be recognised as our great enemy is now being enshrined as an idol to be worshipped."

At the beginning of the period dealt with by the author this tendency hardly existed:—

"The tendency to hide ignorance under the cover of a mathematical formula had already appeared, but was not openly advocted; hence students were still taught to form definite ideas of the processes of nature."

So far an advantage seems to him to lie with the past; but then, on the other hand, he recollects a less excellent tendency which then existed to regard the scope of physics as already fairly complete, with all the main avenues explored, and only side tracks and subsidiary paths awaiting the would-be discoverer—whose aim sometimes was to get hold of some neglected residual effect, by employing extremely sensitive instruments and applying power enough to bring it within the compass of observation; and whose other and highly estimable aim was to measure with careful accuracy effects already known.

This condition of things Prof. Schuster thus describes:—

"In many cases the student was led to believe that the main facts of nature were all known, that the chances of any great discovery being made by experiment were vanishingly small, and that therefore the experimentalist's work consisted in deciding between rival theories, or in finding some small residual effect which might add a more or less important detail to the theory."

It is perhaps singular that such an outlook should have so closely preceded an outburst of novelties such as have of late years aroused the enthusiasm of the worker, as well as the occasional derision of the sceptical critic.

"Looking back now on this period, when Röntgen rays and radio-activity were undreamt of, we may well learn to be cautious in our own predictions of the future."

Nevertheless, some of the discoveries were made in what may be called the old-fashioned way, one example being of the first magnitude:—

"A typical example of a great discovery brought about by the method indicated by Maxwell is furnished by Rayleigh's measurements which culminated in the discovery of argon, through a research undertaken to determine with accuracy the density of gases. . . . It is nevertheless indisputable that the greatest discoveries, both formerly and in recent years, have not originated in the hunt of residuals."

No; they have sometimes been begun accidentally, but they have been followed up by those who have been guided by a clue of theory; and some of the most splendid have been made by mathematical physicists who were clearly conscious all the time of what their aim was and what was the meaning of the phenomena they observed.

"Altogether I am doubtful," says Prof. Schuster, "whether any great discovery has ever been made by anyone who has only aimed at recording a number of facts."

Those who contemn theory, and who affect to disbelieve the explanation which physicists give of recently observed phenomena, would do well perhaps to realise that ultra-scepticism has often been a drag on scientific progress, as well as occasionally a safeguard and a help.

As an example tending in this cautionary direction we may quote from the author as follows:—

"The frame of mind with which the academic physicist [or, we might add, the academic chemist] looked upon investigations of the passage of electricity through gases, might be made the subject of instructive comment. The facts, so far as they had been ascertained, did not fit in with recognised views: hence they were ignored, and students were warned off the subject. There was a feeling that perhaps in a century or so the question might be attacked, but that in the meantime it had better be left to be played with by cranks and visionaries. No criticism was more frequent, at that time, than that of characterising as premature any new idea or fresh line of investigation in this direction; as if any advance of science has ever been made which was not premature a fortnight before it was made."

The extreme usefulness of a working hypothesis or theoretical clue can scarcely be emphasised better than by the following:—

M

"If we look back upon these experiments now, they may be used to point the moral that experiments conducted in what is sometimes considered to be the true philosophic spirit, where the investigator without any preconceived theories or notions simply wishes to classify facts, seldom lead to any valuable results.

"Progress began when the subject was attacked with some definite object in view, either some theory however crude which had to be supported, or some numerical connection which had to be investigated."

It has been one of the features of Sir J. J. Thomson's work, for instance, that theory and experiment have gone hand in hand and have been published together. The reviewer has heard this feature objected to, but it is more than justified. The publication of the great discovery which is being here specially referred to is thus mentioned by Prof. Schuster:—

"The lecture in which the above experiments were described, was delivered to the British Association [at Dover] on the occasion of the visit of members of the French Association, which met concurrently at Boulogne.[1] It at once carried conviction, and, though to those who had followed the gradual development of the subject it only rendered more certain what previous experiments had already plainly indicated, the scientific world seemed suddenly to awake to the fact that their fundamental conceptions had been revolutionised. A new era of science begins at this point."

Prof. Schuster had himself made experiments which would have received their quantitative explanation had the idea of a separate atom of electricity detached from matter been at that time fairly conceivable. But, as he says—in full accordance with the attitude of most others at the time—

"The separate existence of a detached atom of electricity never occurred to me as possible, and if it had, and I had openly expressed such heterodox opinions, I should hardly have been considered a serious physicist, for the limits to allowable heterodoxy in science are soon reached."

There were not wanting critics to emphasise the heterodoxy of the idea, even when the discovery had been made; and chemical scepticism concerning *ions* exerted a retarding effect in Britain:—

"This ionic theory of gas discharges, while ignored in England, made good progress abroad; Arrhenius adopted it, as well as Elster and Geitel."

But it is in connection with the subject of terrestrial magnetism and its explanation that the author makes the most biting comment:—

"There can only be one solution of the problem, and if we can explain any magnetic effect on the earth's surface by outside forces, it follows that it cannot at the same time be explained by internal forces. This remark disposes of a good deal of the criticism lavished on pioneer attempts to open out this region of science. Though this criticism is often confined to a judicious shrugging of the shoulders, it stops scientific progress more effectually than active opposition, and is apt to become a constitutional habit with those who give way to its undoubted temptations."

Of course, caution is necessary; but on the whole, says the author—

[1] The title originally was "On the Existence of Masses Smaller than the Atoms," but was changed when the paper was published in the *Philosophical Magazine*, xlviii., p. 565 (1899), to "On the Masses of Ions in Gases at Low Pressure."

"The state of plasticity and flux—a healthy state, in my opinion—in which scientific thought of the present age adapts itself to almost any novelty, is illustrated by the complacency with which the most cherished tenets of our fathers are being abandoned."

For instance,

"Nowadays the student finds little to disturb him, perhaps too little, in the idea that mass changes with velocity; and he does not always realise the full meaning of the consequences which are involved."

This part of the treatise is so important, and the usefulness of theory as a guide to discovery is so vital, that we must dwell on the author's treatment of the more philosophical aspect of physics with special interest.

First of all he admits that we must allow something for intuition:—

"When we consider two rival theories in any branch of human knowledge, we are sometimes drawn towards one or towards the other, not by any process of reasoning, but by an instinctive feeling which may be so strong that we unhesitatingly reject one of the alternatives. . . . The strongest of our scientific 'instincts' is our ultimate belief in the simplicity of nature. If both light and electrical attractions are transmitted through a medium, it would revolt our feelings—that is to say, our non-reasoning faculties—to assume, without strong evidence to the contrary, that two different media exist for the two manifestations."

But it is not to be supposed that the intuition is always right. The example which the author takes—in order to illustrate the useful consequences of even an erroneous theory—is not one with which the reviewer sympathises, for he is one of those who desire dogmatically to deny the possibility of physical action except through a medium; whereas Prof. Schuster says:—

"To me it seems that the dogmatical denial of action at a distance is a survival of the ancient anthropomorphic explanation of natural phenomena."

He admits, however, with cordiality that the search for the medium has resulted in many discoveries, and, like many other theoretical clues—whether correct or not—has been justified by results. From this, he says:—

"Two lessons may here be learned. One is, that the temporary success of a doctrine does not necessarily justify the grounds of its foundation; and the other, that progress in science is more often achieved by a definite hypothesis, which may be followed up and tested, than by a wider and perhaps more philosophic doctrine, which cannot be disproved because it does not endeavour to go deeper than the mere descriptive classification of phenomena."

In the same spirit as that in which he maintains the possibility or conceivability of physical action at a distance, the author is not frightened away from any hypothesis because of its excessive strain upon ordinary common sense. For instance, he is able to contemplate the view that an atom or an electron may be a source or a sink of fluid, continually appearing out of nothing at some points and continually going out of existence at others.

"The universe must have begun by a process which lies outside physical laws, and it seems to me no easier to grasp the conception of a creation which took place at one single time than a creation which continues throughout all ages. Indeed, if we come to think of it, the continuance of a physical law like that of gravitation is as much a miracle as the continuous uniform creation of matter would be."

In this, as in a few other matters, the reviewer is unable to follow him completely.

Coming to another subject, the lecturer has some wise things to say regarding laboratory teaching in physics; some of which—like much else of school teaching—is calculated rather to promote dislike and dulness than to arouse any enthusiasm for science; and whatever may be the merit of college courses in physics, he cannot refrain from noticing how little of that sort of training was available for, or was needed by, the great discoverers.

"The cardinal fact to bear in mind is that previous to 1870, when laboratory instruction, if given at all, was sporadic, the experimental skill of investigators was as great as it is now. We need only mention the names of Faraday, Joule, Helmholtz, and Regnault, in support of that contention. The conclusion is irresistible that an intelligent student, possessing a sufficient theoretical knowledge, is capable of starting research work in physics without previous special training. It is not for him that complicated laboratory courses have been designed, but for the ordinary student."

It is very desirable in all cases that the stimulation of interest shall not be subordinate to the acquisition of mere technical skill. Without enthusiasm, the mere ability to measure all sorts of uninteresting quantities is of comparatively little use.

"The future investigator will no doubt ultimately save time if at an early stage he acquires a certain technical skill and becomes acquainted with physical methods, but otherwise the efforts of the teacher should be directed to stimulating his scientific activity rather than sending him through all manipulations which he might possibly have to perform."

That the author is a great authority in the subjects of terrestrial magnetism and atmospheric electricity is well known, and in his last lecture he enters into these rather fully, compared with his rapid survey of other subjects. Hence these portions have a value of their own, and a few *obiter dicta* may be extracted.

Concerning the view which has been held about the annual and diurnal variations in terrestrial magnetism, he says:—

"A better agreement may be obtained by making the plausible hypothesis that the electric conductivity of the higher regions of the atmosphere is due to solar radiation, and is therefore greater in summer than in winter, and also greater in daytime than at night."

On the subject of atmospheric electricity:—

"The earth as a whole is charged negatively, and on the average we find that there must be nearly a million electrons on every centimetre of its surface. . . . Lenard, in an important research, has shown that a drop of water as it falls never reaches a velocity greater than 8 metres per second, however large the drop, while drops having a diameter of 1·5 millimetres fall with a velocity of about half that amount. . . . The larger drops break up in the air, and doing so become positively electrified, according to Dr. Simpson. If the ascending current spreads out laterally near the top of the cloud, the vertical velocity is diminished, the drops will grow and fall, but only to break up and be carried upwards again. A quantity of electricity large enough to account for the lightning discharge can thus accumulate in a cloud."

We have thus taken a rapid survey of this interesting book and given a sample of its contents.

The only fault we have to find with it is a minor one, that ought not however to pass unnoticed,—the punctuation is of a systematically irritating kind. In the extracts here made it has in most places been corrected, so that the defect will not be noticed in them, but before concluding we must quote without correcting. There is evidently some one among the printers or readers for the press who has a theory about commas; one rule apparently being that a comma must always precede a relative pronoun.

To illustrate the nonsense which is often thus made, it will suffice to quote a few sentences at random:—

P. 158: "To put the result in a form, which is readily appreciated, I will compare different molecules," &c.

P. 98: "Energy cannot be expressed entirely by quantities, which merely depend on change of position (kinematical factors), but must involve," &c.

P. 139: "Nothing has been said as yet on the explanation of the secular variation of terrestrial magnetism, and in our ignorance of the causes, which make the earth behave like a magnet, it is perhaps wisest to put the question aside for the present."

P. 130: "The discussion of the problem [of diurnal variation of terrestrial magnetism] . . . shewed that there is a substantial remnant which comes to us from the inside of the earth, and this is, as it should be, because the earth being a conductor, any change of the magnetic forces must give rise to induced internal currents."

The main part of the cause of diurnal variation, however, lies above the surface of the earth, and is due to electric currents in the upper atmosphere,—says the author; who thereby seems to contravene a more general pronouncement, quoted above, as to the uniqueness of a given explanation. It is probably the more general pronouncement that he would wish to modify.

The immediately preceding extract is of interest for its own sake, and not merely as an illustration of seriocomic punctuation. So is the following:—

P. 156: "It is always satisfactory when we find that different lines of reasoning lead to the same result, and at present there is hardly one, in the domain of Geo-Physics which stands on so firm a basis as that giving to the earth an extremely high rigidity."

In the selected quotations we have done less than justice to the author's treatment of the many problems which have coincided with his active life, and to the solution of which he has so often contributed; but the book is accessible and very readable. We may be grateful to the University of Calcutta for having stimulated the production of these lectures, and to the author for writing them out and publishing them. They constitute another link in the chain which is binding together East and West.

Oliver Lodge.

CHEMICAL STRUCTURE AND PHYSIOLOGICAL ACTION.

The Chemistry of Synthetic Drugs. By P. May. Pp. xiii+229. (London: Longmans, Green and Co., 1911.) Price 7s. 6d. net.

IT is the expressed aim of the author of this volume to bring to the notice of chemists a branch of their subject affording scope for commercial application, and at the same time to interest medical men who may desire information concerning the chemical nature of the synthetic remedies presented to them. It is obvious that but little can safely be assumed as common ground of previous knowledge, in appealing to so wide a constituency of readers, and it was a good thought to begin with a glossary of technical terms: although it seems a little difficult to believe in the existence of the chemist who needs "antipyretic" or "narcotic" defined for him.

The author is to be congratulated on having presented a readable account of a difficult subject in 220 pages of text, not a few of which, moreover, are of necessity occupied by structural formulæ.

A selection of the more interesting and instructive classes of synthetic drugs for discussion probably afforded the only possibility of dealing, within such limits, with a subject in which recorded observations are overwhelmingly abundant and sound generalisations but few. The gain in interest for the non-specialist is well worth the loss in comprehensiveness. It is no disparagement of such a volume to say that it owes much to Fränkel's "Arzneimittelsynthese," as the author duly acknowledges. It could be wished, however, that he had leaned a little less heavily on that authority, particularly in some matters of pharmacological detail. For example, he follows Fränkel in stating that "pilocarpine closely resembles nicotine in many of its pharmacological effects" (p. 31), and accordingly regards as significant the possession by both of a five-membered ring. Of a writer on this subject for English readers one might expect such slight acquaintance with the work of the Cambridge school of physiology as would have sufficed to save him from accepting this statement. That the real pharmacological affinities of pilocarpine are with muscarine, with which it has no obvious community of structure, is one of the anomalies with which the subject bristles. The statement that "atropine and cocaine are closely related . . . in their physiological action, both of them causing dilatation of the pupil" (p. 86), is another instance of a tendency to attach importance to superficial resemblances, in the interests of a preconceived correspondence between structure and action. Mr. May's direct contact with the subject is obviously on the chemical side, but the description of the action of apomorphine as "quite opposite to that of morphine," is again a little crude, even for pharmacology at second hand.

The introductory chapter, dealing with the general theories of the physiological action of drugs, follows Fränkel closely, and would have gained by more attention to the development of theories since 1906. It is rather for its chapters dealing with special groups than as a general theoretical survey that the book should prove of value. Atropine and the tropeines, cocaine and the local anæsthetics, the morphine and isoquinoline groups of alkaloids, are all dealt with in a manner which should enable even the medical practitioner, with mere remnants of his student chemistry as a basis, to follow intelligently the aims of those engaged in producing new synthetic compounds in the different series. The citation of trade names provides a useful link with practical therapeutics. In treating of the isoquinoline alkaloids and the adrenaline series of bases, much space is devoted to recent, and particularly to English, publications: and if some of these seem thus to acquire more prominence in the general scheme than their intrinsic importance warrants, the fault is in the right direction; for, as the author points out, much of this work, as well as that on the organic arsenic and antimony compounds, has not before been collected into one volume.

On the whole, by what it omits as well as by the presentation of what it includes, the book succeeds in giving a more readable, if a slighter, account of the subject than its predecessors in the same field. A high degree of originality is excluded by the nature of the subject. The book would gain much by comparatively slight revision at the hands of someone directly acquainted with the physiological side of the subject, and the author may be recommended to seek such aid before publishing a new edition.

MECHANISM IN CRUCIFEROUS FLOWERS.

Prinzipien der Physikalisch-Kausalen Blütenbiologie. In ihrer Anwendung auf Bau und Entstehung des Blütenapparates der Cruciferen. Von Dr. A. Günthart. Pp. ix+172. (Jena: Gustav Fischer, 1910.) Price 4.50 marks.

THE floral construction of the Crucifer, repeated in so many familiar wild and cultivated plants, is at first sight so remarkably simple that the type is utilised possibly more than any other for the purposes of elementary botany, as presenting a handy symmetrical blossom with few parts and apparently little complication in relation to pollination. More careful observation, however, shows that this is by no means the case; the biological construction is definitely transversely zygomorphic, involving a duplicate mechanism; while morphological considerations show that the apparent simplicity has been attained by extreme reduction-specialisation from anthostrobiloid forms of which phylogenetic suggestions can only be traced in the allied families of the Capparidaceæ and Resedaceæ.

Dr. Günthart's volume constitues an extremely valuable and interesting contribution to the detailed investigation of the floral biology of these flowers. Representative types of twenty-five genera, arranged in thirteen groups, have been worked out by sectional methods, and are copiously illustrated by 136 schematic figures and diagrams. As the title indicates, the special point at issue is the determination of the extent to which any definite purpose or intention can be traced in the elaboration of complex floral mechanism devoted to cross-pollination by insect agency. The reading in of ideas involving purpose or forethought on the part of the plant has been so extremely general in œcological description of flowers, is so pleasing to the imagination, and proves so popular and difficult to escape from in elementary teaching, that a detailed analysis of such well-known Crucifer types as Matthiola, Raphanus, Alyssum, Aubrietia, &c., is particularly welcome.

Thus, among Crucifers generally, (1) the claws of the petals bend away from the lateral stamens as if to leave definite "entrance-slits" to the assumed nectar-containing pouches of the lateral sepals; (2) the anthers of the longer stamens are commonly twisted on their filaments so as to face round towards the adjacent lateral ones, as if with the intention of rubbing the entering proboscis of an insect; (3) the edges of the filaments are frequently extended into elaborate appendage-growths which are apparently intended to guide the proboscis of the insect-visitor exactly to the secreting surface. Such details are so obviously included under the heading of special adaptations to secure insect-pollination that the question of their actual origin demands most careful investigation.

The object of Dr. Günthart's work is to show that practically all subsidiary details of special mechanism and final adjustment may be traced back to a few fundamental tendencies in the floral construction, which, being given by phylogeny, work out on simple mechanical lines the construction details which are at first sight so purposeful. Such "active-factors" in the case of the Cruciferous flower are distinguished as:—

1. The tendency of the floral receptacle to extend in the transverse plane of the floral diagram, this factor controlling the dorsiventral insertion of the petals, the lateral apertures of the flower-tube, &c.

2. A tendency for the median sepals and adjacent parts to be "elevated" by a peculiar growth-extension in the median plane of the receptacle, which is responsible for "true" (primary) calyx-pouches and the increasing restriction of the secreting surface to lateral hollows.

3. The transverse and longitudinal extension of the ovuliferous region: the former phenomenon (Siliculoseæ) still further exaggerating characters induced by the original transverse construction.

4. The mutual pressures between a closed calyx and central ovary exerted on "passive" petals and stamens leading to the production of rotated anthers and marginal extensions of the filaments.

In tracing the elaborate mechanical connections of these phenomena, however, the problem of their meaning is admittedly only removed one step further back. We still remain ignorant of the reasons for the initiation of these "active" characters. Nor is there any reason to believe that continued research will ever satisfactorily solve all problems which stretch back into the distant phylogeny of the group. Still, every step cleared up is one gained, and the vague conception of intention is gradually replaced by the view that from an initial tendency, itself probably induced by some physical cause, certain mechanical results will necessarily follow, which will in turn determine the subsequent possibilities of the evolution of the race. Further, the fundamental factors thus deduced should give the key to the systematic arrangement of the family.

FACT AND FANCY IN DIETETICS.

"*What Shall I Eat?*": *a Manual of Rational Feeding.* By Dr. F. X. Gouraud. With a Preface by Prof. A. Gautier. Authorised English translation by F. J. Rebman. Pp. xvi+379. (London: Rebman, Ltd.; New York: Rebman Co., n.d.) Price 6*s.* net.

THERE appears to be a plethora of books on diet just now, but the present volume does not reach the same standard of excellence which is noticeable in several other books on the subject recently reviewed in these columns.

Dr. Gouraud's work contains a certain amount of useful information, it is true, but it is so interwoven with speculations and contradictions that it is not likely to prove useful either to specialists or to the public at large.

The preface tells us it is intended for the business man and the educated housewife among others, but we wonder what the average man of business would make out of the following sentences:—

"Endogenetic purin is produced by the rejection of nuclein by the organism; its percentage, though variable in each individual, is a fixed quantity in each individual. Exogenetic purin of alimentary origin varies considerably according to diet, and may be reduced to zero by a regimen entirely free of all xanthic bodies."

"Beef is a powerful factor in membral hyperacidity. Its alimentary value, which depends almost wholly on the percentage of fats present in it, is rather slight. It takes only second place to butter, sugar, and rice. Its sole merit from the alimentary standpoint can only be that it supplies within a small compass a comparatively large amount of assimilable nitrogen."

"The third nutritive element in milk is the carbohydrates, *i.e.* lactose or milk sugar. This is a bihexose well known for its diuretic properties which makes the sugar in diabetics. Phosphorus is also abundant, and is present chiefly in the shape of physiological values well differentiated."

Quotations such as the preceding could be multiplied indefinitely. A physiologist will at once detect the gross misstatements of fact; but the man in the street, so far as he can make head or tail out of technical language, will at any rate detect the want of logic and of a knowledge of English composition. The glossary at the end of the book will not help him much, for we learn there that purins are unclean or poisonous substances, that xanthin is a yellow colouring matter, that steapsin is a diastasic ferment, that inosite is a saccharine substance, that casein is a derived albumin, that galactose is lactose, that ammonia contains hydrogen atones, &c., &c.

The translator does not in the greater number of instances know the English equivalents for French technical terms, or for the names of pathological conditions. We select only one gem for special mention; we are told that milk is curdled by the *pressure* of the stomach. This is a very free translation of *présure*, which really means rennet. Not having seen the book in the original French, it is a little difficult to apportion the blame between Dr. Gouraud and his translator. Internal evidence leads one, however, to conclude that both are at fault.

The book is a curious and muddled medley of fact and fancy; the translation has evidently been carried out by someone unfamiliar with physiology, and deficient in his knowledge of both French and English.

W. D. H.

OUR BOOK SHELF.

Lilies. By A. Grove. Pp. xi + 116 + 8 coloured plates. *Apples and Pears.* By G. Bunyard. Pp. xi + 116 + 8 coloured plates. (Present-day Gardening Series.) (London and Edinburgh: T. C. and E. C. Jack, n.d.) Price 1*s.* 6*d.* each.

MR. GROVE's book on lilies is one of the most welcome that have appeared in this series. Among popular flowers the genus is, perhaps, the most trying with which English gardeners have to deal, and the presence of many species in our gardens is due more to the efficiency and rapidity of ocean transit than to a proved capability of our cultivators to grow them in gardens. It is probably to the facility with which stocks can be renewed that the present unsatisfactory state of lily cultivation is largely due. The incentive to conquer the problems of keeping them alive and propagating them are, to a great extent, lacking when a new and vigorous stock can be easily obtained from the salerooms. Mr. Grove is, however, an enthusiast, and we have it on the authority of Mr. Elwes—himself the author of a classical work on the genus—that he knows more about their cultivation than anyone else living. There is no botany in the work; it is purely a gardening book cleverly and pleasantly written by a master of his subject. Mr. Elwes contributes an interesting preface.

Mr. Grove's study of lilies has been carried on unostentatiously in his garden on the Berkshire hills, and his name is comparatively unknown except to the *élite.* It is otherwise with Mr. Bunyard. As the head of one of the first fruit-tree nurseries, and an experienced author on hardy fruits, he has long filled a high place in the esteem of those occupied in the same pursuits. The present little volume is certainly one of the best that has ever appeared on the subject of apples and pears. Although concise it is comprehensive, and deals efficiently with every phase of their treatment. The author gives lists of the best sorts for various purposes and different districts, all the better because they are comparatively short. He deals with their cultivation from the propagation and planting of the trees, and the way to combat insect pests, to the storing of the fruit. The state of many orchards of this country impels one to hope that this book may be widely read.

Each of these volumes is illustrated by eight coloured plates, and makes a very creditable addition to the useful series to which it belongs.

The Animal World. By Prof. F. W. Gamble, F.R.S. With an Introduction by Sir Oliver Lodge, F.R.S. (Home University Library of Modern Knowledge.) Pp. 255. (London: Williams and Norgate; New York: Henry Holt and Co., n.d.) Price 1*s.* net.

PROF. GAMBLE'S account of the animal world is written from the point of view of function. Its chief aim is to direct attention to the adaptations of structure to the performance of movement, breathing, and other vital functions. An introductory chapter, which contains a general survey of the structure and classification of animals, is rather condensed, and will probably be more useful to the reader who has already a little knowledge of animal life than to the beginner. The description of the movements, and of the succession and distribution of animals, provides opportunity for pointing out the great advantages possessed by birds and mammals in consequence of their warm blood. The quest for food, modes of breathing, the colours and senses of animals, societies and associations, symbiosis, the care of the young, and short accounts of the life-history of a few animals, form the subjects of successive chapters. The concluding chapter on heredity and variation might well have been a little more extended: the subject-matter is too briefly explained to be of full value to the reader for whom the book is intended.

Several of the figures are crude, especially that of Vorticella. The statement on p. 28 that the buds of cœlenterates may remain in connection with the parent tissues "by strings of mesenchyme" requires modification. On p. 37 the spaces between the mesenteries of a sea-anemone are designated the cœlom, and immediately below are referred to as increasing the capacity of the digestive cavity.

The book, which is written in a fresh clear style, is characterised throughout by breadth of view, and is also noteworthy for the aptness of the illustrative examples cited. The thoughtful reader, with an interest in biology, will find in this volume food for thought in abundant measure.

Orthochromatic Filters. Pp. 55. (Croydon: Wratten and Wainwright, Ltd., n.d.) Price 6*d.*

THE title of this little book does not include its contents, for there is a chapter on "contrast filters," with some very striking examples of their use. A photograph of an engineers' blue print taken through a strong red filter that needs the exposure to be increased twenty-four times with a Wratten's panchromatic plate, renders the blue as a full black, instead of the rather feeble grey given by an ordinary plate with no filter. The great improvement obtainable in the rendering of the grain of dark-coloured woods, as well as in other cases, is well illustrated. We learn that the sensitiveness to green and red of ordinary orthochromatic plates is generally from 2 to 5 per cent. of the total sensitiveness, while in a panchromatic plate this rises to as much as 18 per cent. From these and other figures of a like nature the necessary increase of exposure when using certain colour filters with various specially sensitised plates is calculated in a simple way. The chapter that will be of most interest to those who are fairly familiar with the use of colour filters and sensitised plates, deals with the optical properties of filters. It gives clear examples of the degradation of defining power of the lens by the use of a filter strained by being too tightly screwed up in its cell, and also of filters which introduce various degrees of astigmatism. Many other matters are dealt with which are of prime importance to those who use colour screens.

Studies of Trees and Flowers. By M. Wrigley. With descriptions by Annie L. Smith. Pp. 129 + viii + 129 plates. (London: Methuen and Co., Ltd., n.d.) Price 15*s.* net.

THE photographs that form the chief feature of this weighty volume reflect considerable credit on the skill of the author as a manipulator with the camera. Undoubtedly the most impressive are the photographs of plants *in situ*; the picture of the foxglove is good, except that it fails to show the lower portion of the plant; those of the birches, especially of the silver birch and of the Burnham beeches, are instructive, but the best are the illustrations of two groups of Scotch firs at Kincraig that betoken group as well as individual habit. Many of the sprays, notably of the blossoming myrtle and hawthorn, and of the fruiting broom, are attractive, but it is not apparent that any useful purpose is served by these or the general collection, since it is not difficult and more advisable to obtain natural specimens in season. Miss Lorrain Smith has carried out satisfactorily the task of supplying appropriate brief notes, and doubtless appreciated the Peziza and Usnea that appear at the end.

LETTERS TO THE EDITOR.

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

The Ooze of the Thames.

Some time ago I directed attention to the part played by annelids in making the ooze of rivers, such as the Nile, fertile. Aided by a Government grant, research has been continued during the year, and in August a special visit was paid to Kew Gardens and the Thames. The river was very low, and I was able to collect specimens which are not always available, and bring away a sample of the ooze for careful examination. I found the mud teeming with *Helodrilus oculatus*, Hoffm., a new record for the south of England; *Paranais naidina*, Bretscher, new to Britain; *Monopylephorus elegans*, Friend, new to science; and other things, showing how much work still remains to be done by London naturalists. There were also many living nematodes, all apparently belonging to one species, half an inch or more in length. I have not yet been able to work out its history or discover its host, but the thing which seems to me to be of special interest relates to this parasitic creature. In examining the ooze from time to time the thing that struck one was the presence of numberless white threads of considerable length and great tenuity. These proved to be the integuments of vast numbers of dead nematodes. In the case of annelids, the process of decay is so rapid that dead worms are rarely found, and only by means of the most careful microscopic examination or chemical analysis can one discover how numerous they have been. But the evidence goes to show that the ooze of rivers is immensely enriched in nitrogenous matter year by year through the death of annelids, as well as oxygenated by their tireless movements.

While much has been done in the analysis of soils, little if anything seems to have been undertaken in relation to ooze. My own researches are at present largely restricted to the systematic study of the living species of annelids; but it would be of immense advantage to science, and especially to agriculture, if some expert like Dr. Russell could give us careful analyses of river oozes. I have appealed many times for samples of ooze from estuaries and rivers in order that something might be done, but hitherto the response has been very heartless, and there has been no alternative but to make special journeys to interesting localities, at great cost of time and money. The importance of the subject, however, is such that I venture again to bring it to the notice of students and investigators in the hope that it may receive the attention it deserves.

Swadlincote, September 16. HILDERIC FRIEND.

Ancient Forests in Scotland.

Referring to your correspondent's letters which appeared in Nature of June 1 and August 24 last in regard to the contemplated cutting down of the fir trees at Auchnacarry, in south Inverness-shire, permit me to state that, though very old (say two to three hundred years), these cannot properly be said to have formed part of the ancient Caledonian Forest. The fir was very probably found in the latter, and in certain places it may have been the prevailing description; unquestionably it is the most prominent survivor, and during the last few centuries has been one of the most important economical products of the Highlands of Scotland.

The cause of the disappearance of the Caledonian Forest has hitherto seemed obscure, if not inexplicable. Some light, however, is perhaps afforded by the fact that over the entire area which it covered, say all the counties north of the Firths of Forth and Clyde, except perhaps the Isle of Bute, Fife, Caithness, and the Orkney and Shetland Islands, the surface is frequently bestrewn with iron slags. So numerous are these latter in some districts that a hundred heaps of slag may be found almost within the confines of a single parish. From an examination of the pieces of charcoal found amongst these slags it has been ascertained that when these were formed the principal trees in the neighbourhood were birch and oak, but in some instances traces have been found of beech, ash, elm, fir, and holly.

Evidently in the more ancient times, namely, before the use of water-power was introduced in Scotland for the extraction of iron from the ore, two processes were successively employed for the purpose. In the earliest, the natural wind was taken advantage of, and the seat of operations was determined by the favourable physical configuration of the land to guide and concentrate the blast on the materials of combustion. From one document, at least, we learn that this method seems to have been employed down to 900 years ago. The sites associated with the later or succeeding process, and at which, presumably, bellows were used, are all in sheltered positions where the remaining forests were located; a few of the very last of these in operation can be dated as belonging to the fourteenth and fifteenth centuries. There is reason to believe that the bellows were in use in this connection as early as, if not earlier than, the Roman occupation.

When water-power for iron-making was introduced into Scotland at the beginning of the seventeenth century, the sites chosen were not only in protected situations also, but on low ground, on the banks of rivers, and preferably with suitable wood for fuel in the vicinity; but some of the latter seems to have been rolled down from the heights above, or floated by water from considerable distances. This class of works continued in operation generally until about 1760, and in the case of those near Inverary and Buname until much more recent years. Charcoal made from pine wood was very largely used at all of this series of works.

From the foregoing it may be gathered that as the iron slag heaps of Scotland form the memorials of her ancient forests, our knowledge of the latter may be much restricted by a neglect of the study of the metallurgical industries there in former times. GEORGE TURNER.

30n Langside Road, Glasgow, September 4.

"The Polynesian Wanderings."

Your review of my book, "The Polynesian Wanderings" (August 10), is warmly appreciated as performing the service of an introduction to scholars interested in the philology of the Pacific. In order to prevent a misconception of the work, I ask leave to note an exception to one or two statements in the review which might produce a wrong impression.

Mr. Ray comments upon the incommensurability of the several languages of Polynesia and Melanesia. What he puts in a few lines I had discussed in pages, and had announced that it was impracticable, in our present knowledge of Melanesian speech, to essay a quantitative comparison. On pp. 142 and 143 of the volume I have been at pains to establish my method of comparison by computing a coefficient of recognisability of the Proto-Samoan borrowed element in some ninety Melanesian languages. This is a figure which may be reached independently of the quantity of the loan material; it rests upon each borrowed word by itself in comparison with the same word as found in the present speech of Nuclear Polynesia; it expresses the extent of the deviation from the norm. The determination of quantity lying beyond our reach at present, I have utilised the only element of comparison which in years of research I have been able to discover, that of quality. When Mr. Ray has read again my detailed statement of method he will be the first to thank me for having introduced some principle of comparison where none has hitherto existed. I am convinced that this coefficient of quality amounts to more than a makeshift; its value will exist in its applicability as a constant factor. Mr. Ray cites my determination of coefficient 93 for Nguna and 76 for Sesake, "the same language, Sesake being a colony from Nguna." The lower coefficient of Sesake is not a matter of mere opinion; it is the mathematical product of the presence in that language of several consonant mutations expressive of a wider divarication from the Proto-Samoan stem. If we were in possession of practically complete dictionaries of Nguna and Sesake, this coefficient of quality would, in my best judgment, still be applicable. Suppose that such dictionaries should exhibit Nguna as having Proto-Samoan loan material quantitatively to the extent of 100 words to the thousand, and Sesake 125; of course, it is understood that I am using figures symbolically. We should err in assigning to Nguna a 10 per cent. Proto-Samoan element and to Sesake $12\frac{1}{2}$ per cent. We should have to regard quality as well as quantity; we should have to employ my quality coefficient (subject to such recomputation as a better supply of data would make possible) as an essential factor. Thus Nguna, as a result of the combination of the two elements, would be indicated by 9·3 per cent. and Sesake by 9·5 per cent. Then and thus only will it be possible to state positively that Nguna and Sesake have received the same influence from the Proto-Samoan, the question of whether *qua* Melanesian they are the same language being a matter wholly distinct.

It was of set purpose that I have omitted the discussion of the syntax of the grammar of Oceanic languages. Our present material is all stated most inaccurately; our authorities, without exception, have stated their considerations of grammar in terms of the grammatical categories of inflected speech. The grammar of these isolating languages must be newly written. It will form a large part of the Samoan dictionary of Polynesian philology upon which I am now engaged. In various publications I have made preliminary announcement of some of the principles of this grammar—*e.g.* in my monograph on the Beach-la-mar jargon, just published, I have dealt with the evolution of the verb in the diffuse attributive; but in the present incomplete stage of the study it did not seem advisable in the volume under review to seek to exceed the phonetic examination of the material there assembled.

WILLIAM CHURCHILL.

New York, August 28.

In my review of Mr. Churchill's book, "The Polynesian Wanderings," I certainly intended my remark as to the liability of error arising from deficient and imperfect material to apply both to quantitative and qualitative comparisons. With regard to the former, there can be no dispute, and the impracticability of quantitative comparison was recognised by Mr. Churchill on p. 143 of his book. But a qualitative comparison as given by Mr. Churchill in his tables, and referred to in the letter, seems to be equally liable to error through inaccuracy in the material. Referring again to the tables for Nguna and Sesake, which I took as typical cases, Mr. Churchill finds that the lower coefficient of Sesake—*i.e.* 76 as opposed to Nguna 93 (implying that Sesake was less like Polynesian than Nguna)—was due to the presence in Sesake "of several consonant mutations expressive of a wider divarication from the Proto-Samoan stem." Mr. Churchill's Sesake words were taken from the lists of Codrington and Gabelentz. The source of his much shorter list in Nguna is not stated. Using a longer list by Bp. Patteson (from which those of Codrington and Gabelentz were derived) and a very long (MS.) vocabulary of Nguna, I find that all Mr. Churchill's examples in Sesake are identical with Nguna, and all the Nguna are identical with Sesake. The consonant mutations are the same. Thus the quality of the likeness to Polynesian is the same for both languages, and the great difference in Mr. Churchill's results is entirely due to the lists being defective and appearing under different names. For the *accurate* application of Mr. Churchill's comparisons the vocabularies used *must* be equal in extent and signification.

My desire in the note on Mr. Churchill's omission to discuss grammar was to direct attention to the fact that he had not shown that any distinctively Polynesian particles (as, *e.g.*, the article *te*, the verbal signs *kua*, *na*, the so-called possessive words *loku*, *toku*, &c.) were used in Melanesian languages.

SIDNEY H. RAY.

Habits of Dogs.

I HAVE read with interest the letter of Miss Everett in your issue of August 31 on dogs eating wasps, as I have a poodle which also eats them, with evident satisfaction. He generally catches them alive, but will also pick them up from the floor when recently killed; he evidently suffers somewhat from the sting, but only for ten or fifteen seconds.

I have always attributed this liking for wasps to some stimulating action of the poison similar to that produced by formic acid on man; this idea was suggested by the following plan, learned in Switzerland.

If a freshly peeled wand be plunged into an ants' nest, so as to be bitten by the infuriated ants, and is then passed between the lips, a sensation of refreshment is experienced which appears to be out of proportion to the effect which one would expect from the mere acidity.

I believe that I have read somewhere that formic acid is a stimulant.

ROBERT VENABLES.

8 rue du Sundgau, Mulhouse, Alsace, September 8.

ON p. 348 Dr. Kidd asks if it is known to be a common thing for dogs to carry hedgehogs in their mouths. I can only answer for my own dog, a fox-terrier. Last season a hedgehog strayed into our garden, and appeared anxious to stay; but the dog carried it in his mouth repeatedly, and so teased it in various ways, that we were not surprised when the hedgehog beat a permanent retreat by absconding. The curious circumstance in the affair was that the dog appeared to carry the hedgehog, rolled in a ball, without causing his lips to bleed; in this particular, Carlo seems to be cleverer than Dr. Kidd's dog!

Braewyn, Earlsfield Road, Wandsworth Common.

R. HOOPER PEARSON.

A Gilbert White Manuscript.

MENTION has been made in the Press of the recent sale of a hitherto unpublished manuscript by Gilbert White. It consists of a nature calendar which the author of "The Natural History of Selborne" carefully drew up before he wrote the first of the letters which are the basis of his famous book. To the latter, he tells us, he meant to add an "Annus Historico-Naturalis," and it seems that the MS. in question was intended to be used in this connection. I am pleased to say that the Selborne Society will shortly produce the calendar (which is particularly interesting) in facsimile, and print a limited edition on Italian hand-made paper.

I should be glad to give further particulars to any of the many admirers of Gilbert White who would care to have them.

WILFRED MARK WEBB.
(*Honorary Secretary*.)

The Selborne Society, 42 Bloomsbury Square, London, W.C., September 19.

Miniature Rainbows.

THE recent letters on miniature rainbows recalled to my mind a rather interesting case which I observed some years ago at Inversnaid, on Loch Lomond. Here a small stream makes a pretty waterfall; and while standing beside the pool at the base of the fall, and directly opposite the fall itself, I noticed first a brilliant rainbow reflected in the pool. The actual bow was formed in the spray above the pool, and, unless my recollection is greatly at fault, it appeared less brilliant than its reflection. But the bow and its reflected image, viewed together across the pool, formed an almost complete circle, broken only where the extremities of the real bow in the spray appeared to come down towards the surface of the pool.

A. L. LEACH.

Giltar, Shrewsbury Lane, Shooters Hill, September 16.

ARGENTINA AND THE ANDES.[1]

THE author has gathered his Argentine experience from two prolonged sojourns at the estancia of his brother, a settler dating back to 1868. He stayed in the country for more than a year, and since his notes were submitted to English estancieros of experience, the present book may reasonably be assumed to contain no errors of importance; it gives us a very fair idea of the actual life, and also of the conditions, which prevailed in earlier times.

FIG. 1.—The Pampas sown with Alfalfa. From "Argentine Plains and Andine Glaciers."

The homesteads, built like forts, the boundless cattle runs, encounters with Indians, the hunting trips in the wilds, have all cnanged for a better and much duller state of things. The Indians have retreated or vanished before the rapidly advancing civilisation; the runs are all fenced in, and to visit some lagoon, where alone interesting bird life might be watched, is likely to mean trespass!

The influence of the industrious Italians is steadily transforming the Pampas into interminable agricultural fields, a change which is spreading further and further to the West. The process is as follows. The owner of undeveloped blocks of land of his domain of, say, fifty square miles, accepts a number of Italian time-squatters, who after having raised crops of Indian corn, wheat, or linseed for several years, are moved on to another block, whilst the former is then permanently sown with alfalfa, *i.e.* lucerne. These pioneering or preparatory cultivators are North Italians; the Southerners stick to the towns. A family takes up from 700 to 800 acres; they find themselves in everything, and pay a quarter of the produce as rent. This is a better plan than their taking land "on halves," the owner supplying them in this case with everything, an arrangement which necessitates capital and produces friction. The author has carefully gone into these and kindred economic questions.

However, the best description of such a land, with scenery none and the natives gone, cannot rise above the level of a stockfarm, in spite of accounts of ensilage, the lassoing, branding, and counting of stock, and the invasion by locusts. There are some interesting observations. The native-born cattle and sheep have learned to avoid eating the poisonous weed *romerilla* (unfortunately animals and plants are scarcely ever mentioned except by their vernacular names, and our author does not profess to be a naturalist), but the imported horses, bulls, and rams have to be taught not to eat this plant. They are tied up, and the collected weeds are burned to the windward of them, so that they are well smoked, after which they dislike the green plant.

The pampas grass is said to be dying out where it comes into contact with this dreary civilisation, and this shrinking seems to take place in a round-about way. Formerly, when all the pasture was native and coarse, the cattle did not touch the still coarser pampas grass; now, when the pasture consists nearly everywhere of lucerne, the cattle go for the grass as a change of diet, or tonic, and thus keep the tussocks stunted, which ultimately succumb to the repeated cropping. The pampas are a land of promise for the energetic young man; if he begins early, and is prepared to work hard, he may, without capital, force

FIG. 2.—Penitentes, with rubble concealing the connecting ice base. From "Argentine Plains and Andine Glaciers."

[1] "Argentine Plains and Andine Glaciers: Life on an Estancia, and an Expedition into the Andes." By Walter Larden. Pp. 320. (London: T. Fisher Unwin, 1911.) Price 14*s.* net.

his way up to a managership, and finally become a wealthy estanciero on his own account. But the author gives the emphatic warning that "Argentina is not a country suitable for the English of the usual emigrant class."

A relief from the monotonous ranch life was the crossing of the Andes into Chile by way of Mendoza, with excursions of several weeks towards Aconcagua and the glaciers of the headwaters of the Tupungato valley, in company of an enthusiastic exploring engineer, who finds his recreation in the climbing of difficult peaks.

The ninety-one original photographs (two of which are here reproduced by the courtesy of the publishers) are excellent representations of a multitude of scenes from lassoing gauchos, sheep-shearing, and locust-plagues, to shifting dunes amongst lagoons, glaciers, and *nieves penitentes*.

THE ERUPTION OF ETNA.

IN the last issue of NATURE (p. 368), a brief reference was made to what has proved to be a somewhat important eruption of Etna. Our knowledge of the successive phenomena is still scanty, the telegrams inserted in English newspapers being short; but, from the more lengthy accounts given in the *Corriere* of Catania, some further details may be gleaned.

The eruption was, as usual, preceded by a series of tremors interspersed with stronger shocks. At Mineo, which lies about 35 miles S.S.W. of Etna, the first movement was recorded on September 10, at 0.58 a.m., followed for more than fifteen hours by almost incessant tremors. After 4.28 p.m., however, a period of calm ensued, which for at least twenty-four hours was interrupted by only one disturbance; and, even at Linguaglossa (about ten miles north-east of the central crater), the shocks had become so infrequent and so slight that the inhabitants were no longer awakened by them.

Almost concurrently with the first tremors, black clouds of vapour and ashes were seen to rise from Etna. The first new vent was opened at 4.30 a.m. on September 10 on the northern flank of the mountain to the north-west of M. Frumento,[1] and at a height of about 9200 feet; the second, at 9.40 a.m., in the neighbourhood of M. Nero; in both cases an hour or more after pronounced shocks. From both openings there issued dense clouds, with lapilli, sand and ashes, but no lava. Later in the day, at 12.15, a third vent appeared, near M. Crozza, and a little later a fourth, near Castiglione Sicilia. After this, new vents opened in rapid succession. On September 11 there were sixteen in action, of which fourteen ejected vapour and dust, and the other two, lower down, lava. On September 13 Prof. Riccò reported that as many as 54 vents had opened in the region between M. Rosso and the craters formed in 1879. The central crater also ejected an immense quantity of ashes, which have covered the surrounding country to the depth of several inches.

During the first day there seems to have been no outflow of lava. At 1.30 a.m. on September 11, however, during a period of comparative seismic calm, a new vent opened between M. Rosso and M. Nero, at a height of about 5250 feet, with enormous emission of dust, &c., followed by a stream of lava. Five hours later another vent appeared in the same district, from which a copious stream of lava issued. The streams rapidly descended the steep slope, passed round M. Rosso and then between the lavas of 1646 and 1809, thus assuring the safety of Linguaglossa. The main stream presented a front from 12 to 15 yards high, and from 500 to 600 yards wide, and advanced rapidly, sometimes at the rate of a quarter of a mile an hour. During the next two or three days, its velocity was reduced. On September 13, it had crossed the carriage road and circum-Etnean railway; the next day it had approached to within two miles of the Alcantara River, which forms the northern boundary of the volcano. On the 15th the main stream split into four subsidiary streams, and the violence of the eruption perceptibly abated. At the time of writing (September 18) the lava stream, the flow of which appeared to be checked, had made another onward movement.

C. DAVISON.

[1] It should be remembered that some of the names given above are duplicated on Mount Etna. The height of the mountain in 1900 was 10,758 feet.

THE CENTENARY CELEBRATION OF THE UNIVERSITY OF CHRISTIANIA.

THE delegates of the foreign and national universities and of many academies of science met an enthusiastic reception at the centenary festival. The organisation was admirable throughout, and much useful assistance was given by a number of students, who acted as marshals, and by ladies who had been asked by the University authorities to help in the entertainment. The majority of the professors and students spoke English well, so that if any foreign delegate met with a difficulty—which is improbable—at least the way was made smooth for all who spoke English.

The Prime Minister, Mr. Konow, and many of the other high officials of the State associated themselves throughout with the University, so that the festival was regarded not merely as academic but also as national.

On the afternoon of Monday, September 4, a short reception was held at the University by the rector, Dr. Brögger, to welcome the delegates, who numbered about 130, and to explain the expediency of dividing us into twelve groups, according to the geographical positions of our several countries. Each group was requested to choose a spokesman, and I had the honour of being chosen to represent the British Empire.

On the evening of Monday the doctors and professors of the University invited their foreign and Norwegian guests, to the number of three or four hundred, to supper at the Grand Hotel. Before supper Prof. Morgenstjerne gave us a cordial welcome in a speech delivered in French, and afterwards we went to the dining-rooms, of which there were several, and supped in groups of skilfully chosen parties of congenial spirits.

The more formal part of the festival took place the following morning (Tuesday, September 5) at the National Theatre. Dr. Brögger presided on the stage, to which access was given by two gangways on each side of the orchestra. The King and Queen honoured the meeting with their presence; and the spectacle was brilliant with the dresses of the ladies, the academic robes, and bright uniforms.

The proceedings began with a cantata composed by Mr. Winter Hjelm, of which the words are by Björnson, entitled "Lyset" (the Light), sung by the students, both men and women, with a full orchestra. After two parts of the cantata had been given Dr. Brögger addressed the audience in German on the history of the University. The groups of delegates then presented their several addresses of congratulation, and each spokesman delivered a speech of a few minutes in length. The rest of the cantata was then given, and this brought the meeting to an end.

In the evening the King and Queen received all the delegates at the castle, and said a few gracious words to each guest.

On Wednesday (September 6) the second formal meeting took place in the handsome new Aula of the University. This hall is not so large as the National Theatre, where the meeting had taken place on the previous day, so that it was only possible to admit national and foreign delegates, but other entertainments were provided by the committee of ladies.

The proceedings on this occasion consisted of instrumental and vocal music, and of a short address by Prof. Stang on the work of the University. The rector then explained that in the honorary degrees which were to be conferred, the claims of mathematics and astronomy were purposely excluded, because degrees in these branches of science had been conferred only a few years ago, on the occasion of the Abel Festival, I myself having then received a degree.

The heads of faculties then presented the names of the several doctors in the various departments of learning to the rector. It may be interesting to note that of the five speeches two were in English, two in German, and one in French. The degrees were then conferred by the rector on the new doctors, of whom but few were actually present. It may here suffice to say that the new British doctors were Prof. Sanday, Prof. Alfred Marshall, Sir Frederick Pollock, Sir Thomas Barlow, Sir John Bradford, Sir William Osler, Prof. Sayce, Dr. Henry Sweet, Sir James Dewar, Principal Miers, Sir John Murray, Sir William Ramsay, Prof. Sollas, and Sir Joseph Thomson.

In the evening the Municipality of Christiania entertained the delegates at dinner in the municipal buildings.

On the following morning a number of parties were taken round the museums, and the two old Viking ships naturally attracted much attention. In the afternoon the Videnskabs Selskabet—the national academy of science—gave a party in the garden attached to their fine house. This home of science was presented to the society not long ago by two Norwegian ladies, whose names, unfortunately, I omitted to take down. As the weather was glorious, this was one of the pleasantest of our many entertainments.

In the afternoon Prof. Birkeland gave a lecture in French on the phenomena attending the discharge of electricity through rarefied gas, with the application of his ideas to cosmogony on the largest scale. The lecture was of great interest; but it contained so much that was new, at least to me, that I will not venture to give a detailed account of his results. I understand that he is now sending a paper on the subject to the *Comptes rendus*.

The festival at Christiania terminated with a brilliant gala performance at the theatre of three acts of Björnson's "Mary Stuart," in the presence of the King and Queen.

On the following morning (Friday, September 8) a large number of the delegates, accompanied by ladies and their Norwegian hosts, left Christiania for Bergen in a special train put at their disposal by the Government. The line affords scenery of great beauty, and is a monument of the triumph of the engineers over enormous difficulties, for we climbed to the height of 4000 feet, and reached the region of snow and glaciers. The weather had been magnificent on the eastern side of the mountains, but we were in heavy rain as we descended the wonderful gorges of the western side. It had been supposed by most of us that the arrival at Bergen would be the real end to the hospitality shown to us; but in this we were mistaken. Every house in Bergen was illuminated in our honour, so that we ran into a city of light, and, notwithstanding the heavy rain, the streets were densely crowded in the neighbourhood of the station. On Saturday and Sunday it was fine again, and thus we learned that Bergen is not a city of eternal rain.

On Saturday a visit to the museum and to the marine biological station had been organised, followed by a drive through the romantic hills which surround the town. In the late afternoon the municipality, as represented by the President and by the first Burgomaster (for in Norway there are two Mayors for each city), invited us to a dinner, at which there were many excellent speeches. Finally, we were invited to the theatre, where a comedy by Björnson was admirably acted. This play, entitled "Geography and Love," was perhaps chosen to teach men of science that they ought not to become intolerable nuisances to their wives.

On Sunday morning the special train returned to Christiania, somewhat emptied by the departure by sea of some delegates, who were bound for St. Andrews.

It is notoriously difficult to judge of places and institutions in their holiday dress, but I am sure that all the visitors must have carried away an impression of great activity in the study of literature and science on the part both of the professors and students; and what I have written will have shown how great was the hospitality extended to us during this crowded week.

G. H. DARWIN.

CELEBRATION OF THE FIVE-HUNDREDTH ANNIVERSARY OF THE FOUNDATION OF THE UNIVERSITY OF ST. ANDREWS.

CELEBRATIONS there have been in St. Andrews from very early times, more especially when its ancient chapels and monasteries were in full activity, and still more when its splendid cathedral, the largest and finest in Scotland (yet so ruthlessly destroyed by the Reformers) lent its countenance to the ceremonies. The present, however, surpasses them all save in the absence of the King, who so often favoured the city and the University up to the time of Charles II. Thus, to confine the remarks to academic life, great were the rejoicings on February 14, 1413, when Henry Ogilvie, M.A., the bearer of the papal Bull of the cultured Benedict III. endowing the young University with its important privileges, entered the city. Bells sounded from the steeples, a solemn convocation of the clergy was held in the refectory of the Priory, and a procession to the high altar of the cathedral was made by the whole assembly in rich canonicals, "whilst 400 clerks, besides novices and lay brothers and an immense number of spectators, bowed down before the high altar in gratitude and adoration."[1] After high mass the day was devoted to mirth and festivity. Such was a fitting baptism to a university which owed its beginning more to the impulse of learned men to teach than to public or private endowments. No special buildings at first existed, the masters opening pedagogies in various parts of the town, the larger meetings in churches or in the refectory of the Priory so recently and so judiciously restored by the late Lord Bute.

Now, after the lapse of five centuries of an almost unbroken continuity in academic life, the University again engages in festivity and rejoicing. During its long and chequered career it has surmounted numerous trials and difficulties—such as the turmoil of revo-

[1] Tytler, "Hist. Scot."

lutions, the asperities of reformations, and the paralysing spoliations—and to-day is not lacking in vitality, vigour, and eagerness to fit a university of the olden time to every modern improvement. Formerly it had seen the burning of martyrs in front of its gates or in its vicinity, had endorsed the law on the unfortunate witches, and rigidly excluded women even from its quadrangle, on one hand; and, on the other, it had reared or fostered many men of note who spread its fame throughout other lands, or sent its best and wisest to preside over the sister-universities or to teach within their walls. Science, literature, and divinity have been enriched by the labours of its staff throughout this long period, its students have increased in number, women have entered its gates on the same footing as men, and its interests have been widened by the union with the college of the enterprising and prosperous city of Dundee.

With its long, chequered, and honourable career behind it, and imbued with high purpose for the future, the University held the first function of the celebration on Tuesday afternoon, September 12, in the presentation of his portrait to Mr. Carnegie. This was a gift of the students, Senate, and University Court in recognition of their former rector's munificence to the University, for to him it owes, amongst other things, its fine Carnegie Park, pavilions, library, and gymnasium. The picture represents Dr. Carnegie in his robes as rector. Principal Sir James Donaldson made the presentation on behalf of the subscribers, and Dr. Carnegie made a notable acknowledgment.

In the evening there was a reception by the chancellor, Lord Balfour of Burleigh, who, with Lady Balfour, graciously received the great concourse of visitors and others in the North Hall at the United College of St. Salvator and St. Leonards. No more brilliant scene could have been imagined. Not even the great array of silver ornaments and statues, of gorgeously arrayed Churchmen of every rank at the celebration of the endowment of the young University in 1413 to grant degrees by the papal Bull, could have exceeded the varied and striking array of the representatives of science, of medicine, of arts, divinity, law, and other distinguished men and women from almost every civilised country in lines from New Zealand to Australia and radiating through the old world and through the new to the old grey city on the Scottish coast. The bright colours and ornamentation of the robes and hoods, the gold chains of office—academic and civil—the brilliant orders and medals, and the still more varied colours and graceful drapery of the ladies, mingled with the sheen of spurs and the full-dress uniforms of military men, both highland and lowland, of representatives of the navy and groups of civic dignitaries, made a scene never to be forgotten. One thing more only can be alluded to, and it is that the welcome given by Lord and Lady Balfour to every one of the 3500 was of such a kind that from first to last the proceedings were of a most pleasant and harmonious kind. The band of the Scots Guards at the eastern end of the hall enlivened the proceedings, which were further enhanced by the chaste decoration of the interior, from the platform to the opposite end.

Moreover, a torch-light procession of the students starting from the Carnegie Park, clad in the most varied and fantastic costumes, made a striking and most fascinating scene throughout the city, as the long, snake-like line of fire wound its way along crescent, street, and promenade. Whether man or woman held the torch it was sometimes difficult to say; so that if the women students were not present, their places were sympathetically filled. To add to the charm of the proceedings the old tower of the United College of St. Salvator and St. Leonards was outlined each evening at every angle by rows of electric lamps—white, blue, and red.

Finally, a symposium was held in the Volunteer Hall under the auspices of the Students' Representative Council, at which all graduates and students of the University met. Many old friends thus had an opportunity of seeing each other and of contrasting the old *régime* with the new, and there was no happier assembly during the celebration than this.

Under bright sunshine the morning of Wednesday, September 13, was occupied by marshalling in the United College quadrangle the assembled University Court, Senate, lecturers, graduates—both ordinary and honorary—students, including members of the Officers Training Corps, delegates and distinguished men from the colonies, India, from foreign universities and societies, Lords of Session, sheriffs, the Provost and Town Council, and others to form a procession to the town church (Holy Trinity), so recently and so finely restored under the auspices of Dr. P. M. Playfair. In the church an impressive commemoration service was performed, chapters were read by the chancellor and vice-chancellor, the "Te Deum Laudamus" was sung, and an appropriate and eloquent sermon was given by the Moderator of the General Assembly (Principal Stewart, of St. Mary's College). Prayers were said by Dr. Playfair and the Very Rev. Archibald Henderson, D.D., clerk of the United Free Church, and it is noteworthy that the first prayer was a translation by the late Marquis of Bute, a former rector of the University, of the prayer given in 1413 on the arrival of the papal Bulls establishing the University. The whole tone of the procession and its surroundings and of the service in the Church of the Holy Trinity was in keeping with old academic tradition, and the same feeling pervaded the great assemblage. In no other Scotch city could the combination of past and present render the scene more purely academic.

In the afternoon the presentation of congratulatory addresses took place in the North Hall, the chancellor, rector, and the staff occupying the platform. About 166 addresses were handed in by the distinguished delegates of universities, learned societies, university general councils, town councils, churches, and other important bodies; and as each was as a rule arrayed in official robes, with gold chains and orders, the scene was one of the most interesting in the celebration. As the representatives of each country were announced, the band played a brief but appropriate piece of music. The chancellor (Lord Balfour of Burleigh), after reading a letter from the King, then delivered an eloquent and masterly address, in which he welcomed the delegates from all parts of the world, alluded to the founders of the University, its continental character, its modern modifications, the effect of its training on the national life, and finally he sketched a picture of the future of the University. Principal Sir James Donaldson then welcomed the delegates and guests on behalf of the senate.

A delightful entertainment, consisting of historical tableaux connected with the University, was given by the students in the evening. Moreover, students of the 'eighties (1880–9) had a special symposium.

Equally favourable was the weather of Thursday morning, when the rector of the University, the chosen representative of the students, was installed. The popularity of the Earl of Rosebery, who now has held the rectorship in every Scottish university, was sufficient to have filled the vast hall several times over, and, as it was, every available space was packed, little short of 4000 people being present. Before the entrance of the procession of the chancellor, rector, principals, senate, and staff in general, the students beguiled the time with songs, and as the procession entered the band played "Gaudeamus Igitur." The president of the Students' Representative Council then intimated the result of the rectorial election; Lord Rosebery took the oath, was robed, amidst the cheers of the students and audience, and then delivered his address, which was marked throughout as the production of a finished orator and man of affairs, as the experience of a man of letters, and as the counsel of a statesman. He lightly touched on the early history of the University (much of which recent writers have necessarily borrowed from Lyon, biassed though he was, and others), the troubled times following its foundation, the tenacity of its hold on learning (science for the time being forgotten) amidst the vicissitudes of its centuries, and in a fascinating manner drew a picture of the first rector as a Struldbrug of Swift doomed to perpetual life, who, from a point of vantage, surveyed the progress of the University century after century, and, though shocked at and severely critical in regard to many of the changes, concluded by affirming that, after all, substantial advances had been made all along the line. In his final words the rector counselled the students to hold fast to the simple and temperate life, the dogged perseverance, and the pure and high aims of those who had gone before them. Especially did he warn them of the dangers of losing that self-reliance, that frugality, that resolute application to work, and that masterful surmounting of difficulties which have made their countrymen thrive even under neglect, and have won for them the respect of the world. Above all, should they avoid being a "spoon-fed" nation.

After the conclusion of the rectorial address, congratulations from the Senate were conveyed by Principal Stewart to Sir James Donaldson on the completion of his twenty-fifth year of office, and in recognition of the skill and ability with which he had guided the affairs of the University. The principal feelingly replied. Then the graduation ceremony proceeded. The first (about ninety) were those receiving the honorary degree of LL.D., and as each distinguished graduate stepped on the platform to be capped by the chancellor, he or she was cheered by the students and audience; and so with the fourteen men who received the D.D. degree. Amongst those on whom the degree of LL.D. was conferred were many eminent men of science, as mentioned in the last issue of NATURE (p. 374), some of whom had been students in the old university, or had carried out researches in its marine laboratory.

In the afternoon garden-parties on a large scale were given by the mistress and council of St. Leonards' School in their fine grounds, the band of the Scots Guards playing at intervals; whilst another large party was entertained at Mount-Melville, the seat of Mr. J. Younger. Both had endless beautiful and interesting pictures in scenery and landscape gardening, in fine trees and shrubs, to entertain them, especially at Mount-Melville, where arboriculture has long been prominent.

The banquet in the Bell-Pettigrew Museum in the evening was on a large scale, the chair being occupied by the chancellor, and he was supported by the rector and principals, by Lord Reay, Lord Elgin, Lord Stair, Lord Ailsa, Lord Pentland, Lord Kinnoull, Lord Tullibardine, Lord Haddo, Lord Southesk, Lord Kinnaird, Lord Glenconner, Lord Shaw, the principals of Edinburgh, Glasgow, and Aberdeen, Dr. Andrew Carnegie, Mr. Whitelaw Reid, Mr. A. J. Balfour, the Maharajah Gaekwar of Baroda, and a long list of distinguished men. After the loyal toast the chancellor declared the museum open, and alluded to the munificent gift of Mrs. Bell-Pettigrew. Speeches were given by the rector, principals, Mr. Balfour, Sir William Turner, Sir Donald Macalister, Lord Reay, Lord Elgin, Lord Pentland, Mr. Munro-Ferguson, President Butler (New York), and many others, and the dinner was throughout of the most agreeable and successful character.

In order to entertain those whom the limited capacities (550) of the hall had of necessity excluded, a ladies' "at home" was held in the large North Hall, under the auspices of the Ladies' Celebration Committee. Lady Balfour, Lady Leconfield, Lady Helen Munro-Ferguson, and the ladies of the executive committee received the guests, who spent a most enjoyable evening. Moreover, a similar reception was held in the Victoria Art Galleries, Dundee, where Lady Baxter of Invereighty and Mrs. Urquhart, the wife of the Lord Provost of Dundee, received the guests, and the evening was spent in the same happy and memorable way.

The close of the quincentenary celebrations occurred on Friday, September 15, which was chiefly spent in Dundee in connection with University College (formerly the Baxter College), which is now an integral part of the University of St. Andrews. A special train conveyed the Court, Senate, staff and guests from St. Andrews to Dundee at 10 a.m., and all the visitors assembled at University College Library, signed the visitors' book, and proceeded to the gymnasium, where, on behalf of the council of the college, Lord Camperdown gave them a cordial welcome. Remarks were then made by the chancellor and by the rector, who, in a humorous yet suggestive speech, held that universities of the future would always be founded in great centres of population. The buildings, especially the new Carnegie Physics Laboratory, the medical buildings, the engineering laboratory, the college museum of natural history, the various class-rooms, and the city museum, were then inspected, and a tribute paid to the wonderfully complete arrangements for the teaching of medicine, engineering, physics, and other departments.

A luncheon was given by the University in the drill-hall, where the guests were received by Lord Provost Urquhart and the magistrates. The chancellor occupied the chair, and many distinguished men supported him, viz. Lord Reay, Lord Rosebery, Lord Camperdown, Lord Stair, Lord Shaw, the principals, senate, and staff of the University, and others. Between 600 and 700 persons were present. The usual toasts were given, and the company broke up about half-past two to proceed to view various large mills in the city, to join the excursions to Glamis, Rossie Priory, and a sail by steamer to Perth—all under most favourable auspices.

Another function was a graduates' and students' dinner in the Bell-Pettigrew Museum at St. Andrews, presided over by the chancellor, at 7.20 p.m. More than 500 were present, and amongst the guests was Sir Dyce Duckworth, who has so frequently visited St. Andrews, and he, in his speech, took his hearers back to the days of Principal Tulloch, on whose grave that afternoon a procession of old graduates and alumni had placed a wreath. The same would have been done if the grave of Sir David Brewster, of world-wide renown, had been in St. Andrews, for the University cherishes the memory of her, and subsequently Edinburgh's, great scientific principal.

Lastly, a students' ball at 10 p.m. brought the proceedings to a termination. This was one of the brightest and gayest of the social gatherings, under the auspices of the Students' Representative Council and its president, Mr. Dickey. The uniforms of the officers of the warships at present in St. Andrews Bay, the bright robes of the foreign and British graduates, the varied hues of the ladies' attire, and the gowns of the students themselves lent a charming novelty to the picture.

Thus ended the stately celebration of the five-hundredth anniversary of the foundation of St. Andrews University, under the most cheerful of sunny skies, pure (but not "piercing" air), and amidst the unique academic surroundings of the place, which usually, and unfortunately, are wholly absent in those great populous centres where the universities spoken of by the rector will in future be. But the great stretches of pure sand, the expanse of the blue waters of the bay (on which the warships proudly ride), and the long lines of tidal rocks remind us that nowhere within the British dominions can the sciences of geology, botany, and zoology be studied under more inspiring or more favourable auspices than in the little city by "the cold North Sea." Be that as it may, one thing is certain, viz. that both guests and hosts vied with each other in making this celebration one of the most delightful and memorable gatherings it is possible to conceive. W. C. M.

EDWARD WHYMPER.

IN Edward Whymper, who died suddenly at Chamonix on Saturday last, September 16, we have lost one who was more than a most undaunted and successful climber of mountains. Born on April 27, 1840, the son of an artist and engraver on wood, he was brought up to the work and carried it to great perfection. He went to the Alps on a professional errand in 1860 and began his career as a climber. Next year he made the first ascent of the Pelvoux, and in 1864 vanquished its neighbour, the Ecrins, the highest summit of Dauphiné. Before that he had attacked the Matterhorn. How this was at last conquered, in 1865, and of the tragedy of the return, when four lives were lost, it is needless to tell. In 1867 he visited Greenland and attempted to penetrate the inland ice. It was a failure, though not from his fault. In 1872 he returned to do some surveying on the coast. In 1879–80 he undertook his notable journey to the Ecuadorian Andes, during which he successfully ascended ten volcanic mountains, ranging from 15,000 feet to above 20,000 feet, most of them hitherto unclimbed, spent a night on the summit of Cotopaxi, and twice reached that of Chimborazo.

In later years Whymper made four or five exploratory expeditions in the Canadian Rockies and Selkirks. But he was more than a successful mountaineer: he was a keen observer of all natural phenomena. His two great and beautifully illustrated books, "Scrambles amongst the Alps" and "Travels amongst the Great Andes of the Equator," contain much of scientific value. He was a student of glaciers, and a keen critic of those who claimed for them great powers of erosion; a close observer of volcanic and other geological phenomena, and a collector who knew what was worth bringing. While at Disco Bay he obtained a fine series of fossil plants and of Eskimo relics. From the Andes he brought many specimens of rocks and other material, descriptions of which have been published, and himself wrote a paper on the aneroid barometer, besides devising a modification of the mercurial instrument for use on high mountains.

Whymper's latest books, "Chamonix and Mont Blanc," published in 1896, and "Zermatt and the Matterhorn," which appeared in the following year, are admirable of their kind, and have met with great success. He was a fellow of the Royal Society of Edinburgh, had received the Patron's medal of the Royal Geographical Society, and been decorated with the Order of St. Maurice and St. Lazare, besides being an honorary member of foreign geographical societies and Alpine clubs. T. G. BONNEY.

NOTES.

THE Government of the Commonwealth of Australia has promised to contribute 5000*l.* towards the expenses of the Mawson Antarctic Expedition, and the Victorian Government 6000*l.* This amount brings the contributions of the various Australian Governments to the sum of 22,000*l.*

THE friends of the late Christian A. Herter have contributed to a memorial fund in recognition of his labours in promoting medical science. The fund, which amounts to 8000*l.*, has been confided to the directors of *The Journal of Biological Chemistry*. The chief aim of the trust is to further the interests of that journal, which was founded by Herter.

ACCORDING to the *Revue Pratique de l'Électricité*, a bronze statue has been erected at Poleymeux, in the Rhone Department, France, in memory of Ampère. The inventor is represented standing in an attitude of meditation, the right hand raised to the forehead, the left clenched. On the side is inscribed "La Science," suggestive of the subject of his meditation.

AN International Engineering Exhibition is to be held in April next at Baku, Russia, and will be open for six weeks. The exhibits will comprise internal-combustion engines, air-compressors, electrical apparatus, motor-cars, &c. Particulars of the prospective arrangements may be obtained from the sole honorary representative in this country—Dr. P. Dvorkovitz, 1 Broad Street Place, E.C.

DR. R. KARSTEN, lecturer in comparative religion in the University of Helsingfors, has started on an expedition to Gran Chaco and Bolivia for the purpose of making investigations on the sociology and religion of various tribes of natives, some of whom are little known, while others have never been visited. He will be accompanied by his cousin, O. Lindholm.

M. G. FAYET, of the Paris Observatory, has been appointed astronomer at the Nice Observatory, in succession to M. Simonin.

MR. MARCONI has been elected president of the Junior Institution of Engineers in succession to Sir J. J. Thomson, F.R.S.

MR. J. J. NOCK has been appointed by the Secretary of State for the Colonies, on the recommendation of the Kew authorities, curator of the Hakgala Gardens, Ceylon.

THE meeting of the International Sanitary Conference to revise the provisions of the convention of 1903 for the prevention of the invasion and propagation of plague and cholera, is to take place in Paris on October 10 next.

A CONFERENCE of members of the Museums Association and others interested is to take place in the Free Public Museums, Liverpool, on Wednesday, October 18, the object being to discuss subjects of interest to those concerned in the work of museums.

PROF. LUIGI CARNERA, hitherto the director of the International Latitude stations at Carloforte and Oncativo, has been appointed professor of astronomy and geodesy in the Istituto Idrografico della R. Marina at Genoa, to which address he desires all communications to him to be sent.

THE new session (the seventieth) of the Pharmaceutical Society's School of Pharmacy is to be opened on October 4, when the inaugural address will be delivered by Dr. J. Macdonald Brown. The Hanbury gold medal will be presented on the occasion to M. Eugène Léger, of the Hôpital St. Louis, Paris.

A REUTER message from Adelaide states that Mr. Brown, the South Australian Government geologist, reports that the uranium ores recently discovered in the northern portion of South Australia possess great importance, owing to the limited extent of the world's supply of radium-producing ore. He also reports the existence of extensive deposits of corundum in the same district, and recommends prospecting there for rare gems.

THE third exhibition of small power engineering appliances, models, and scientific apparatus will be held at the Royal Horticultural Hall, Vincent Square, Westminster, on October 13 to 21. It will comprise working and stationary engineering models of all kinds, small power steam, gas, and oil engines, lathes and light machine tools, electrical appliances, &c. There will also be a completely equipped model engineering workshop, in which demonstrations of metal-working processes and small engine building will be given daily.

AN agreement has been signed by the representatives of the United Kingdom and Germany, the carrying into effect of which will mean a thorough investigation into the extent of sleeping sickness in the Gold Coast Colony, the Ashanti and Northern Territory Protectorates, and Togoland. Each Government will keep the other informed of the incidence, extent, and possible spread of the disease in its territory, and will treat the other's native subjects free of charge; but each may impose restrictions on the frontier traffic and may prevent suspected sufferers from crossing its border. The agreement is for three years certain from December 1, 1911, and continues thereafter for yearly periods, unless denounced at least six months before the close of a year.

IT is reported in *The Lancet* that the chief medical officer of one of the Austrian army corps has recently ordered the use of Calmette's serum against serpent-bites, and a fairly large stock of it has now been issued to each regiment in the south of the Empire. The men and the medical officers are instructed in the use of it, and regular inspections of the stock, as well as lectures on the natural history of the poisonous kinds of serpents, are provided for. In addition to the serum, the various appliances necessary for its proper application have been supplied to the army hospitals. Hitherto much dependence has been placed on the treatment of such injuries by alcohol and the application of permanganate of potash.

IN May last great excitement was created in Turkey and throughout the Mohammedan world by the rumour that a party of English archæologists had profaned the Mosque of Omar at Jerusalem in search of the regalia of Solomon, the Ark of the Covenant, and the Tables of the Law. A full account of the results of this expedition appear in *The Field* of September 16, of which a summary is given by *The Times* of the previous day. The excavations were chiefly devoted to what is known as the Virgin's Well and the maze of tunnels and chambers connected with it. Many fragments of Jewish and Hellenistic pottery were found. While some of it may be attributed to Canaanitish potters, none can be safely dated so late as the ninth century B.C. One Israelitish lamp, in almost perfect condition, is certainly as old as the eleventh century B.C. The Hellenistic pottery betrays indubitable evidence of that school of pottery which was transformed in the eighth and ninth centuries B.C. by Cypriote or Rhodian influence.

THE mediæval belief that the neuro-hystero-psychic manifestations known as Tarantism, because they were attributed to the bite of the Tarantula spider (*Lycosa tarantula*), has again appeared in the Troad, according to an interesting account given by a correspondent of *The Times* in its issue of September 9. The ecstatic dances, now said to be due to the promptings of the spirit of St. George, are similar to those which prevailed in Europe from 1374 to the beginning of the sixteenth century, the only difference being that in the present case the excitement is shared by men as well as women. The correspondent quotes two instances, which may probably be attributed to automatic suggestion, in which spider bites were said to be the cause of similar phenomena in one of the Troad villages. Similar manifestations are said to have occurred recently in the small island of Marmora, and at Balouki, a suburb of Constantinople. It is suggested that the investigation of these phenomena should be undertaken by medical experts and by the societies devoted to psychical research.

DR. MAX OHNEFALSCH-RICHTER publishes in *The Times* of September 11 an interesting letter on the discoveries of the Prussian Academy's archæological expedition to Paphos, in Cyprus. We appear to allow the Germans to excavate as they please in one of our colonies. That is very good of us, and it is all to the good of science; but it is a pity that our archæologists cannot be digging in the kingdom of Cyprus too. That little island-realm, which owns the sway of George V. (in succession to Richard Lionheart, who was the first English King of Cyprus) is full of archæological treasures which only await the spade. Witness the fine collections of Minoan antiquities from Enkomi in the British Museum. Dr. Ohnefalsch-Richter describes antiquities of a later period, chiefly Greek inscriptions, written in the peculiar Cypriote syllabic script, from Paphos. A discovery of his own at Rantidi last year gave the impetus to the Prussian work which has resulted in so great an addition to our knowledge of Cypriote inscriptions. The site on which they have been found by Dr. Zahn is that of the ancient high-place of Aphrodite at Paphos.

INFORMATION has been received of the arrival of the magnetic survey vessel, the *Carnegie*, at Mauritius on August 6, having been thirty-one days out from Colombo, Ceylon. The exceptionally large chart errors (approximating in magnetic declination to four degrees for one extensively used chart and for another even to six degrees) which were shown on the portion of the cruise from Cape Town to Colombo, *via* St. Paul I., April–June, have been confirmed by the cruise from Colombo to Mauritius. The *Carnegie* also arranged her route so as to intersect the tracks of the *Gauss* (1901–3), and thus has been able to secure valuable secular variation data. A fuller account is published in the September issue of *Terrestrial Magnetism and Atmospheric Electricity*. Dr. Bauer, during his visit to Australian institutions, was able to set afoot a general magnetic survey of Australia, one of the largest land areas remaining to be explored in this respect. The survey is to be conducted under the joint auspices of local organisations and of the Carnegie Institution of Washington, the observer-in-charge for the latter being Mr. E. Kidson, formerly of the Christchurch Magnetic Observatory, and more recently observer on board the *Carnegie*. Cooperation has also been effected between the Mawson Antarctic expedition and Dr. Bauer's department.

In the obituary notice of the Rev. F. J. Jervis-Smith, F.R.S., which appeared in Nature of September 7, the writer, who was an old friend, remarked:—"Trained as a mechanical engineer, he gave up the calling of his choice, went to Oxford, and entered the Church for family reasons." Mr. E. J. Jervis-Smith writes to say that this is not correct, as his father's education was entirely classical. Also, he says, "My father intended from his earliest childhood to enter Holy Orders, as it was his father's greatest wish that he should do so." The Rev. F. J. Jervis-Smith certainly knew all the tricks of the engineer's workshop, and prided himself upon so doing; and this led the writer of the notice to believe that he had been trained in mechanical engineering, instead of receiving the usual classical education with the intention of entering Holy Orders. His interests were, however, scientific and engineering, whatever was his educational course, for his son says:—"As a child my father saw a great deal of Mr. William Ellis Metford, who imbued him with a love of mechanics and scientific apparatus. He had a small scientific and mechanical laboratory of his own at Taunton, where he carried on research work before going to Oxford as Millard lecturer."

We learn from *The Lancet* that a society for the prevention of diseases and epidemics (Gesellschaft zur Bekämpfung von Volksseuchen) has been founded in Austria which will act in concert with the Public Board of Health and the Sanitary Department of the Ministry of the Interior. Its aims are to supplement the endeavours of the public authorities in combating diseases, to improve the general circumstances of patients and their families belonging to the poorer classes, to provide adequately trained attendants for the care and nursing of patients during epidemics, and to organise medical help and hospital accommodation in non-epidemic times. The society will also encourage investigations relative to the spread of diseases, as well as their prophylaxis and treatment, and will, so far as possible, make the general public acquainted with the results of these scientific researches. The society will endeavour to improve the knowledge, not only of the so-called epidemics, but also of all diseases which prevail extensively. The present intention is that the scientific part of the work shall be divided amongst all practitioners in the country through the instrumentality of the local medical unions and councils. It is thought possible that an international society for the study of epidemic diseases may in the course of time be called into existence.

Man for September contains an important report by Mr. C. L. Woolley on the great collection of pottery brought by Dr. M. A. Stein from Chinese Turkestan and western China, which dates from the first century B.C. onwards. Much of it consists of hand-made pots fired in an open hearth, as is still the custom in modern India, and showing in the section the uneven bands of colour usually resulting from this process. An important advance is illustrated by the moulded ware, in which the moulds employed show distinct Gandhara influence. The wheel-made pots are usually of finely levigated clay, kiln-fired, sometimes smothered, sometimes of a clear terra-cotta red. It is not necessary to suppose that the glazed specimens were imported, because similar glazes, though on a different body, were certainly locally produced.

Recent reports announce numerous important prehistoric finds in this country. In a sepulchral barrow of the Bronze age at Eye, near Peterborough, a pot containing food offerings to the dead was unearthed in 1910. But it was only in the present year that the actual interment was discovered, the skeleton being that of a tall man, whose corpse had been laid on the right side with the head to the south-west, and the arms and legs flexed, a disposition typical of this period. The absence of articles accompanying the interment makes it difficult to fix the date more closely than in the second millennium B.C. During the visit of the Cambrian Association to Promontory Hill Fort, which overlooks the Vale of Clwyd, near which some fine bronze trappings were found some forty years ago, the accidental discovery by a member of the party of some fragments of pottery at the mouth of a rabbit burrow enabled Prof. Boyd Dawkins to conclude that this site had been occupied from the later Bronze and Iron age down to the end of the second or third century of the Roman occupation.

The Times of September 6, in its second article describing the excavations made by Commendatore Boni at the Roman Forum, throws some light on the problems connected with the famous Niger lapis, or black stone, which was unearthed in 1890, and has since supplied the material for a vigorous controversy. It is a slab of black marble covering remains which are certainly of great antiquity, including a broken rectangular stele bearing an inscription, which has hitherto remained undeciphered. These remains bear marks of intentional demolition; and close to the place were found a series of dedicatory gifts, such as small idols of clay, bone, or bronze, with some river sand, which was obviously brought here from a distance to serve some special religious purpose. It thus appears to mark the site of a ruined sanctuary, hitherto assumed to be an unlucky spot—the grave of Romulus, or of his foster-father Faustulus, or Hostus Hostilius. Commendatore Boni now believes that this was the site of the rostra destroyed by the patricians at the beginning of the civil war, about 124 B.C. The present remains, he supposes, mark an expiatory rite performed in obedience to an oracle procured from the shrine of Demeter at Enna, in Sicily, from which advice was sought how best to expiate the contamination of the Forum by the slaughter of so many Roman citizens. It thus represented a popular monument intended to be a lasting memorial of plebeian resentment against this outrage on the part of the aristocratic faction.

The contents of Nos. 3 and 4 of the second volume of the Economic Proceedings of the Royal Dublin Society include an article by Prof. G. H. Carpenter on insects, &c., injurious to crops and trees observed in Ireland in 1910.

We have received a copy of the report of the museum of the county borough of Warrington for the year ending June 30. It may be noticed that the museum accepts such miscellaneous objects as a Rhone beaver and a portion of tree-trunk gnawed by the Canadian representative of the same.

In the September number of *British Birds* Miss E. L. Turner records the breeding of the bittern in Norfolk during the past summer. It appears that three adult birds were observed in the latter part of December, 1910; booming commenced at the end of the following January, and continued, with the exception of February, until June 4, when it ceased. A half-fledged young bird was taken on July 8 (and subsequently liberated) which appeared to be four or five weeks old; and it is suggested that this was the latest of the brood, the other members of which had dispersed. The empty nest was observed. If, as appears to be the case, the cock ceases to boom immediately after the young are hatched, it may be inferred that both parents share in the task of feeding their offspring. Although the bittern is doubtless a night-feeder, it appears to tend its young at intervals throughout the day, as one at least of the old birds was observed to visit the nest several times a day.

A FEW weeks ago reference was made in this journal (August 10, p. 200) to the discovery of a breeding colony of fulmar petrels at Berriedale Head, Caithness. In the September number of *The Irish Naturalist* Mr. R. J. Ussher announces the existence of a colony of these birds on a high, perpendicular cliff on the coast of Mayo, this being the first instance of the breeding of the species in Ireland. According to the local boatmen, these white "cawnoges" made their appearance on the cliff, which is about 700 feet high, four years ago, and have been steadily increasing in numbers since that date. On July 10 Mr. Ussher scaled the cliff, and, with the aid of binoculars, counted eighteen sitting fulmars on a ledge about 400 feet above the water, the specific identity of the bird being rendered certain by individuals which flew close overhead. It is also stated that a colony of about twenty fulmars was observed on a cliff in Ulster in May, the birds, according to local report, having made their appearance in 1910, and remained through the breeding season. Mr. Ussher does not believe that the fulmars have been attracted by the whaling stations on the west coast of Ireland, but that their appearance is part of the extension of the breeding area of the species now in progress. Of this extension Mr. R. M. Barrington gives a summary in a separate paper in the same serial.

IN an article on the purpose and some principles of systematic zoology, published in *The Popular Science Monthly* for September, Mr. Hubert Lyman enunciates the following five propositions, which he regards as of prime importance in regard to the present condition of the science and the lines on which it is studied:—(1) Naming and describing new species and correcting nomenclatural errors, while valuable, and indeed essential, is frankly the most elementary, and hence the lowest, form of zoology. (2) To be of real worth and permanent value, the systematic study of any group of animals must take into account, so far as they are known, the pre- and post-natal development, the geological history, and the geographical distribution of the species which compose it. (3) While genera and larger groups in our systems of classification ought to be based on relationship, their delimitation is often of necessity artificial, and is purely a matter of expediency and convenience. (4) The value of a character for distinguishing species or higher groups depends chiefly on its constancy, and for indicating relationships within a group on its significance; in neither case is its conspicuousness anything more than a matter of convenience. (5) In all systematic work, the line between facts of nature and opinions of the worker should be sharply drawn; the value of the work often depends on the clearness of this line. The article is certainly opportune, as there is a decided tendency at the present day to regard systematic work as the end and final aim of zoology instead of the foundation.

A NOTE by Prof. A. C. Seward in *The Geological Magazine* (July) describes a fossil bipinnate leaf, taken from the Molteno beds at the base of the Stormberg series in Cape Colony, that supplies the type of a new genus, Stormbergia. The stalked pinnules furnish the chief distinctive feature of what is regarded as a probable fern frond; in some respects it resembles *Bernoullia helvetica*, a fossil fern of Rhætic age.

IT is obvious that the task of exhibiting alpine plants on tables in April calls for considerable enterprise and previous calculation. A prize offered by the Royal Horticultural Society of Ireland has inspired an article on the subject, contributed by Mr. W. H. Paine to *Irish Gardening* (September). The cultural directions refer to species of Primula, Androsace, Viola, Aubrietia, Saxifraga, Shortia, and Anemone. With regard to methods, while the various plants have their special soil requirements, it is recommended that the plants should be panned in autumn to get established, then plunged in sand and covered with a depth of leaves, sand, or bracken through the winter. Preparations for bringing the plants into exhibiting condition must be started several weeks before the show takes place.

WITH the object of estimating the aperture of stomata, Dr. Francis Darwin, assisted by Miss D. F. M. Pertz, has devised an ingenious apparatus that he calls a porometer. It consists of a small campanulate glass vessel attached to an air chamber. The glass vessel is fixed to a leaf, and pressure in the chamber is reduced, whereby air is drawn through the stomata. The rate of flow of the air into the chamber is measured, and supplies a comparative indicator of changes in the apertures of the stomata. The porometer provides a continuous method; it indicates the movements of a group of living cells, and possesses a great advantage over the horn hygroscope and cobalt paper, inasmuch as the readings of the instrument are independent of transpiration. The experiments described in the Proceedings of the Royal Society (vol. lxxxiv.) are designed to show how illumination and water supply influences stomatal aperture.

THE main features of an address, delivered by Mr. R. R. Gates before the National Academy of Sciences at St. Louis, on the mode of chromosome reduction, is published in *The Botanical Gazette* (May). With regard to general facts, it is noted that there are two ordinary methods of chromosome reduction in organisms, the one involving an end-to-end arrangement, the other a side-by-side pairing; the difference is not of phylogenetic or hereditary value, but is a matter of cell mechanics. Consequent upon the important point first demonstrated by Strasburger, that the chromosomes are in homologous pairs throughout the tissues of the sporophyte, it is argued that the reduction process consists in a segregation of the paired somatic chromosomes in the heterotypic mitosis, and a split of these chromosomes in the homotypic, and that the supposed function of synapsis to bring about a pairing of the chromosomes is not justified.

A MEMORANDUM on the monsoon conditions prevailing during June and July, with a forecast for August and September, issued by the officiating director-general of Indian observatories on July 30, states that an almost complete break in the rains began between June 18 and 26. On July 5 a fresh advance of the Arabian Sea current occurred, and extended rapidly into the interior; but by July 15 the monsoon had again begun to weaken, and a second break set in, which lasted until about July 27. The total rainfall of this month fell short of the normal by about 34 per cent., the defect being almost general. From a consideration of the various extra-Indian conditions which usually influence the behaviour of the monsoon, the inference is drawn that although the latter may be expected to continue unsteady and weak, the drought is likely to become less general as the season progresses. The combined rainfall of August and September, however, will probably fall short of the normal, particularly in parts of central and north-west India. Reports subsequently received by telegraph seem to show that this forecast is, in the main, likely to be fulfilled.

The Scientific American of August 19 publishes a most interesting article entitled "The Head of the Official Meteorological World," accompanied by an excellent photograph of Dr. W. N. Shaw, taken by Mrs. Shaw (who, in addition to her skill as an amateur photographer, takes an active interest in educational matters). The presidency of the International Meteorological Committee, comprising the principal directors of the national weather services of the world, is by no means an easy position. Great tact is required at meetings in reconciling opinions which are sometimes quite opposed to each other, in introducing new subjects for discussion, and in referring difficult matters to the consideration of carefully selected subcommittees. The writer of the article (Mr. C. F. Talman) points out that the committee was singularly fortunate in having among its members a man ideally fitted to occupy this post, vacated by Prof. Mascart (head of the French Meteorological Service) shortly before his death in 1907. He reviews with much ability the varied and useful work of the present holder of the position, from the beginning of his academic career, the marks of his "directive genius" as shown in the operations of the Meteorological Office, and briefly sketches some of the evidences of the "advanced position that he has come to occupy in the general campaign of meteorological research." To mention one important matter only, the British meteorological year-books and their appendices now appear so punctually that they set the pace for similar publications throughout the world.

In *The Cairo Scientific Journal* for August Dr. W. F. Hume gives an account of the finding of a meteorite which fell in the delta of the Nile on June 28, in the village lands of El Nakhla, some 44 kilometres E.S.E. of Alexandria. Fragments were reported as having fallen at five separate localities, and several pieces were secured for examination. The specific gravity was 3·4, and the interior of the specimen showed prismatic crystals, probably of enstatite, and yellow grains of olivine or peridot; the outer surface was covered with a black, glistening skin rich in iron. Specimens were exhibited in Section C at the British Association, where Dr. Hume gave further details.

In the same number Mr. J. I. Craig describes a fragment of a sundial which was found at the temple of Basa in the Sudan, in lat. 16° 42′ and long. 33° 53′ E. It is constructed from a block of marble which is not of local origin, but must have been imported, probably from Europe. It contains portions of seven converging lines, and two curved lines on a conoidal surface, and much resembles two sundials which are now in the museum at Alexandria. Since the worked surface is not complete, and what is left is not a true geometrical surface, computation of the locality for which the dial was constructed is impossible; but it is suggested that the block was carved after an Alexandrian model, and the hour lines were adjusted for a place in the Sudan. Illustrations of the dial are given, but the article does not mention where it is preserved.

Mr. H. Grindell Matthews recently succeeded in establishing communication by means of his wireless telephone over a distance of five and a half miles by speaking from Beachley, near Chepstow, to New Passage, on the opposite bank of the Severn. The system will now be tried by the War Office at Aldershot, which will be given the option of purchasing Mr. Matthews's invention. Meanwhile further experiments are being carried out, and attempts to communicate from Chepstow to Cardiff, a distance of twenty-five miles, are being made. Cody man-lifting kites play a prominent part in the necessary arrangements, and apparently Mr. Matthews recently received a bad electric shock from the wire attached to the kite, although no power was being used at the time. Mr. Matthews was also able to obtain sparks when the kite wire was touched by another coil of wire. This apparently has convinced Mr. Matthews that, given a sufficient length of insulated wire, it is possible to collect energy from the atmosphere. We shall wait to see the results of further experiments in this direction, which doubtless Mr. Matthews will make shortly.

The researches of Pictet have made it probable that most of the plant alkaloids are to be regarded as degradation products of vegetable proteins, since they are formed by the union of these simple substances with formaldehyde. The ring compounds synthesised in this manner are subjected to further minor changes in the plant, such as oxidation, reduction, replacement of hydroxyl, &c., and converted into the natural alkaloids. Pictet showed how in this way the majority of the alkaloids could be supposed to be formed, but specially excluded the isoquinoline alkaloids, which comprise such important representatives as morphine and the alkaloids of opium, berberine, &c., from his hypothesis. In the current number of the *Berichte* he shows how tyrosine or phenylalanine condense with formaldehyde to tetrahydroisoquinoline derivatives, and is able to effect the complete synthesis of hydroxyberberine starting from homopiperonylamine and formaldehyde. The conception that alkaloids are derived from proteins is therefore to be extended also to the isoquinoline alkaloids.

The September issue of *The Central*, the magazine of the City and Guilds of London Central Technical College Old Students' Association, is of special interest. It opens with an appreciative account, by Mr. G. C. Turner, of the career and work of Prof. Henrici, F.R.S., who retired from his professorship at the college at the end of last term. A full report follows of the banquet to Prof. H. E. Armstrong, F.R.S., in May last, which was duly noted in Nature at the time. Important articles by old students of the college deal with lifeboat launching slipways, the training of alluvial rivers by the guide-bank system, modern simple span truss-bridge construction, and the electro-technical commission.

OUR ASTRONOMICAL COLUMN.

The Expected Return of Comet 1905 II. (Borrelly).—From a number of observations made in 1905, M. Fayet has calculated a definite orbit for Borrelly's comet of that year, and finds that perihelion passage should take place on 1911 December 18·601 (Paris M.T.). Ephemerides based on these elements are published in No. 4523 of the *Astronomische Nachrichten*, and the complete discussion is to appear shortly in vol. xxx. of the Annals of the Paris Observatory.

Until the end of November the southern declination of the comet will make observations impossible in our northern observatories, although the general conditions of this apparition are more favourable than those of 1905.

The Discovery of Eclipsing Variables; β Aurigæ a Variable Star.—In an interesting paper appearing in

No. 2, vol. xxxiv., of *The Astrophysical Journal*, Dr. Joel Stebbins discusses the probability of there being a number of readily detectable eclipsing variables among those stars known to be short-period spectroscopic binaries. Such stars must offer the phenomena of mutual eclipse to some parts of the universe, and Dr. Stebbins establishes the probability that a very fair proportion will present more or less partial eclipses to the earth; as a class, that is, they offer greater probability of the discovery of eclipsing variables than do the bulk of the stars. Not only that, but their periods can be more or less determined from their spectroscopic elements, and so the times of maximum light-variations suggested. Such periods would be the most favourable for observation, and with the selenium photometer Dr. Stebbins considers that for stars of magnitude 2·0 and brighter a 0·10 magnitude variation may be considered conspicuous, so that very small eclipses might become evident in properly timed observations.

To test his proposition, Dr. Stebbins made observations of β Aurigæ and δ Orionis, and found that both were eclipsing variables. The work on the latter is not yet complete, but its extreme light-range is not far from 0·10 magnitude.

In the case of β Aurigæ, a number of consecutive observations indicated no change, but on October 23, 1910, the selenium photometer showed the magnitude to be 0·07 fainter than before. From a number of observations, fully discussed in the same number of the journal, Dr. Stebbins finds that the total range is 0·087 magnitude, of which 0·076 is due to eclipses and 0·011 is due to ellipticity of figure of the two components. The times of light-minimum are apparently in exact accordance with the times predicted from Baker's spectroscopic elements. It would also appear that the surface-intensities of the components are many times greater than that of the sun.

Cometary Phenomena.—From Dr. K. Bohlin we have received an abstract from the *Naturwissenschaftlichen Rundschau* in which he reviews our present knowledge of cometary phenomena. In the first part systems of comets are dealt with, and in the last of five well-defined systems, we find comet 1910*a* classed with 1890 IV. and 1907 I. In dealing with the light, extent, and structure of comets, there is little that is new to record; and in the chapter on spectra the latest results are not mentioned, although they replace much that preceded them. The section discussing the tails of comets, and the strange fluctuations in the streams of matter forming them, is interesting, and is illustrated by some reproductions from photographs.

Observations and Catalogues of Nebulæ.—Now that the subject of the classification and distribution of nebulæ is to the fore, Dr. Bauschinger's publication in vol. iv., part i., of the *Annalen der Kaiserlichen Universitäts-Sternwarte in Strassburg*, of the Strassburg observations and catalogue, will prove a welcome addition to the literature dealing with the subject.

The publication consists of three parts, in the first of which Dr. Wirtz discusses his observations of nebulæ made with the 49-cm. refractor during the period April, 1902, to March, 1910. The general methods of observation are described, and then the results tabulated; special micrometer measures of the stars in the Omega and Dumbell nebulæ were made, and the results are shown on two charts.

The second part of the present publication contains a general catalogue of the nebulæ observed at Strassburg from 1881 until 1910, and gives the various designations, the positions (1900·0), and brief descriptions of the physical features of 1257 nebulæ; the catalogue has been compiled by Dr. Wirtz, who writes the introduction, wherein he points out that it is the outcome of the work initiated by Winnecke in 1872. The final part of the publication consists of a most interesting comparison, by Dr. Wirtz, of the Strassburg results with those of other nebulæ observers.

A New Observatory in Africa.—From No. 4519 of the *Astronomische Nachrichten* we learn that the French Geographical Society charged M. Jarry Desloges with the erection of a more or less temporary observatory on the "Hautes Plateaux" of northern Africa. Extensive and arduous researches as to the "seeing" at various places over a wide region at an altitude of 1100 metres or more have been made, and now an observatory is in course of erection.

RECENT SOIL INVESTIGATIONS.

It is well known that the United States Bureau of Soils does not attach the same importance to a chemical analysis of the soil as is usual elsewhere. The argument adopted is that all soils contain the same rock minerals, and therefore the soil solution from which plants derive their nourishment must be identical in composition, so far as mineral plant food is concerned, in all cases. But inasmuch as the aqueous extracts of different soils show the same kind of differences towards plants as the soils themselves, it follows, if the original hypothesis is true, that the infertility of the poor soils must be due to some toxic organic substance. Search is therefore being made for substances of this nature, and during the progress of the experiments numerous interesting fields are opening up. Evidence has, for example, been obtained which is considered to prove that the roots of growing plants, and particularly the root hairs, possess an extracellular oxidising power; this power is greatest in fertile soils, and is diminished in certain infertile soils. The oxidation is attributed mainly, if not entirely, to the activity of a peroxidase produced by the roots. Messrs. Schreiner and Reed, the authors of this paper, also consider that soil itself can effect oxidations closely analogous to those of an oxidase, although, in their view, the process is mainly non-enzymotic.

Another publication, also from the Bureau of Soils, gives the results of Messrs. Robinson and McCaughey's investigations on the colours of soils, which they trace to organic matter and to ferric oxide. All varieties of colour, from white to yellow, red, brown, and black, are thus derived, the darker colours indicating, as a rule, the better agricultural conditions.

In addition to the research work going on, the Bureau of Soils is also engaged in a soil survey of the States, the results of which are issued in the form of circulars dealing with particular soil types. The basis of the survey is the mechanical analysis of the soil; but the officer in charge makes full local investigations, so that the report always takes account of the agricultural conditions. Among the reports issued, so far, are those dealing with the Portsmouth sandy loam, the Sassafras silt loam, the Norfolk fine sandy loam, and the Norfolk fine sand. In a general introductory circular Dr. Whitney describes in non-technical language the kind of examination that is made in the laboratory, and the limitations to which soil analysis is subjected. The account is very interesting, and will be found useful to others engaged in this work.

Messrs. Hart and Peterson, of the Wisconsin Agricultural Experiment Station, have recently published their work on the sulphur requirements of farm crops. Some years ago Mr. Dymond directed attention to the problem here, and showed that the supply of sulphates was not always adequate to the needs of the crop. A similar conclusion is reached by Messrs. Hart and Peterson, and they suggest that, in order to meet the losses due to drainage and cropping, it will be necessary for permanent fertility to supply sulphates to the soil.

The biochemical significance of phosphorus is discussed by Miss Caird in a paper read before the Royal Society of Victoria, a reprint of which was recently to hand. The low phosphorus content of the Australian soils is well known; it appears, also, that Australian native grasses have a markedly lower phosphorus content than European, and that the wood of Australian trees is lower in phosphates than European trees. Acclimatised European grasses contain more phosphorus than the native sorts, but less than the same kinds grown in Europe. Finally, it is pointed out that the loss of phosphorus from Victorian grass lands by export of their products is considerable, and must be made good.

THE ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA.[1]

ORIGINATING on the occasion of the formal opening of the Yerkes Observatory in October, 1897, the Astronomical and Astrophysical Society of America now includes in its membership most of the workers in astronomy and allied subjects throughout the Western Continent, and many from other countries. Inaugurated for the purpose of advancing astronomy and astrophysics, its system has been to hold an annual meeting of the nature of a conference, lasting for several days, generally at a different location each year. Accounts of the meetings, with abstracts of the various papers presented, have been published from year to year either in *The Astrophysical Journal* or in *Science*. At the tenth annual meeting, held at Yerkes, August, 1907, the publication of the present volume of proceedings was authorised, and its preparation entrusted to Prof. W. J. Hussey, of the Detroit Observatory at Ann Arbor, Michigan. It contains full particulars of the organisation of the society, and abstracts of the papers presented at all the meetings; the majority of these are now well known, and being only short summaries are not suitable for further abstraction.

The society undertakes the organisation of special branches of astronomical investigation, in a similar manner to the various sections of the British Astronomical Association. One of the most important of these deals with the collection of data referring to meteors, and it has strongly recommended the establishment of a network of photographic stations about one hundred miles apart for the purpose of obtaining a record as complete as possible of all the meteors appearing within the network. Automatic instruments of as simple and inexpensive type as can be obtained are recommended.

Another section deals with cometary phenomena, and the society financed a special expedition to Honolulu for the photographic recording of Halley's Comet in May, 1910, in charge of F. Ellerman, of the Mount Wilson Observatory.

In a report of progress on the radial velocity determinations at the Lick Observatory, W. W. Campbell mentions that the programmes of observation for the Mills spectrograph attached to the 36-inch equatorial, and for the D. O. Mills expedition to Santiago, Chile, have aimed to secure at least four spectrograms of every star down to 5·0 visual magnitude, with three-prism dispersion if possible, and of fainter stars with two-prism dispersion. Up to June 1, 1907, three-prism spectrograms of 882 stars had been obtained at Mount Hamilton. It was expected that the programme would be completed by June, 1910. On the D. O. Mills expeditions Messrs. Wright and Curtis have obtained 530 stars brighter than 5·01 visual magnitude, and 150 stars fainter than 5·00 magnitude. The total number of separate stars the spectra of which have been photographed is 1368. Many new spectroscopic binaries have been discovered during the progress of the reductions, but it has only been possible to investigate fully the orbits of a few of the total number now known.

CHARLES P. BUTLER.

COAST-SURVEYING.[2]

IN surveying, uniformity of method may be carried to a point at which it militates against maximum efficiency, which demands that each region should be surveyed by the method most suited to its character and the object in view. While a uniform method of operations facilitates the compilation of results, a reasonable adaptation of method to the case in hand distinguishes a scientific survey from a mechanical process of measurement.

Dr. Ball has been engaged for several seasons in surveying the eastern desert of Egypt, including both the mining area and the Red Sea coast, carrying on a triangulation of approximately second-order and a plane-table topographical survey at the same time. In aiming at the greatest economy of time, together with adequate accuracy, he has employed the method described in this paper along the coast of the Red Sea. Having fixed by triangulation a series of points on moderately high ground overlooking the coastal plain, he determines a series of points on the sea-margin by observing their directions and the depression-angles with a theodolite. Thus the azimuths of the lines are obtained from that of a side of the triangulation, and the determined altitude of the observation point furnishes, with the depression-angle, the distance of the sea-margin. So far the method is not new; but the computations involved are troublesome, and this has prevented the more general use of it.

To surmount this difficulty Dr. Ball uses a scale, to be specially constructed by the surveyor for each station occupied, such that when the apparent angle of depression to a point on the coast is observed the scale will enable the true distance of the point from the station to be at once laid down on the chart. The height of the station being accurately known from the triangulation, the distances corresponding to the different depression-angles can be computed for each 5′ and laid off to scale without any great expenditure of time. When a large extent of coastline is to be mapped on a single scale, and numerous stations will be occupied, it will be more economical to construct a single-scale diagram, from which any desired scale can be taken; instances of such a diagram for both metric and British units are given.

This method should greatly facilitate the work of a surveyor engaged on a coast survey who thoroughly understands the use of his theodolite and is possessed of adequate neatness and accuracy in drawing. The accuracy of the method is fully discussed, and the limits of distance for which it can be employed are investigated on the assumption that distances shall be correct to within 100 metres, while the altitude of the station is not more than 1 metre in error, the error of depression-angle does not exceed 10″, and the coefficient of refraction is liable to a variation not exceeding 20 per cent. of itself. This study was undertaken by Mr. H. E. Hurst, of the Survey Department, and the whole memoir forms a very thorough piece of work and an instructive addition to field-surveying.

H. G. L.

WORK OF A LONDON NATURAL HISTORY SOCIETY.[1]

THE South London Entomological and Natural History Society has existed since 1872, and now numbers 169 members, many of whom are among the most prominent entomologists of the day. The volume of publications before us is well printed and illustrated, and as it is not likely to be so widely circulated as it deserves, it may be well to give a detailed list of the various interesting papers included in it.

Robert Adkin, "On the Lepidoptera of a London Garden." Discusses the conversion of the country village of Lewisham into a suburban district, and the results of thirty years' experience of what was, entomologically, an actually barren plot of ground when laid out as a garden. During this time, about 180 species of butterflies and moths, out of the British list of about 2000, were obtained, of which eleven were butterflies. Among these is *Celastrina argiolus*, which appears to have been common at Lewisham in Stainton's time, and is still a common garden insect at Chiswick, in quite a different part of London. No great rarities are enumerated, but this was perhaps hardly to be expected; on the other hand, a large number of species are mentioned as having been only taken or observed *once*.

Robert Adkin, "Notes on *Hepialus humuli* and its Shetland forms." The writer considers that the form *thulensis* is restricted to Shetland. Alfred Sich, "Larval Legs." Deals with their development in certain Lepidoptera. H. J. Turner, "A few days with the butterflies of Zermatt." Account of a collecting tour. Alfred Sich, "The Middlesex home of *Clausilia biplicata*." Notes on the former occurrence of this and other land-shells in a locality

[1] Publications of the Astronomical and Astrophysical Society of America. Vol. i.—Organisation, Membership, and Abstracts of Papers, 1897–1909. Pp. xxvii+347. (Ann Arbor, Michigan: The Society, 1910.)

[2] "A New Method of Coast-surveying." By Dr. J. Ball. Survey Department Paper, No. 21. (Cairo, 1911.)

[1] Proceedings of the South London Entomological and Natural History Society, 1910–11. With nine plates. Pp. xvi+175. (London: The Society, Hibernia Chambers, London Bridge, S.E., n.d.) Price 4s. 6d.

(now destroyed) at Chiswick. J. Platt Barrett, "The Butterflies of Sicily." Includes "sixty-five Sicilian butterflies out of the ninety-seven given by Ragusa." Dr. T. A. Chapman, "On insect teratology" (remarks to introduce discussion on teratological specimens). W. J. Kaye, "An entomological trip to South Brazil" (Lepidoptera). W. J. Lucas, "The natural order of insects Neuroptera." A general sketch of the families, with illustrations of examples. R. A. S. Priske and H. Main, "Notes on the glow-worm, *Lampyris noctiluca*." W. J. Kaye, annual address, read June 26, 1911. The address is chiefly devoted to the neuration of Lepidoptera, but also contains obituary notices, &c., that of J. W. Tutt being specially noteworthy.

The volume also includes a list of members at the beginning, and an abstract of proceedings at the end.

TRANSMISSION OF TRYPANOSOMES.

IT will be most unwelcome news to many that, according to a recent number of the Bulletin of the Sleeping Sickness Bureau (No. 29, August 17), Dr. Taute, at Tanganyika, has succeeded in transmitting a human trypanosome to monkeys by means of *Glossina morsitans*. So long as it was believed that *G. palpalis* alone was capable of transmitting the trypanosomes of human beings, it was hoped that the range of sleeping sickness would be coterminous with the distribution of this species of fly; but if other tsetses also can transmit the disease, there seems to be no reason why it should not spread over practically the whole African continent. Too much weight must not be laid, however, on laboratory experiments, the success of which, as the editor of the bulletin remarks, does not prove that the like is of common occurrence in nature.

Quite recently, however, a disease of human beings has been found to occur in northern Rhodesia and Nyasaland in regions where only *G. morsitans*, and no *G. palpalis*, is stated to occur, caused by a trypanosome which has been named *Trypanosoma rhodesiense*, since it shows certain peculiarities distinguishing it from the typical *T. gambiense* of sleeping sickness.

In the same number of the bulletin a summary is given of further researches by Chagas on the human trypanosome of Brazil, of which an account was published in NATURE (August 4, 1910, p. 142). Chagas has found that the parasite multiplies in other tissues besides the lungs, namely, the cardiac muscle, the central nervous system, and the striated muscles more especially; he believes that in the lungs a multiplication of sexual forms takes place, and that the multiplication in the tissues is asexual. The infection caused by this trypanosome, transmitted by a bug (Conorhinus sp.), attacks the whole population in the districts in which it occurs, so that children probably all sicken in their first year, and either die or pass over to the chronic stage. The chronic disease shows various forms, but two more especially, those in which heart-symptoms occur and others in which nervous symptoms preponderate. The goitre frequently seen in the province of Minas Geraes is believed to be attributable to the same infection.

THE BRITISH ASSOCIATION AT PORTSMOUTH.

SECTION K.

BOTANY.

OPENING ADDRESS BY PROF. F. E. WEISS, D.Sc., PRESIDENT OF THE SECTION.

GREATLY as I prize the honour done me by the Council of the British Association in electing me to the office of President of the Botanical Section, my gratification has been heightened by the knowledge that the meetings of this section would be graced by the presence of the distinguished group of Continental and American botanists who have just taken part in the International Phytogeographical Excursion to the British Isles.

I am sure that I am voicing the unanimous feeling of the section in offering them a hearty welcome to our deliberations, and, in conveying to them our sense of the honour they have done us by their acceptance of the invitation of this Association, I should like to express our hope that by their participation in our proceedings they will help us to promote the advancement of botanical science, for which purpose we are met together.

In view of these special circumstances in which we forgather, it may seem inappropriate if I deal, as I shall be doing, in my Presidential Address mainly with fossil plants, with the study of which I have been for some time occupied; but I need hardly assure our visitors that, while we entertain some feelings of satisfaction at the contributions made during the past half-century towards our knowledge of extinct flora of Britain, yet, as the later sittings of this section will show, and as they have no doubt realised during their peregrinations through this country, our botanical sympathies and energies are by no means limited to this branch of botanical study. Moreover, I hope during the course of my address to point out the ecological interest which is afforded by certain aspects of Palæobotany.

On the sure foundations laid by my revered predecessor, the late Prof. Williamson, so vast a superstructure has been erected by the active work of numerous investigators that I must limit myself in this address to exploring only certain of its recesses, and I shall consequently confine myself to some aspects of Palæobotany which have either not been dealt with in those able expositions of the subject given to this section by previous occupants of this presidential chair, or which may be said to have passed since then into a period of mutation.

The great attractiveness of Palæobotany, and the very general interest which has been evinced in botanical circles in the progress of recent investigations into the structure of fossil plants, are due to the light they have thrown upon the relationship and the evolution of various groups of existing plants. It was the lasting achievement of Williamson to have shown, with the active cooperation of many working-men naturalists from the Lancashire and Yorkshire coalfields, that the structure of the coal-measure plants from these districts can be studied in microscopic preparations as effectively as has been the case with recent plants since the days of Grew and Malpighi. Indeed, had Sachs lived to continue his marvellous historical account of the rise of botanical knowledge up to the year 1880 or 1890, he would undoubtedly have directed attention to the remarkable growth of our knowledge of extinct plants gained by Binney and Williamson from the plant remains in the calcareous nodules of English coal-seams, and by Renault from the siliceous pebbles of Autun. We are not likely to forget the pioneer work of these veterans, though since then investigations of similar concretions from the coal deposits of this and other countries have been undertaken by numerous workers, and have revealed further secrets from that vast store of information which lies buried at our feet.

The possibilities of impression material had indeed been practically exhausted in 1870, and further advance could only come from new methods of attacking the problems that still remained to be solved. The most striking recent instance of the insufficiency of the evidence of external features alone was Prof. Oliver's demonstration of the seed-bearing nature of certain fern-like plants, based on microscopical comparison of the structure of the cupule of Lagenostoma, with the fronds of Lyginodendron, after which discovery confirmatory evidence speedily came to hand from numerous plant impressions examined by Kidston, Zeiller, and other observers.

Undoubtedly in the hands of a less competent and far-sighted observer than Williamson the new means of investigation might have proved as misleading as the old method had been in many instances. Indeed, as is well known, the recognition in the sections of Calamites and Sigillarias of the presence of secondary wood had caused Brongniart to place these plants among conifers, owing to his belief that no Vascular Cryptogams exhibited exogenous growth in thickness. It required all Williamson's eloquence and pugnacity to convert both British and French Palæobotanists to his views, ultimately accepted with such handsome acknowledgment by Grand' Eury, one of his antagonists, in his "Géologie et Palæontologie du Bassin Houiller du Gard."

It is curious that Grand' Eury refers in his introduction to the discovery of traces of secondary growth in Ophioglossum, and not to that of Isoëtes, a plant much more nearly related, as we now believe, to the Lepidodendraceæ, and the structure of which had been so thoroughly investigated by Hofmeister. Williamson, it is true, refers to the secondary growth in the stem of Isoëtes in his memoir on Stigmaria, but compares it with the periderm-forming cambium of that plant, and does not, therefore, recognise any agreement in the secondary growth of these two plants.

Adopting Von Mohl's interpretation of the root-bearing base of the Isoëtes plant as a "caudex descendens," Williamson instituted a morphological comparison between the latter and the branching Stigmaria, and came to the conclusion that they were homologous structures, a view which, as we heard at Sheffield, is supported by Dr. Lang on the strength of a re-examination of the anatomy of the stock of Isoëtes. If we do not accept Williamson's interpretation of the Stigmarian axis as a downward prolongation of caulome nature, the question remains open whether this underground structure represented a leafless modification of a normal leaf-bearing axis such as is known in the leafless rhizoms of Neottia and other saprophytic plants, or whether the Stigmarian axes were morphological entities of peculiar character. Grand' Eury, in comparing them with the rhizoms of Psilotum, accepted the former alternative, and, apart from morphological considerations, was led to this view by the fact that he had observed aërial stems arising in many instances as buds on the horizontal branches of Stigmaria. Confirmation of this mode of growth is still required, but it is quite conceivable that there may have been a mode of vegetative reproduction in the Stigmariæ analogous to that of Ophioglossum.[1]

The alternative interpretation of the Stigmarian axes as special morphological entities has received weighty support from Scott and Bower, who consider them comparable to the rhizophores of Selaginella, which, as is well known, may either be root-bearers, or in certain circumstances become transformed into leafy shoots. This peculiarity has led Goebel to regard them as special members, somewhat intermediate between stems and roots. But though they might therefore be regarded as of a primitive nature, the rhizophores of the Selaginellaceæ seem such specialised structures that I incline to agree with Bower that, so far as their correspondence with Selaginella is concerned, the Stigmarian axes would agree most closely with the basal knot formed on the hypocotyl of *Selaginella spinulosa*. Seeing, however, that the nearest living representative of the Lepidodendraceæ is in all probability Isoëtes, which Bower has aptly summarised as like "a partially differentiated Lepidostrobus seated upon a Lepidodendroid base," we must inevitably consider the root-bearing base of Isoëtes as homologous with the branching axes of Stigmaria, whatever their morphological nature may have been, and perhaps we shall be on the safest ground if we consider them both as different expressions of the continued growth of the lower region of the plant, which appears to have been a primary feature in the morphology of both these members of the Lycopodiales.

The somewhat considerable difference in external appearance between the homologous organs of these two plants may be considered bridged over by the somewhat reduced axes of Stigmariopsis and by the still more contracted base of the Mesozoic Pleuromoia, which, in spite of its very different fructification, we may unhesitatingly compare with Isoëtes so far as its root-bearing axis is concerned.

I was inclined at one time to seek an analogy for the Stigmarian axis in that interesting primitive structure, the protocorm of Phylloglossum, and of embryo Lycopods; but I now consider that the resemblances are largely superficial, and do not rest upon any satisfactory anatomical correspondence.

One of the features which has caused some divergence of opinion in the past as to the morphology of the Stigmarian axis has been the definite quincuncial arrangement and the apparent exogenous origin of the roots borne on these underground organs. Schimper, indeed, considered these two features so characteristic of foliar organs that he suggested that these so-called "appendices" might possibly be metamorphosed leaves. Not quite satisfied with this view, Renault endeavoured to establish the existence of two types of lateral organs on the Stigmarian axis, true roots with a triarch arrangement of wood and root-like leaves of monarch type. Williamson, however, clearly showed that the apparent triarch arrangement was really due to the presence at two angles of the metaxylem of the first tracheids of secondary wood, and reasserted the existence of only one type of appendicular organs, agreeing so closely, both in structure and in their orientation to the axis, on which they were borne, with the roots of Isoëtes that it would be impossible to deny the root nature of the Stigmarian "appendices" without applying the same treatment to the roots of Isoëtes.

Still, so distinguished a Palæobotanist as Solms Laubach, after a careful weighing of all the available evidence, continued to uphold Schimper's view of the foliar nature of these outgrowths, both in his "Palæophytologie" and in his memoir on Stigmariopsis, in which he stated that he was in complete agreement with Grand' Eury's conclusion: "Que ces organes sont indistinctement des rhizomes et que les Sigillaires n'avaient pas de racines réelles, ainsi que Psilotum." Indeed, in reviewing the account I gave of the occurrence of a special system of spiral tracheids in the outer cortex of the Stigmarian rootlets, Count Solms directed attention to their similarity to the transfusion tissue of Lepidodendroid leaves, and asserted that we have here a further indication of the former foliar nature of these rootlets. Personally, I still adhere to the belief, expressed at the time, that these peripheral cortical tracheids represent a special development required by a plant with an aquatic monarch root of the Isoëtes type and a large development of aërial evaporating surface. The fact that the lateral outgrowths from the Stigmarian axis have been generally considered to be exogenous is not a valid argument against their root nature, as the same origin is ascribed to the roots of Phylloglossum and to those produced on the rhizophores of Selaginella. Probably, indeed, as Bower points out in his masterly exposition of the "Origin of a Land Flora," in dealing with the Lycopodiales, "the root in its inception would, like the stem of these plants, be exogenous." According to the "recapitulation theory," indeed, the exogenous formation of the roots in the embryo of certain Lycopods, as well as of the first roots of Isoëtes and the first root of the Filicales, might be regarded as the retention of a more primitive character in these particular organs. The roots of Stigmaria, even if exogenous, might therefore merely represent a more ancestral stage. This difference between the roots of Isoëtes and the rootlets of Stigmaria may, however, be more apparent than real, for my colleague, Dr. Lang, has directed my attention to the fact that there appear to be in Stigmaria remnants of a small-celled tissue on the outside of what has generally been taken to be the superficial layer of the Stigmarian axis, and a careful investigation of this point inclines me to agree with him that very probably the Stigmarian rootlets were actually formed like those of Isoëtes, somewhat below the surface layer, which, after the emergence of the rootlets, became partially disorganised. Should this surmise prove correct, when apices of Stigmaria showing structure come to light, the last real difference between the rootlets of Isoëtes and the rootlets of Stigmaria will have disappeared, and the view for which Prof. Williamson so strongly contended will be finally established.

While a careful comparison of Isoëtes with the extinct Lycopodiaceous plants may be taken to settle finally its systematic position, the Psilotaceæ have been somewhat disturbed by such comparisons. Placed formerly without much hesitation in the phylum Lycopodiales, certain features in their organisation, such as the dichotomy of their sporophylls and the structure of their fructification generally, have suggested affinity with that interesting group of extinct plants, the Sphenophyllales. Their actual inclusion in this group by Thomas and by Bower may

[1] It is of interest in this connection to note that Potonié has recently put forward the suggestion that many of these vertical outgrowths from the more or less horizontal Stigmarian axes, some of which, as figured and described by Goldenberg, taper off rapidly to a point, without any trace of ramification, may be comparable with the conical "knees" of Taxodium, and represent woody pneumatophores so common in the Swamp Cypress and other swamp-inhabiting trees.

seem, perhaps, somewhat hazardous, considering the differences existing between the Psilotaceæ and Sphenophyllum; and the more cautious attitude of Seward, in setting up a separate group for these forms, seems, on the whole, more satisfactory than forcing these aberrant relatives of the Lycopods into the somewhat Procrustean bed of Sphenophyllales, which necessitates the minimising of such important differences as the dichotomous branching of the axis and the alternate arrangement of their leaves, though the latter character allows, it is true, of some bridging over. But, even adopting this more cautious attitude, the study of the Sphenophyllales has been of great help in coming to a clearer understanding of certain morphological peculiarities of the Psilotaceæ, quite apart from the flood of light which this synthetic group of Sphenophyllales has thrown upon the relationship of the Lycopodiales to the Equisetales.

More far-reaching in its bearing on the relationships of existing plants has been the study of those interesting fern-like plants which seem to show in their vegetative organs a structure possessing both fern-like and Cycadian affinities. Full of interest as these so-called Cycadofilices were in their vegetative organisation, they were destined to rivet on themselves the attention of all botanists by the discovery of their fructifications. No chapter in the recent history of Palæobotany is more thrilling than the discovery, by the patient and thorough researches of Prof. Oliver, of the connection between Lyginodendron and the well-known palæozoic seed, Lagenostoma. With Dr. Scott as sponsor, this new and startling revelation met with ready acceptance, and, thanks to the indefatigable energies of Palæobotanists, no fossil fern seemed at one time safe from possible inclusion among the Pteridospermæ.

The infectious enthusiasm with which the discovery of the seed-bearing habit of the Lyginodendreæ and the Medullosæ was greeted carried all before it, and we in England, particularly, have perhaps not looked carefully enough into the foundations upon which rested the theory that these groups form the "missing links" between the Ferns and Cycads. A criticism against the wholesale acceptance of this view has been put forward by Prof. Chodat,[1] of Geneva, that distinguished and versatile botanist whom we have on several occasions had the pleasure of welcoming among us. Couched throughout in friendly and courteous language, and full of admiration for the work of those who were concerned in the establishment of the group of Cycadofilices, now termed Pteridospermæ, Prof. Chodat suggests that English Palæobotanists have not sufficiently appreciated the work of Bertrand and Corneille[2] on the fibro-vascular system of existing ferns, and have not revised, in the light of the researches of these French investigators, the interpretation given to the arrangement of the primary vascular tissues of Lyginodendron. In Chodat's opinion the structure of the primary groups of wood found in the stem and in the double leaf-trace of this plant is not directly comparable with the arrangement found in the petiole of existing Cycads. In the latter the bulk of the metaxylem is centripetal, while we have, in addition, a varying amount of small-celled centrifugal wood towards the outside of the protoxylem, and, though separated from it by a group of parenchymatous cells, the bundle may be conveniently described as mesarch. In Lyginodendron, and the same applies to Heterangium, the primary bundles of the stem appear at first sight to be mesarch too, but in Chodat's opinion, if I understand him correctly, the metaxylem is exclusively centrifugal in its development, but, widening out and bending inwards again, in form of the Greek letter ω, the two extremities of the metaxylem are united on the inside of the protoxylem, forming an arrangement described by Bertrand and Corneille in the case of several fern petioles under the name of "un divergeant fermé."

Several details of structure, such as the type of pitting of the metaxylem elements and the separation of the protoxylem from the adaxial elements of metaxylem by parenchymatous cells, confirm Chodat in his view that the primary bundles of Lyginodendron are not really mesarch, and that the stem of Lyginodendron is essentially Filicinean in nature. Chodat cites other characters, such as the presence of sclerised elements in the pith, and the absence of mucilage ducts, in support of his view of the purely filicinean affinities of the Lyginodendreæ. The presence of secondary thickening in Lyginodendron, he regards not as indicative of Cycadian affinity, but merely as another instance of secondary growth in an extinct Cryptogam, taking up very much the position of Williamson in his earlier controversy with French botanists with regard to the secondary thickening of Calamites and Lepidodendreæ. Chodat is also at variance with Kidston and Miss Benson as to the nature of the microspores borne on the fronds of Lyginodendron or Lyginopteris, as he prefers to call this plant. He certainly figures some very fern-like sporangia, attached to the fronds of Lyginodendron, but anyone who has worked with the very fragmentary and somewhat disorganised material contained in our nodules knows how difficult it is to be absolutely certain of structural continuity. Nevertheless a re-investigation of the whole question of the microsporangia of Lyginodendron seems to me clearly called for by the publication of Chodat's figures.

As regards the seed-bearing habit of Lyginodendron, Chodat adopts wholeheartedly Oliver's correlation of Lagenostoma with the fronds of Lyginodendron, but would regard the seed, apparently devoid of endosperm at the time of pollination, as a somewhat specialised macrosporic development, of more complex structure, but analogous in its nature to the seed-like organ exhibited by Lepidocarpon in another phylum of the Pteridophyta. "In any case," he concludes, "the origin and the biology of this kind of seed must have been very different from those of the seeds of the Gymnosperms."

This contention, based mainly on the tardy development of the endosperm in Lagenostoma, is the least weighty part of Chodat's criticism, for it has never been asserted that the seeds were identical with those of existing Cycads. We know that the seed-habit was adopted by various groups of Vascular Cryptogams, and it is revealed in fossil plants in various stages of evolution, so that it may be readily presented to us at a special stage of its evolution in Lyginodendron. Moreover, we must remember that in so highly organised a Gymnosperm as Pinus, the macrospore itself is not fully developed at the time of pollination. Though not suggesting this as a primitive feature in the case of the pine, we can well imagine how, by a gradual process of "anticipation," the prothallus might become established before pollination in any group of primitive seed-bearing plants. There are other more specialised rather than primitive features in the complex structure of Lagenostoma which might with much more reason be invoked, to show that the seed of Lyginodendron does not form a step in the series of forms leading to the Cycadian ovule.

But leaving this point out of consideration, Chodat brings forward some strong reasons for his conclusions that the Lyginodendreæ were plants possessing stems of purely fern-like structure, increasing in thickness by means of a cambium, that their foliage was of filicinean structure, but provided with two kinds of sporangia, microsporangia similar to those of Leptosporangiate ferns, and macrosporangia of specialised type, containing a single macrospore. This group, therefore, Chodat regards as a highly specialised group of ferns, which, he considers, shows no particular connection with the Cycads, and may have formed the end in a series of highly differentiated members of the Filicineæ.

Of the Medullosæ, on the other hand, Chodat takes a very different view. Both in the structure of their primary and secondary growth, as well as in their polystely, he sees close affinity of these forms to the Cycads, borne out by smaller secondary features, such as the presence of mucilage ducts and the simple form of pollen-chamber. Chodat considers the agreement of the Medullosæ with the Cycadaceæ to be so close that he regards them as Protocycadeæ, the fern-like habit being restricted to the position of the sporangia on the vegetative fronds. Medullosa, therefore, would be only one link in the chain connecting the Cycads with the Filicales, and a link very

[1] Chodat, R.: "Les Ptéropsides des temps paléozoïques," *Archives des Sciences physiques et naturelles*, Genève, tome xvi, 1903.

[2] Bertrand, C. E., and Corneille, F.: "Étude sur quelques caractéristiques de la structure des filicinées actuelles," *Travaux et mémoires de l'Université de Lille*, 1902.

near the Cycadian end of that chain. Other forms more closely connected with the Filicinean phylum are still to be sought.

In bringing Prof. Chodat's views to your notice, I do not wish to urge their acceptance, but his criticism seems to me sufficiently weighty to demand a careful reconsideration of the structure and affinities of the Lyginodendreæ, which, whatever may be their ultimate position in our scheme of classification, will continue in the future, as they have done in the past, to command the attention of all botanists interested in the evolution of plant life.

If the wholeheartedness with which we in England received the theory of the Cycadian affinity of Lyginodendron has laid us open to friendly criticism, I am afraid some of us may be accused of exceeding the speed-limit in our rapid acceptance of the Cycadoidean ancestry of the Angiosperms. Ever since Wieland put forth the suggestion in his elaborate monograph of the "American Fossil Cycads" that "further reduction and specialisation of parts in some such generalised type, like the bisporangiate strobilus of Cycadoidea, could result in a bisexual angiospermous flower," speculation as to the steps by which the evolution might have been brought about has been rife, and Hallier in Germany and Arber and Parkin in England have put forward definite schemes giving probable lines of descent. Arber and Parkin in their criticism and detailed suggestions connect phylogenetically with the Bennettitales, the Ranales, as primitive Angiosperms, and displace from this position the Amentales and Piperales, which were regarded by Engler as probably more closely related to the Proangiosperms. Of course, the resemblance between the amphisporangiate, or, as I should prefer to call it, the heterosporangiate "strobilus" of Cycadoidea, and the flower, say, of Magnolia is very striking, and the knowledge we have gained of the structure and organisation of the Bennettitales certainly invites the belief in a possible descent of the Angiosperms from this branch of the great Cycadian plexus; but the ease with which the flower of the Ranales can in some respects be fitted on to the "flower" of Cycadoidea raises suspicion. Critics of the Arber-Parkin hypothesis may possibly incline to the view that "truth is often stranger than fiction," and that the real descent of the Angiosperms may have been much less direct than that put forward in these recent hypotheses. The particular view of the morphology of the intraseminal scales and seed pedicles adopted by Arber and Parkin is, as they admit, not the only interpretation that can be put upon these structures, and the views on this point will probably remain as various as are those of the female cone of Pinus. Even if we regard the ovulate portion of the Cycadoidean "flower" as a gynæcium, and not as an inflorescence, we are bound to admit, as do Arber and Parkin, that it is highly modified from the pro-anthostrobilus type with a series of carpels bearing marginal ovules. Cycadoidea was evidently a highly specialised form, and may well have been the last stage in a series of extinct plants.

Arber's very sharp separation of mono- and amphisporangiate Pteridosperms does not seem to me quite justified. Amphisporangiate forms may have been preserved, or may have arisen anew in various groups of Pteridosperms or in their descendants. Heterospory, we know, originated independently in at least three of the great phyla of vascular Cryptogams, and originally, no doubt, the same strobilus contained both macro- and microsporangia, as was the case in Calamostachys Casheana, in the strobili of most Lepidodendraceæ, and as is still the case in the strobili of Selaginella and in Isoëtes. Even in the existing heterosporous Filicineæ, micro- and macrospores are found on the same leaf and on the same sorus; and though in the higher Cryptogamia and the lower Phanerogamia there may have been a tendency to an iso-sporangiate condition, yet, as the two kinds of spores are obviously homologous in origin, nothing is more natural than an occasional reversion to a heterosporangiate fructification. Thus, in the group of Gymnosperms, we have many instances of the occurrence of so-called androgynous cones. In 1891, at the meeting of the British Association at Leeds, I described such amphisporangiate cones which occurred regularly on a *Pinus Thunbergii* in the Royal Gardens of Kew, and only this spring I was able to gather several hermaphrodite cones of *Larix europea*. They have, of course, been observed and described by many authors for a variety of Gymnosperms. What more likely than that many extinct Gymnosperms may have developed heterosporangiate fructifications? It is not necessary, therefore, to fix on one group of ancestors for the origin of all existing Angiosperms. Indeed, the great variety of forms, both of vegetative and reproductive organs, which we meet with in the Angiosperms, not only to-day, but even in the Cretaceous period, in which they first made their appearance, warrants, I think, the belief in a polyphyletic origin of this highest order of plants. It is no doubt true, as Wieland points out, "that the plexus to which Cycadoidea belonged, as is the case in every highly organised plant type, presented members of infinite variety," and, indeed, so far as the vegetative organisation goes, we knew already, through the labours of Nathorst, of such a remarkable form as *Wielandiella angustifolia*, while Wieland has shown us a further type in his Mexican Williamsonia. Nevertheless, these diverse forms all agree in the structure of their gynæcium, the particular organ which is not so easy to bring into line with that of the Angiosperms.

I am quite alive to, though somewhat sceptical of, the possibility of a direct descent of the Ranales from the Cycadoideæ, but my hesitation in accepting Arber and Parkin's view of the ancestry of the Angiosperms is enhanced by the consideration that it seems almost more difficult to derive some of the apparently primitive Angiosperms from the Ranales, than the latter from Cycadoidea. Indeed, this common origin of Angiosperms from the Ranalian plexus will, I feel sure, prove the stumbling-block to any general acceptance of the Arber-Parkin theory. It is easy enough to assume that all Angiosperms with the unisexual flowers have been derived by degeneration or specialisation from forms with hermaphrodite flowers of the primitive Ranalian type, but unfortunately some of these degenerate forms possess certain characters which appear to me to be undoubtedly primitive.

It is difficult for those who accept Bower's view of the gradual sterilisation of sporogenous tissue not to regard the many-celled archesporium in the ovules of Casuarina and of the Amentales as a primitive character, and though, as Coulter and Chamberlain point out, this feature is manifested by several members of the Ranunculaceæ and Rosaceæ, as well as by a few isolated Gamopetalæ, its very widespread occurrence in the Amentales seems to indicate its more general retention in this group of plants, and does not agree readily with the theory that these unisexual orders are highly specialised plants, with much-reduced flowers. The possession of a multicellular archesporium is, however, not the only primitive character exhibited by some of the unisexual orders of the Archichlamydeæ. Miss Kershaw[1] has shown, in her investigation of the structure and development of the ovule of Myrica, that in this genus, which possesses a single erect ovule, the integument is entirely free from the nucellus, and is provided with well-developed vascular bundles, in both of which features it resembles very closely the palæozoic seed Trigonocarpus. The same features were shown, moreover, by Dr. Benson[2] and Miss Welsford to occur in the ovules of *Juglans regia*, and in a few allied genera, such as Morus and Urtica. Also in a large number of Amentales with anatropous ovules (Quercus, Corylus, Castanea, &c.), Miss Kershaw has demonstrated the occurrence of a well-developed integumentary vascular supply. No doubt a further search may reveal the occurrence of this feature in some other dicotyledonous ovules, but in the meantime it seems difficult to believe that such a primitive vascular system, which the Amentales share with the older Gymnosperms, would have been retained in the catkin-bearing group, if it had undergone far-reaching floral differentiation, while it had disappeared from the plants which in other respects remained primitive. It would be still more difficult to imagine that it had arisen in the Amentales subsequently to their specialisation.

There are other structural characters and general morphological considerations, which I have not time to deal with, which underlie the belief in the primitiveness of the

[1] *Annals of Botany*, vol. xxiii., 1909. [2] *Ibid.*

Amentales and some allied cohorts, and I trust they will be set forth in detail by a better systematist than I can claim to be. My object in bringing the matter forward at all is to point out some of the difficulties which prevent me from accepting a monophyletic origin of the Dicotyledons through the Ranalian plexus.

One of these difficulties lies in the relationship of the Gnetales to the Dicotyledons. Arber and Parkin have recently made the attempt to gain a clearer insight into the affinities of this somewhat puzzling group by applying to it the "strobilus theory[1] of Angiospermous descent." The peculiar structure of the flowers of Welwitschia lends itself particularly well to a comparison with those of Cycadoidea, and a good case can no doubt be made out for a hemiangiospermous ancestry of this member of the Gnetaceæ, and by reduction the other members, in many respects simpler, might be derived from a similar ancestor, though probably, so far as Ephedra and Gnetum are concerned, an equally good, if not better, comparison might be made with Cordaites. But even supposing we admit the possibility of a derivation of the Gnetales from an amphisporangiate Pteridosperm, I think the Amentales merit quite as much as the Gnetales to be considered as having taken their origin separately from the Hemiangiospermæ, and not from the Ranalian plexus. I find this view has been put forward also by Lignier[2] in his attempt to reconstruct the phylogenetic history of the Angiosperms, and I feel strongly that such a polyphyletic descent, whether from the more specialised anthostrobilate Pteridospermæ or from several groups of a more primitive Cycado-Cordaitean plexus, is more in accordance with the early differentiation of the Cretaceous Angiosperms, and with the essential differences existing now in the orders grouped together as Archichlamydeæ.

Attempts at reconstructing the phylogeny of the Angiosperms are bound to be at the present time largely speculative, but we may possibly be on the threshold of the discovery of more certain records of the past history of the higher Spermaphyta, since Dr. Marie Stopes has commenced to publish her investigations of the Cretaceous fossil plants collected in Japan, and Prof. Jeffrey has been fortunate enough to discover cretaceous plant-remains showing structure in America. The former have already provided us with details of an interesting Angiospermic flower, and if the latter have so far only yielded Gymnosperms, we may at all events learn something of the primitive forms of these plants, the origin of which is still as problematical as is that of the Angiosperms.

I trust that the criticisms I have made of the theory put forward by Messrs. Arber and Parkin will not be taken as a want of appreciation on my part of the service they have done in formulating a working hypothesis, but merely as an expression of my desire to walk circumspectly in the very alluring paths by which they have sought to explore the primæval forest, and not to emulate those rapid but hazardous flights which have become so fashionable of late.

While the description of new and often intermediate forms of vegetation has aroused such widespread and general interest in Palæobotany, other and more special aspects of the subject have not been without their devotees, and have proved of considerable importance. Morphological anatomy has gained many new points of view, and our knowledge of the evolution of the stele owes much to a careful comparison of recent and fossil forms, even when these investigations have produced conflicting interpretations and divergent views.

Another promising line of Palæobotanical research lies in the direction of investigations of the plant tissues from the physiological and biological points of view. Happily, the vegetable cell-wall is of much greater toughness than that of animal cells, and in consequence the petrified plant-remains found in the calcareous nodules are often so excellently preserved that we can not only study the lignified and corky tissues, but also the more delicate parenchymatous cells. Even root-tips, endosperm, and germinating fern-spores are often so little altered by fossilisation that their cells can be as easily studied as if the sections had been cut from fresh material. It is this excellence of preservation which has enabled us to gain so complete a knowledge of the anatomy of palæozoic plants, and since the detailed structure of plant organs is often an index of the physical conditions under which the plants grew, we are able to form some opinion as to the habitat of the coal-measure plants. Though a beginning has already been made in this direction by various authors, we have as yet only touched the fringe of the subject, and, as Scott points out in the concluding paragraph of his admirable "Studies," the biology and ecology of fossil plants offer a wide and promising field of research. Such studies are all the more promising, as we now have material from such widely separated localities as the Lancashire coalfield, Westphalia, Moravia, and the Donetz Basin in Russia.

Now that it has been definitely shown by Stopes and Watson that the remains of plants are sometimes continuous through adjacent coal-balls, we may safely accept their conclusion that these calcareous concretions were in the main formed *in situ*, and that the plant-remains they contain represent samples of the vegetable débris of which the coal-seam consists. We have in these petrifactions, therefore, an epitome, more or less fragmentary, of the vegetation existing in palæozoic times on the area occupied by the coal-seam, and the Stigmarian roots in the underclay, as well as other considerations, lead us to believe that the seam more frequently represents the remains of the coal-measure forest carbonised *in situ*. While this seems to be the more usual formation of coal-seams, it is obvious from the microscopic investigations of coal made by Bertrand, and as has recently been so clearly set forth by Arber in his "Manual on the Natural History of Coal," that in the case of bogheads and cannels the seam represents metamorphosed sapropelic deposits of lacustrine origin. In other cases, again, considerations of the nature of the coal and the adjacent rocks may incline us to the belief that some, at any rate, of the deposits of coal may be due to material drifted into large lake-basins by river agency.

Broadly speaking, however, and particularly when dealing with the seams from which most of our petrified plant-remains have been collected, we may consider the coal as the accumulated material of palæozoic forests metamorphosed *in situ*. What, then, were the physical and climatic conditions of these primæval forests? The prevalence of wide air-spaces in the cortical tissues of young Calamitean roots, as indeed their earlier name Myriophylloides indicates, leads us to believe that, as in the case of many of their existing relatives, they were rooted under water or in waterlogged soil. We gather the same from the structure of Stigmaria, while the narrow xerophytic character of the leaves at any rate of the tree-like Calamites and Lepidodendra closely resembles the modifications met with in our marsh plants. It has been suggested by several authors that the xerophytic character of the foliage of many of our coal-measure plants may be due to the fact that they inhabited a salt marsh. A closer examination of the foliage, however, of such plants as Lepidodendron and Sigillaria does not reveal the characteristic succulency associated with the foliage of most Halophytes, and in view of the absence of such water-storing parenchyma, the well-developed transfusion-cells of the Lepidodendreæ can only be taken to be a xerophytic modification such as is met with in recent Conifers.

The specialisation of the tissues indeed is only such as is quite in keeping with the xerophytic nature of marsh plants. Moreover, the particular group of Equisetales are quite typical of fresh water, and we should expect that if their ancestors had been Halophytes, some at any rate at the present day would have retained this mode of life. Nor have we at the present time any halophytic Lycopodiales, while Isoëtes, the nearest relative to the Lepidodendra, is an aquatic or sub-aquatic form associated with fresh water.

Among the Filicales, *Acrostichum aureum* seems to be the only halophytic form, inhabiting as it does the swamps of the Ceylon littoral,[1] and though, as Miss Thomas has

[1] Arber, E. A. N., and Parkin, J.: "Studies on the Evolution of Angiosperms," "The Relationship of the Angiosperms to the Gnetales," *Annals of Botany*, vol. xxii., 1908.

[2] Lignier, O.: "Essai sur l'Evolution morphologique du Règne vegetal," *Bull. de la Soc. Linnéenne de Normandie*, 6 sér., 3 vol., 1909, réimprimé Février 1911.

[1] Tansley, A. G., and Fritsch: "The Flora of the Ceylon Littoral," *New Phytologist*, vol. iv., 1905.

pointed out, its root structure is in close agreement with that of many palæozoic plants, its frond shows considerable deviation from that of Lyginodendron or Medullosa, both of which plants, as Pteridosperms, are on a higher plane of evolution, and might therefore be expected to show a more highly differentiated type of leaf. But, on the contrary, these coal-measure plants show a more typically Filicinean character, both as regards the finely dissected lamina, and also in the more delicate texture of the foliage compared with the specialised organisation of the frond of *Acrostichum aureum*, described by Miss Thomas.

Nor is it necessary to call to aid the salinity of the marsh to explain the excellent preservation of the tissues of the plant-remains in the so-called coal-balls, in view of the well-known power of humic compounds to retard the decay of vegetable tissues. In addition to these arguments, I might direct attention to the presence of certain fungi among the petrified débris, as more likely to be found in fresh water than in marine conditions. Peronosporites, so common in the decaying Lepidodendroid wood, and the Urophlyctis-like parasite of Stigmarian rootlets, seem to me to support the fresh-water nature of the swamp; just as the occurrence of the mycorhiza, described by Osborn, in the roots of Cordaites seems to indicate the presence of a peaty substratum for the growth of that plant. Potonié also refers to the occasional occurrence of Myriapoda and fresh-water shells as indicative of the fresh-water origin of at least many of the coal-deposits, and a common feature of the petrified remains of coal-measure plants is the occurrence of the excrements of some wood-boring larvæ in the passages tunnelled by these palæozoic organisms through the wood of various stems.

A strong argument in favour of the brackish nature of these swamps would be supplied by the definite identification of Traquairia or Sporocarpon as Radiolaria, though we must remember that certain marine Cœlenterata find their way up into the Norfolk Broads, and fresh-water Medusæ are by no means unknown in different parts of the tropics. Of course, if the coal-measure swamps were estuarine or originated in fresh-water lagoons near the sea, they may have been liable from time to time to invasions of salt water, sufficient to account for the presence of occasional marine animals, but without constituting a halophytic plant association.

Potonié, who has made so close a study of the formation of coal, and supports the theory of its fresh-water origin, considered for a long time the comparison between the coal-measure swamp and the cypress swamps of North America, as the nearest but at the same time a somewhat remote analogy, more particularly as he believed that the nature of the coal-measure vegetation required a tropical and also a moister climate than obtains in the southern States of North America. Though, in view of the great development of Pteridophytic vegetation in countries like New Zealand, I think Potonié possibly exaggerates the temperature factor, he is probably right in assuming a fairly warm climate for the coal-measure forest. The difficulty, so far, has been to account for the great thickness of humic or peaty deposits which must have accumulated for the formation of our coal-seams, in view of the fact that extensive peat-formation is generally associated with a low temperature. In the tropics, peat may be deposited at high altitudes, where there is low temperature and high rainfall, but it is generally supposed that the rate of decomposition of vegetable remains is so active that lowland peat-formation was out of the question. Dr. Koorders, however, has observed a peat-producing forest in the extensive plain on the east side of Sumatra, about a hundred miles from the coast. This swamp-forest has been recently re-explored at the instance of Prof. Potonié, and he finds it to agree closely with the vegetative peculiarities which he considers must have been presented by the vegetation of the coal-measure forest. A typical "Sumpflachmoor," this highly interesting tropical swamp has produced a deposit of peat amounting in some places to 30 feet in thickness. The peat itself consists mainly of the remains of the Angiospermic vegetation of which the forest is made up, including pollen-grains and occasional fungal filaments; the preservative power, which has enabled this accumulation of débris to take place, being due to the peaty water which is seen above the roots of the bulk of the vegetation. The latter consists mainly of dicotyledonous trees belonging to various natural orders, and they mostly show such special adaptations as breathing roots (pneumatophores) and often buttress roots. With the exception of a tree-fern, Pteridophyta, Liverworts, and Mosses, and, indeed, all herbaceous vegetation, are poorly represented in this swamp, though high up in the branches of the trees there is a fair number of epiphytes, and at the edge of the swamp-forest lianes, belonging particularly to the palms, play an important part in the vegetation. The water, partly on account of its peaty nature, partly owing to the intense shade, is almost devoid of Algæ, and none of these organisms were found in the peat itself. The interesting account given by Potonié of this tropical peat-formation is very suggestive when certain features, as, for example, the absence or relative paucity of certain of the lower groups of plants, such as Algæ and Bryophyta, in the peat, are compared with the plant-remains in some of our coal-seams. Replacing the now dominant Angiosperms by their Pteridophytic representatives in palæozoic times, we have a very close parallel in the two formations.

Another interesting question arises when we consider the great variety of types of vegetation met with among the plant-remains of the coal-seams. For in addition to the limnophilous Calamites and Lepidodendraceæ mentioned above, the coal-balls abound with the remains of representatives of the Filicales, the Pteridospermæ, and the Cordaitaceæ. Were these also members of this swamp vegetation, or have their remains been carried by wind or water from surrounding areas? With regard to some plant-remains, namely, those found exclusively in the roof nodules, the latter was undoubtedly the case; for we have ample evidence, both in their preservation and their mode of occurrence, that they have drifted into the region of the coal-measure swamp after its submergence below the sea. This would apply to such plants as *Tubicaulis Sutcliffii* (Stopes), *Sutcliffa insignis* (Scott), *Cycadoxylon robustum*, and *Poroxylon Sutcliffii*, and other forms, the remains of which have so far not been observed in the coal-seam itself. These plants represent a vegetation of non-aquatic type, and may be taken to have grown on the land areas surrounding the palæozoic swamps. But, on the other hand, we have remains of many non-aquatic plants in the coal-seam itself, closely associated with fragments of typical marsh-plants. How can their juxtaposition be explained?

The advance of our knowledge of ecology points, I think, to a solution of this difficulty. No feature of this fascinating study, which has of late gained so prominent a place in botanical investigation, is more interesting than to trace out the succession of plant associations within the same area, noting the ever-changing conditions which the development of each association brings about. If we follow with Schroeter the gradual development of a lacustrine vegetation from the reed-swamp through the marsh (or Flachmoor) to a peat-moor (Hochmoor), we see how one plant association makes place in its turn for another. May not the mixture of various types of vegetation which we meet with in the petrifactions of our coal-seam represent the transition from the open Calamitean or Lepidodendroid swamp to a fen or marsh with plentiful peat-formation, due to the gradual filling up of the stagnant water with plant-remains? Thus in places, at any rate, a transition from aquatic to more terrestrial types of vegetation would take place, while the tree-like forms rooted in the deeper water would continue to flourish. The coal-measure swamp in this stage would differ from the tropical swamp of Kooders by a more abundant undergrowth of herbaceous and climbing plants, rooted in damp humus and passing off gradually into drier peat. Such an undergrowth of Cryptogamic types, mainly Filicinean or Pteridospermic, would have admirable conditions for luxuriant development, apart from the provision of a suitable substratum for its roots, owing to the narrow xerophytic nature of the foliage on the canopy of the trees under which it grew.

Here, too, we see the explanation of the striking difference between the microphyllous and arborescent Calamites and Lepidodendraceæ, and the large ombrophile foliage of the Filicineæ and Pteridosperms, which spread out their shade-leaves under the cover of marsh xerophytes, in exactly the same way as Prof. Yapp has so admirably depicted for recent plants in his account of the "Stratification in the Vegetation of a Marsh."

The development of a mesophytic vegetation in the shelter of the marsh xerophytes makes it unnecessary to postulate an obscuration of the intense sunlight by vapours, as was done by Unger and Saporta for the Carboniferous period. The assumption of a variety of conditions of plant life within the same area helps materially to clear up the difficulties presented by the somewhat incongruous occurrences met with in the petrified plant-remains. The presence of fragments of Cordaites, mixed with those of Calamites and Lepidodendra, in the coal-balls cannot always be explained either by a drift theory or by conceiving the fragments to be wind-borne; but, given an area of retrogressive peat above the ordinary water-level, even so xerophytic a plant as Cordaites might well establish itself there, its mycorhiza-containing roots being well adapted for growth in drier peat. The curious occurrence of more or less concentric rings in the secondary wood of the stem and roots of Cordaites may represent a response, probably not to annual variations of climate, but to abnormal periods of drought, which would affect the upper-peat layers, but not the water-logged soil in which were rooted the Calamites and Lepidodendra.

If, as I suspect, we had in the peat deposit of the coal-seam a succession of associations, we ought to find its growth and history recorded by the sequence of the plant-remains, very much as Mr. Lewis has discovered with such signal success in our Scottish peat-bogs. That some differences occur in the plant-remains building up a seam can be noted by a microscopic examination of the coal itself, in which, as Mr. Lomax tells me, the spores of Lepidodendra occur in definite bands. But no systematic attempt has as yet been made to investigate from this point of view the seams charged with petrified plant débris. Before the Shore pit, which was reopened last summer through the renewed generosity of Mr. Sutcliffe, was finally closed down, I obtained two series of nodules, ranging from the floor to the roof of the seam, and have had these cut for detailed examination. I should not, however, like to make any generalisation from these isolated series, but intend, during the coming winter, to investigate in the same manner further series taken from large blocks of nodules, which have been removed bodily so as to retain the position they occupied in the seam. Though at present the data are only fragmentary, there seems to be some indication that the plant-remains are not without some relation to their position in the seam. Of course, Stigmarian rootlets are ubiquitous, and in the nodules of the lower part of the seam predominant, but other plant-remains appear to be more frequently found at one level of the seam than another. The problem, however, is very involved, and it has become apparent that it is as important to study the fine débris in which the larger fragments are embedded as the distribution of these latter. Moreover, attention must be paid to the stage of decomposition presented by the particles forming the matrix of the nodule, as this varies in the lower and upper parts of a seam, very much as in a peat-bed we can distinguish the lighter-coloured fibrous peat from the darker layers at the base of a peat-cutting. Mr. Lomax, who has a unique experience of these coal-balls, informs me that he can tell whether a nodule is from the top or bottom of the seam by the lighter or darker colour of the matrix. The importance of applying the methods which have been so successful in elucidating the history of modern peat-deposits to the investigation of the coal-seam will be clearly appreciated both by palæobotanists and ecologists, and this particular problem offers a striking illustration of the interdependence of various branches of botanical investigation. It is fortunate, indeed, that the two fields of work, Palæobotany and Plant Ecology, though they have been subjected to fairly intensive cultivation, have not become exclusively the domain of specialists. The strength and progress of modern Botany have been due to the close collaboration of workers engaged in different branches of botanical science, and the fact that British ecologists have combined to attack a series of the problems from very diverse points of view leads one to hope that, with a continuance of that intimate cooperation which has characterised their work so far, and with the added stimulus of the friendly visit of our distinguished colleagues from abroad, considerable progress may be expected in the future in this branch of botanical study. Privileged as I have been to assist at the deliberations of the British ecologists, without as yet having taken any active part in their work, I feel myself at liberty to point with appreciation to the excellent beginning they have made of a botanical survey of Great Britain and Ireland, as well as to the more detailed investigations of special associations and formations, such as the woodlands, the moorlands, the fens, the broads, salt marshes, and shingle beaches. I am glad to think that our foreign visitors have been able to see these interesting types of vegetation under the guidance of those who have made a special study of these subjects.

The importance to ecologists of an up-to-date critical Flora was dwelt upon by my predecessor in this presidential chair, and this obvious need may be regarded as a further illustration of the inter-relationship of the various aspects of Botanical Science. Though it has been obvious to all that the swing of the pendulum has been for a long time away from pure systematic botany, I am convinced that the great development of plant ecology, of which we have many indications, will not merely lessen the momentum of the swinging pendulum, but will draw the latter back towards a renewed and critical study of the British flora. That a revival of interest in systematic botany will come through the labours of those who are engaged in survey work and other forms of ecological study, is foreshadowed by the fact that Dr. Moss has undertaken to edit a "New British Flora," which will, I believe, largely fulfil the objects put forward by Prof. Trail in his Presidential Address. I trust, however, that in addition to the ecologists, those botanists who are interested in genetics will contribute their share towards the completion of our knowledge of critical species, varieties, and hybrids, all of which offer such intricate problems alike to the systematist and to the student of genetics.

De Vries prefaced his lectures on "Species and Varieties, their Origin by Mutation," with the pregnant sentence: "The origin of species is an object of experimental investigation," and this is equally true of the study of the real and presumptive hybrids of our British flora, which may be investigated either synthetically or, when fertile, also analytically, as in some cases their offspring show striking Mendelian segregation. Some good work has already been accomplished in this direction, but more remains to be done, and we have here an important and useful sphere of work for the energies of many skilled plant-breeders.

I would therefore like to plead for intimate collaboration between all botanists, hopeful that, as progress in the past has come through the labours of men of wide sympathies, so in the future, when studies are bound to become more specialised, there will be no narrowing of interests, but that the various problems which have to be solved will be attacked from all points of view, the morphological, the physiological, the ecological, and the systematic. Thus by united efforts and close cooperation of botanists of all schools and of all countries we shall gain the power to surmount the difficulties with which our science is still confronted.

SUB-SECTION K.

AGRICULTURE.

OPENING ADDRESS BY W. BATESON, M.A., F.R.S., CHAIRMAN OF THE SUB-SECTION.

THE invitation to preside over the Agricultural Sub-section on this occasion naturally gave me great pleasure, but after accepting it I have felt embarrassment in a considerable degree. The motto of the great Society which has been responsible for so much progress in agricultural affairs in this country very clearly expresses the subject of our deliberations in the words "Practice with Science," and to be competent to address you, a man should be well conversant with both. But even if agriculture is allowed to include horticulture, as may perhaps be generally conceded, I am sadly conscious that my special qualifications are much weaker than you have a right to demand of a President.

The aspects of agriculture from which it offers hopeful lines for scientific attack are, in the main, three: Physiological, Pathological, and Genetic. All are closely interrelated, and for successful dealing with the problems of any one of these departments of research, knowledge of the results attained in the others is now almost indispensable. I myself can claim personal acquaintance with the third or genetic group alone, and therefore in considering how science is to be applied to the practical operations of agriculture, I must necessarily choose it as the more special subject of this address. I know very well that wider experience of those other branches of agricultural science or practical agriculture would give to my remarks a weight to which they cannot now pretend.

Before, however, proceeding to these topics of special consideration, I have thought it not unfitting to say something of a more general nature as to the scope of an applied science, such as that to which we here are devoted. We are witnessing a very remarkable outburst of activity in the promotion of science in its application to agriculture. Public bodies distributed throughout this country and our possessions are organising various enterprises with that object. Agricultural research is now everywhere admitted as a proper subject for University support and direction.

With the institution of the Development Grant a national subsidy is provided on a considerable scale in England for the first time.

At such a moment the scope of this applied science and the conditions under which it may most successfully be advanced are prominent matters of consideration in the minds of most of us. We hope great things from these new ventures. We are, however, by no means the first to embark upon them. Many of the other great nations have already made enormous efforts in the same direction. We have their experience for a guide.

Now, it is not in dispute that wherever agricultural science has been properly organised valuable results have been attained, some of very high importance indeed; yet with full appreciation of these achievements, it is possible to ask whether the whole outcome might not have been greater still. In the course of recent years I have come a good deal into contact with those who in various countries are taking part in such work, and I have been struck with the unanimity that they have shown in their comments on the conditions imposed upon them. Those who receive large numbers of agricultural bulletins purporting to give the results of practical trials and researches will, I feel sure, agree with me that with certain notable exceptions they form on the whole dull reading. True they are in many cases written for farmers and growers in special districts, rather than for the general scientific reader, but I have sometimes asked myself whether those farmers get much more out of this literature than I do. I doubt it greatly. Nevertheless, to the production of these things much labour and expense have been devoted. I am sure, and I believe that most of those engaged in these productions themselves feel, that the effort might have been much better applied elsewhere. Work of this unnecessary kind is done, of course, to satisfy a public opinion which is supposed to demand rapid returns for outlay, and to prefer immediate apparent results, however trivial, to the long delay which is the almost inevitable accompaniment of any serious production. For my own part, I much doubt whether in this estimate present public opinion has been rightly gauged. Enlightenment as to the objects, methods, and conditions of scientific research is proceeding at a rapid rate. I am quite sure, for example, that no organisation of agricultural research now to be inaugurated under the Development Commission will be subjected to the conditions laid down in 1887 when the Experimental Stations of the United States were established. For them it is decreed in Sect. 4 of the Act of Establishment:—

"That bulletins or reports of progress shall be published at said stations at least once in three months, one copy of which shall be sent to each newspaper in the States or Territories in which they are respectively located, and to such individuals actually engaged in farming as may request the same and as far as the means of the station will permit."

It would be difficult to draft a condition more unfavourable to the primary purpose of the Act, which was "to conduct original researches or verify experiments on the physiology of plants and animals" with agricultural objects in view. I can scarcely suppose the most prolific discoverer should be invited to deliver himself more than once a year. Not only does such a rule compel premature publication—that nuisance of modern scientific life—but it puts the investigator into a wrong attitude towards his work. He will do best if he forget the public and the newspaper of his State or Territory for long periods, and should only return to them when, after repeated verification, he is quite certain he has something to report.

In this I am sure the best scientific opinion of all countries would be agreed. If it is true that the public really demand continual scraps of results, and cannot trust the investigators to pursue research in a reasonable way, then the public should be plainly given to understand that the time for inaugurating researches in the public's name has not arrived. Men of science have in some degree themselves to blame if the outer world has been in any mistake on these points. It cannot be too widely known that in all sciences, whether pure or applied, research is nearly always a very slow process, uncertain in production and full of disappointments. This is true, even in the new industries, chemical and electrical, for instance, where the whole industry has been built up from the beginning on a basis developed entirely by scientific method and by the accumulation of precise knowledge. Much more must any material advance be slow in the case of an ancient art like agriculture, where practice represents the casual experience of untold ages and accurate investigation is of yesterday. Problems, moreover, relating to unorganised matter are in their nature simpler than those concerned with the properties of living things, a region in which accurate knowledge is more difficult to attain. Here the research of the present day can aspire no higher than to lay the foundation on which the following generations will build. When this is realised it will at once be perceived that both those who are engaged in agricultural research and those who are charged with the supervision and control of these researches must be prepared to exercise a large measure of patience.

The applicable science must be created before it can be applied. It is with the discovery and development of such science that agricultural research will for long enough best occupy its energies. Sometimes, truly, there come moments when a series of obvious improvements in practice can at once be introduced, but this happens only when the penetrative genius of a Pasteur or a Mendel has worked out the way into a new region of knowledge, and returns with a treasure that all can use. Given the knowledge it will soon enough become applied.

I am not advocating work in the clouds. In all that is attempted we must stick near to the facts. Though the methods of research and of thought must be strict and academic, it is in the farm and the garden that they must be applied. If inspiration is to be found anywhere it will be there. The investigator will do well to work

"As if his highest plot
To plant the bergamot."

It is only in the closest familiarity with phenomena that we can attain to that perception of their orderly relations, which is the beginning of discovery.

To the creation of applicable science the very highest gifts and training are well devoted. In a foreign country an eminent man of science was speaking to me of a common friend, and he said that as our friend's qualifications were not of the first rank he would have to join the agricultural side of the university. I have heard remarks of similar disparagement at home. Now, whether from the point of view of agriculture or pure science, I can imagine no policy more stupid and short-sighted.

The man who devotes his life to applied science should be made to feel that he is in the main stream of scientific progress. If he is not, both his work and science at large will suffer. The opportunities of discovery are so few that we cannot afford to miss any, and it is to the man of trained mind who is in contact with the phenomena of a great applied science that such opportunities are most often given. Through his hands pass precious material, the outcome sometimes of years of effort and design. To tell him that he must not pursue that inquiry further because he cannot foresee a direct and immediate application of the knowledge is, I believe almost always, a course detrimental to the real interests of the applied science. I could name specific instances where in other countries thoroughly competent and zealous investigators have by the shortsightedness of superior officials been thus debarred from following to their conclusion researches of great value and novelty.

In this country, where the Development Commission will presumably for many years be the main instigator and controller of agricultural research, the constitution of the Advisory Board, on which Science is largely represented, forms a guarantee that broader counsels will prevail, and it is to be hoped that not merely this inception of the work, but its future administration also, will be guided in the same spirit. So long as a train of inquiry continues to extend, and new knowledge, that most precious commodity, is coming in, the enterprise will not be in vain and it will be usually worth while to pursue it.

The relative value of the different parts of knowledge in their application to industry is almost impossible to estimate, and a line of work should not be abandoned until it leads to a dead end, or is lost in a desert of detail.

We have, not only abroad, but also happily in this country, several private firms engaged in various industries —I may mention especially metallurgy, pharmacy, and brewing—who have set an admirable example in this matter, instituting researches of a costly and elaborate nature, practically unlimited in scope, connected with the subjects of their several activities, conscious that it is only by men in close touch with the operations of the industry that the discoveries can be made, and well assured that they themselves will not go unrewarded.

Let us on our part beware of giving false hopes. We know no hæmony "of sovran use against all enchantments, mildew blast, or damp." Those who are wise among us do not even seek it yet. Why should we not take the farmer and gardener into our fullest confidence and tell them this? I read lately a newspaper interview with a fruit-farmer who was being questioned as to the success of his undertaking, and spoke of the pests and difficulties with which he had had to contend. He was asked whether the Board of Agriculture and the scientific authorities were not able to help him. He replied that they had done what they could, that they had recommended first one thing and then another, and he had formed the opinion that they were only in an experimental stage. He was perfectly right, and he would hardly have been wrong had he said that in these things science is only approaching the experimental stage. This should be notorious. There is nothing to extenuate. To affect otherwise would be unworthy of the dignity of science.

Those who have the means of informing the public mind on the state of agricultural science should make clear that though something can be done to help the practical man already, the chief realisation of the hopes of that science is still very far away, and that it can only be reached by long and strenuous effort, expended in many various directions, most of which must seem to the uninitiated mere profitless wandering. So only will the confidence of the laity be permanently assured towards research.

Nowhere is the need for wide views of our problems more evident than in the study of plant-diseases. Hitherto this side of agriculture and of horticulture, though full of possibilities for the introduction of scientific method, has been examined only in the crudest and most empirical fashion. To name the disease, to burn the affected plants, and to ply the crop with all the sprays and washes in succession ought not to be regarded as the utmost that science can attempt. There is at the present time hardly any comprehensive study of the morbid physiology of plants comparable with that which has been so greatly developed in application to animals. The nature of the resistance to disease characteristic of so many varieties, and the modes by which it may be ensured, offers a most attractive field for research, but it is one in which the advance must be made by the development of pure science, and those who engage in it must be prepared for a long period of labour without ostensible practical results. It has seemed to me that the most likely method of attack is here, as often, an indirect one. We should probably do best if we left the direct and special needs of agriculture for a time out of account, and enlisted the services of pathologists trained in the study of disease as it affects man and animals, a science already developed and far advanced towards success. Such a man, if he were to devote himself to the investigation of the same problems in the case of plants, could, I am convinced, make discoveries which would not merely advance the theory of disease-resistance in general very greatly, but would much promote the invention of rational and successful treatment.

As regards the application of Genetics to practice, the case is not very different. When I go to the Temple Show or to a great exhibition of live stock, my first feeling is one of admiration and deep humility. Where all is so splendidly done and results so imposing are already attained, is it not mere impertinence to suppose that any advice we are able to give is likely to be of value?

But so soon as one enters into conversation with breeders, one finds that almost all have before them some ideal to which they have not yet attained, operations to perform that they would fain do with greater ease and certainty, and that, as a matter of fact, they *are* looking to scientific research as a possible source of the greater knowledge which they require. Can we, without presumption, declare that genetic science is now able to assist these inquirers? In certain selected cases it undoubtedly can—and I will say, moreover, that if the practical men and we students could combine our respective experiences into one head, these cases would already be numerous. On the other hand, it is equally clear that in a great range of examples practice is so far ahead that science can scarcely hope in finite time even to represent what has been done, still less to better the performance. We cannot hope to improve the Southdown sheep for its own districts, to take a second off the trotting record, to increase the flavour of the muscat of Alexandria, or to excel the orange and pink of the rose Juliet. Nothing that we know could have made it easier to produce the Rambler roses, or even to evoke the latest novelties in sweet peas, though it may be claimed that the genetic system of the sweet pea is, as things go, fairly well understood. To do any of these things would require a control of events so lawless and rare that for ages they must probably remain classed as accidents. On the other hand, the modes by which combinations can be made, and by which new forms can be fixed, are through Mendelian analysis and the recent developments of genetic science now reasonably clear, and with that knowledge much of the breeder's work is greatly simplified. This part of the subject is so well understood that I need scarcely do more than allude to it.

A simple and interesting example is furnished by the work which Mr. H. M. Leake is carrying out in the case of cotton in India. The cottons of fine quality grown in India are monopodial in habit, and are consequently late in flowering. In the United Provinces a comparatively early-flowering form is required, as otherwise there is not time for the fruits to ripen. The early varieties are sympodial in habit, and the primary apex does not become a flower. Hitherto no sympodial form with cotton of high quality has existed, but Mr. Leake has now made the combination needed, and has fixed a variety with high-class cotton and the sympodial habit, which is suitable for cultivation in the United Provinces. Until genetic physiology was developed by Mendelian analysis, it is safe to say that a practical achievement of this kind could not have been made with rapidity or certainty. The research was planned on broad lines. In the course of it much light was obtained on the genetics of cotton, and features of interest were discovered which considerably advance our knowledge of heredity in several important respects. This work forms an admirable illustration of that simultaneous progress both towards the solution of a complex physiological problem and also towards the successful attainment of an economic object which should be the constant aim of agricultural research.

Necessarily it follows that such assistance as genetics can at present give is applicable more to the case of plants and animals which can be treated as annuals than to creatures of slower generation. Yet this already is a large area of operations. One of the greatest advances to be claimed for the work is that it should induce raisers of seed crops especially to take more hopeful views of their absolute purification than have hitherto prevailed. It is at present accepted as part of the natural perversity of things that most high-class seed crops must throw "rogues," or that at the best the elimination of these waste plants can only be attained by great labour extended over a vast period of time. Conceivably that view is correct, but no one acquainted with modern genetic science can believe it without most cogent proof. Far more probably we should regard these rogues either as the product of a few definite individuals in the crop, or even as chance impurities brought in by accidental mixture. In either case they can presumably be got rid of. I may even go further and express a doubt whether that degeneration which is vaguely supposed to be attendant on all seed crops is a physiological reality. Degeneration may perhaps affect plants like the potato which are continually multiplied asexually, though the fact has never been proved satisfactorily. Moreover, it is not in question that races of plants taken into unsuitable climates do degenerate rapidly from uncertain causes, but that is quite another matter.

The first question is to determine whether a given rogue has in it any factor which is *dominant* to the corresponding character in the typical plants of the crop. If it has, then we may feel considerable confidence that these rogues have been introduced by accidental mixture. The only alternative, indeed, is cross-fertilisation with some distinct variety possessing the dominant, or crossing within the limits of the typical plants themselves occurring in such a way that complementary factors have been brought together. This last is a comparatively infrequent phenomenon, and need not be considered till more probable hypotheses have been disposed of. If the rogues are first crosses the fact can be immediately proved by sowing their seeds, for segregation will then be evident. For example, a truly round seed is occasionally, though very rarely, found on varieties of pea which have wrinkled seeds. I have three times seen such seeds on my own plants. A few more were kindly given me by Mr. Arthur Sutton, and I have also received a few from M. Philippe de Vilmorin—to both of whom I am indebted for most helpful assistance and advice. Of these abnormal or unexpected seeds some died without germinating, but all which did germinate in due course produced the normal mixture of round and wrinkled, proving that a cross had occurred. Cross-fertilisation in culinary peas is excessively rare, but it is certainly sometimes effected, doubtless by the leaf-cutter bee (Megachile) or a humble-bee visiting flowers in which for some reason the pollen has been inoperative. But in peas crossing is assuredly not the source of the ordinary rogues. These plants have a very peculiar conformation, being tall and straggling, with long internodes, small leaves, and small flowers, which together give them a curious wild look. When one compares them with the typical cultivated plants which have a more luxuriant habit, it seems difficult to suppose that the rogue can really be recessive to such a type. True, we cannot say definitely *a priori* that any one character is dominant to another, but old preconceptions are so strong that without actual evidence we always incline to think of the wilder and more primitive characteristics as dominants. Nevertheless, from such observations as I have been able to make, I cannot find any valid reason for doubting that the rogues are really recessives to the type. One feature in particular is quite inconsistent with the belief that these rogues are in any proper sense degenerative returns to a wild type, for in several examples the rogues have *pointed* pods like the cultivated sorts from which they have presumably been derived. All the more primitive kinds have the dominant stump-ended pod. If the rogues had the stump pods they would fall into the class of dominants, but they have no single quality which can be declared to be certainly dominant to the type, and I see no reason why they may not be actually recessives to it after all. Whether this is the true account or not we shall know for certain next year. Mr. Sutton has given me a quantity of material which we are now investigating at the John Innes Horticultural Institution, and by sowing the seed of a great number of individual plants separately I anticipate that we shall prove the rogue-throwers to be a class apart. The pure types then separately saved should, according to expectation, remain rogue-free, unless further sporting or fresh contamination occurs. If it prove that the long and attenuated rogues are really recessive to the shorter and more robust type, the case will be one of much physiological significance, but I believe a parallel already exists in the case of wheats, for among certain crosses bred by Prof. Biffen, some curious spelt-like plants occurred among the derivatives from such robust wheats as Rivet and Red Fife.

There is another large and important class of cases to which similar considerations apply. I refer to the bolting or running to seed of crops grown as biennials, especially root crops. It has hitherto been universally supposed that the loss due to this cause, amounting in Sugar Beet as it frequently does to five, or even more, *per cent.*, is not preventable. This may prove to be the truth, but I think it is not impossible that the bolters can be wholly, or almost wholly, eliminated by the application of proper breeding methods. In this particular example I know that season and conditions of cultivation count for a good deal in promoting or checking the tendency to run to seed; nevertheless one can scarcely witness the sharp distinction between the annual and biennial forms without suspecting that genetic composition is largely responsible. If it proves to be so, we shall have another remarkable illustration of the direct applicability of knowledge gained from a purely academic source. "Let not him that girdeth on his harness boast himself as he that putteth it off," and I am quite alive to the many obstacles which may lie between the conception of an idea and its realisation. One thing, however, is certain, that we have now the power to formulate rightly the question which the breeder is to put to nature; and this power and the whole apparatus by which he can obtain an answer to his question—in whatever sense that answer may be given—has been derived from experiments designed with the immediate object of investigating that scholastic and seemingly barren problem, "What is a species?" If Mendel's eight years' work had been done in an agricultural school supported by public money, I can imagine much shaking of heads on the County Council governing that institution, and yet it is no longer in dispute that he provided the one bit of solid discovery upon which all breeding practice will henceforth be based.

Everywhere the same need for accurate knowledge is apparent. I suppose horse-breeding is an art which has by the application of common sense and great experience been carried to about as high a point of perfection as any. Yet even here I have seen a mistake made which is obvious to anyone accustomed to analytical breeding. Among a number of stallions provided at great expense to improve the breed of horses in a certain district was one which was shown me as something of a curiosity. This particular animal had been bred by one of the provided stallions out of an indifferent country mare. It had been kept as an unusually good-looking colt, and was now travelling the country as a breeding stallion, under the highest auspices. I thought to myself that if such a practice is sanctioned by breeding acumen and common sense, Science is not, after all, so very ambitious if she aspires to do rather better. The breeder has continually to remind himself that it is not what the animal or plant *looks* that matters, but what it *is*. Analysis has taught us to realise, first, that each animal and plant is a double structure, and next that the appearance may show only half its composition.

With respect to the inheritance of many physiological qualities of divers kinds we have made at least a beginning of knowledge, but there is one class of phenomena as yet almost untouched. This is the miscellaneous group of attributes which are usually measured in terms of size, fertility, yield, and the like. This group of characters has more than common significance to the practical man. Analysis of them can nevertheless only become possible when pure science has progressed far beyond the point yet reached.

I know few lines of pure research more attractive and at the same time more likely to lead to economic results than an investigation of the nature of variation in size of the whole organism or of its parts. By what factors is it caused? By what steps does it proceed? By what limitations is it beset? In illustration of the application of these questions I may refer to a variety of topics that have been lately brought to my notice. In the case of merino sheep

I have been asked by an Australian breeder whether it is possible to combine the optimum length of wool with the optimum fineness and the right degree of crimping. I have to reply that absolutely nothing is yet known for certain as to the physiological factors determining the length or the fineness of wool. The crimping of the fibres is an expression of the fact that each particular hair is curved, and if free and untwisted would form a corkscrew spiral, but as to the genetics of curly hair even in man very little is yet known. But leaving the question of curl on one side, we have, in regard to the length and fineness of wool, a problem which genetic experiment ought to be able to solve. Note that in it, as in almost all problems of the "yield" of any product of farm or garden, two distinct elements are concerned—the one is *size*, and the other is *number*. The length of the hair is determined by the rate of excretion and length of the period of activity of the hair follicles, but the fineness is determined by the number of follicles in unit area. Now analogy is never a safe guide, but I think if we had before us the results of really critical experiments on the genetics of size and number of multiple organs in any animal or even any plant, we might not wholly be at a loss in dealing with this important problem.

A somewhat similar question comes from South Africa. Is it possible to combine the qualities of a strain of ostriches which has extra long plumes with those of another strain which has its plumes extra lustrous? I have not been able fully to satisfy myself upon what the lustre depends, but I incline to think it is an expression of fineness of fibre, which again is probably a consequence of the smallness and increased number of the excreting cells, somewhat as the fineness of wool is a consequence of the increased number and smallness of the excreting follicles.

Again the question arises in regard to flax, how should a strain be bred which shall combine the maximum length with maximum fineness of fibre? The element of number comes in here, not merely with regard to the number of fibres in a stem, but also in two other considerations: first, that the plant should not tiller at the base, and, secondly, that the decussation of the flowering branches should be postponed to the highest possible level.

Now in this problem of the flax, and not impossibly in the others I have named, we have questions which can in all likelihood be solved in a form which will be of general, if not of universal, application to a host of other cognate questions. By good luck the required type of flax may be struck at once, in which case it may be fixed by ordinary Mendelian analysis, but if the problem is investigated by accurate methods on a large scale, the results may show the way into some of those general problems of size and number which make a great part of the fundamental mystery of growth.

I see no reason why these things should remain inscrutable. There is indeed a little light already. We are well acquainted with a few examples in which the genetic behaviour of these properties is fairly definite. We have examples in which, when two varieties differing in number of divisions are crossed, the lower number dominates—or, in other words, that the increased number is a consequence of the removal of a factor which prevents or inhibits particular divisions, so that they do not take place. It is likely that in so far as the increased productivity of a domesticated form as compared with its wild original depends on more frequent division, the increase is due to loss of inhibiting factors. How far may this reasoning be extended? Again, we know that in several plants—peas, sweet peas, Antirrhinum, and certain wheats—a tall variety differs in that respect from a dwarf in possessing one more factor. It would be an extraordinarily valuable addition to knowledge if we could ascertain exactly how this factor operates, how much of its action is due to linear repetition, and how much to actual extension of individual parts. The analysis of the plants of intermediate size has never been properly attempted, but would be full of interest and have innumerable bearings on other cases in animals and plants, some of much economic importance.

That in all such examples the objective phenomena we see are primarily the consequence of the interaction of genetic factors is almost certain. The lay mind is at first disposed, as always, to attribute such distinctions to anything rather than to a specific cause which is invisible. An appeal to differences in conditions—which a moment's reflection shows to be either imaginary or altogether independent—or to those vague influences invoked under the name of Selection, silently postponing any laborious analysis of the nature of the material selected, repels curiosity for a time, and is lifted as a veil before the actual phenomena; and so even critical intelligences may for an indefinite time be satisfied that there is no specific problem to be investigated, in the same facile way that, till a few years ago, we were all content with the belief that malarial fevers could be referred to any damp exhalations in the atmosphere, or that in suppuration the body was discharging its natural humours. In the economics of breeding, a thousand such phenomena are similarly waiting for analysis and reference to their specific causes. What, for instance, is self-sterility? The phenomenon is very widely spread among plants, and is far commoner than most people suppose who have not specially looked for it. Why is it that the pollen of an individual in these plants fails to fertilise the ova of the same individual? Asexual multiplication seems in no way to affect the case. The American experimenters are doubtless right in attributing the failure of large plantations of a single variety of apples or of pears in a high degree to this cause. Sometimes, as Mr. W. O. Backhouse has found in his work on plums at the John Innes Horticultural Institution, the behaviour of the varieties is most definite and specific. He carefully self-fertilised a number of varieties, excluding casual pollination, and found that while some sorts—for example, Victoria, Czar, and Early Transparent—set practically every fruit self-pollinated, others, including several (perhaps all) Greengages, Early Orleans, and Sultan, do not set a single fruit without pollination from some other variety. Dr. Erwin Baur has found indications that self-sterility in Antirrhinum may be a Mendelian recessive, but whether this important suggestion be confirmed or not, the subject is worth the most minute study in all its bearings. The treatment of this problem well illustrates the proper scope of an applied science. The economic value of an exact determination of the empirical facts is obvious, but it should be the ambition of anyone engaging in such a research to penetrate further. If we can grasp the *rationale* of self-sterility we open a new chapter in the study of life. It may contain the solution of the question What is an individual?—no mere metaphysical conundrum, but a physiological problem of fundamental significance.

What, again, is the meaning of that wonderful increase in size or in "yield" which so often follows on a first cross? We are no longer content, as Victorian teleology was, to call it a "beneficial" effect and pass on. The fact has long been known and made use of in breeding stock for the meat market, and of late years the practice has also been introduced in raising table poultry. Mr. G. N. Collins,[1] of the U.S. Department of Agriculture, has recently proposed with much reason that it might be applied in the case of maize. The cross is easy to make on a commercial scale, and the gain in yield is striking, the increase ranging as high as 95 per cent. These figures sound extravagant, but from what I have frequently seen in peas and sweet peas, I am prepared for even greater increase. But what *is* this increase? How much of it is due to change in number of parts, how much to transference of differentiation or homœosis, as I have called it—leaf-buds becoming flower-buds, for instance—and how much to actual increase in size of parts? To answer these questions would be to make an addition to human knowledge of incalculably great significance.

Then we have the further question, How and why does the increase disappear in subsequent generations? The very uniformity of the cross-breds between pure strains must be taken as an indication that the phenomenon is orderly. Its subsidence is probably orderly also. Shull has advocated the most natural view that heterozygosis is the exciting cause, and that with the gradual return to the homozygous state the effects pass off. I quite think this may be a part of the explanation, but I feel difficulties, which need not here be detailed, in accepting this as a complete account. Some of the effect we may probably also attribute to the combination of complementary factors;

[1] Bureau of Plant Industry, Bulletin No. 191, 1910.

but whether heterozygosis, or complementary action, is at work, our experience of cross-breeding in general makes it practically certain that genetic factors of special classes only can have these properties, and no pains should be spared in identifying them. It is not impossible that such identification would throw light on the nature of cell division and of that meristic process by which the repeated organs of living things are constituted, and I have much confidence that in the course of the analysis discoveries will be made bearing directly both on the general theory of heredity and on the practical industry of breeding.

In the application of science to the arts of agriculture, chemistry, the foundation of sciences, very properly and inevitably came first, while breeding remained under the unchallenged control of simple common sense alone. The science of genetics is so young that when we speak of what it also can do we must still for the most part ask for a long credit; but I think that if there is full cooperation between the practical breeder and the scientific experimenter, we shall be able to redeem our bonds at no remotely distant date. In the mysterious properties of the living bodies of plants and animals there is an engine capable of wonders scarcely yet suspected, waiting only for the constructive government of the human mind. Even in the seemingly rigorous tests and trials which have been applied to living material apparently homogeneous, it is not doubtful that error has often come in by reason of the individual genetic heterogeneity of the plants and animals chosen. A batch of fruit trees may be all of the same variety, but the stocks on which the variety was grafted have hitherto been almost always seminally distinct individuals, each with its own powers of luxuriance or restriction, their own root-systems, and properties so diverse that only in experiments on a colossal scale can this diversity be supposed to be levelled down. Even in a closely bred strain of cattle, though all may agree in their "points," there may still be great genetic diversity in powers of assimilation and rapidity of attaining maturity, by which irregularities by no means negligible are introduced. The range of powers which organic variation and genetic composition can confer is so vast as to override great dissimilarities in the conditions of cultivation. This truth is familiar to every raiser and grower, who knows it in the form that the first necessity is for him to get the right breed and the right variety for his work. If he has a wheat of poor yield, no amount of attention to cultivation or manuring will give him a good crop. An animal that is a bad doer will remain so in the finest pasture. All praise and gratitude to the student of the conditions of life, for he can do, and has done, much for agriculture, but the breeder can do even more.

When more than fifteen years ago the proposal to found a school of agriculture in Cambridge was being debated, much was said of the importance of the chemistry of soils, of researches into the physiological value of foodstuffs, and of other matters then already prominent on the scientific horizon. I remember then interpolating with an appeal for some study of the physiology of breeding, which I urged should find a place in the curriculum, and I pointed out that the improvement in the strains of plants and animals had done at least as much—more, I really meant—to advance agriculture than had been accomplished by other means. My advice found little favour, and I was taken to task afterwards by a prominent advocate of the new school for raising a side issue. Breeding was a purely empirical affair. Common sense and selection comprised the whole business, and physiology flew at higher game. I am, nevertheless, happy now to reflect that of the work which is making the Cambridge School of Agriculture a force for progress in the agricultural world the remarkable researches and results of my former colleague, Prof. Biffen, based as they have been on modern discoveries in the pure sciences of breeding, occupy a high and greatly honoured place.

In conclusion, I would sound once more the note with which I began. If we are to progress fast there must be no separation made between pure and applied science. The practical man with his wide knowledge of specific natural facts, and the scientific student ever seeking to find the hard general truths which the diversity of Nature hides—truths out of which any lasting structure of progress must be built—have everything to gain from free interchange of experience and ideas. To ensure this community of purpose those who are engaged in scientific work should continually strive to make their aims and methods known at large, neither exaggerating their confidence nor concealing their misgivings,

> "Till the world is wrought
> To sympathy with hopes and fears it heeded not."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—Dr. Alex. Findlay, special lecturer in physical chemistry, is resigning his post in consequence of his acceptance of the chair of chemistry in the University of Wales at Aberystwyth.

Dr. Murray has resigned his post as assistant lecturer and demonstrator in chemistry, having been appointed head of the chemical and metallurgical department of Wolverhampton Technical School.

BY the will of Dr. S. J. Gee, late physician to St. Bartholomew's Hospital, the sum of about 20,000*l.* is left to his daughter for life, with contingent remainder to the Royal College of Physicians, London, upon trust, so far as possible, to form a permanent endowment fund for the college.

THE winter session of the London (Royal Free Hospital) School of Medicine for Women will be opened on Monday, October 2, with an introductory address by Sir Henry Butlin, P.R.C.S., upon "Research in Medicine and Women in Medical Research." Mrs. Garrett Anderson, president of the school, will occupy the chair.

MR. T. HARRIS, of the Imperial College of Science and Technology, and the Cavendish Laboratory, Cambridge, has been appointed lecturer and demonstrator in the physical department of the East London College in succession to Mr. E. Marsden. Mr. P. Kemp has been appointed lecturer in the electrical engineering department of the same college.

THE exchange of professors between Harvard University and the Ministry of Public Instruction in France comes into effect this winter for the first time, and the Bulletin of the American Geographical Society announces that Prof. W. M. Davis will go to Paris to lecture until the end of March, after the International Congress at Rome has ended. Prof. Diehl, of the Sorbonne, will go to Harvard University to lecture on Byzantine history.

A SPECIAL course of twelve lectures on illumination is to be given at the Polytechnic, Regent Street, during the present session. The lectures, which will be under the supervision of Mr. L. Gaster, editor of *The Illuminating Engineer*, will deal with all illuminants, including recent advances in electric, gas, oil, and acetylene lighting; the effect of light on the eye; the hygienic aspects of illumination; and the measurement of light and illumination. Practical problems, such as the lighting of schools, streets, and factories, will be treated in the second half of the course, commencing in January, 1912. Until December 5 the lectures will be held on Tuesday evenings at 7.30, and during January and February next on Thursday evenings at the same hour.

THE new session in the faculties of arts, laws, science, engineering, and medical sciences at University College, London, will begin on October 2. The list of public introductory lectures at the college contains the following, among others:—Wednesday, October 4, Prof. H. R. Kenwood on "The Scope of School Hygiene and the Legislative Provisions dealing with the School Child," being the first of a course of lectures on school hygiene specially designed for school teachers; Friday, October 6, Prof. G. Dawes Hicks on "Bergson's Conception of Creative Evolution" (this lecture is designed as an introduction to a course of four public university lectures to be delivered by Prof. Henri Bergson at University College on October 20, 21, 27, and 28). A course of public lectures on heating and ventilating engineering will be given by Mr. A. H. Barker, the introductory lecture on Tuesday, October 17, being on "Problems in Heating and Ventilation awaiting Solution by the Engineer." On the same day Mr. E.

Kilburn Scott, the newly appointed lecturer on electrical design, will begin his course on that subject.

A REVISED scheme of examination for inspectorships of mines has just been issued. The appointments are made after a competitive examination of candidates nominated by the Home Secretary. Each candidate must hold a first-class certificate under the Coal Mines Regulation Act, and must, within five years previous to his application, have been employed for two years as manager or under-manager of a coal mine, or in some other responsible capacity requiring regular attendance underground in a coal mine. Practical knowledge and experience of metalliferous mining and quarrying will also be taken into consideration. Candidates must be between twenty-three and thirty-five years of age at the time of examination. The revised subjects of examination are:—(1) English; (2) elementary mathematics; (3) elementary geology; (4) coal mining; (5) ore and stone mining; (6) electricity in mines; (7) law relating to mines and quarries; (8) oral examination; (9) chemistry; (10) physics. The last two are optional. ... ate for the return of the filled-up nomination ... e to the next appointments is October 15. ... plication and full particulars can be obtained ... ivate Secretary, Home Office, London.

... nteenth volume of reports, for the academic year 1909–10, from the universities and university colleges which participate in the annual grant made by Parliament for "University Colleges in Great Britain," and from the three colleges in Wales which receive a grant, has been published as a Blue-book (Cd. 5872). For the financial year 1909–10 the amount of grant paid by the Treasury to university colleges in England was 96,100*l.*, and for the year 1910–11, 101,250*l.* In the year 1909–10, 15,000*l.* was added to the annual grant in aid of university education in Wales. An introduction to the reports signed by the President of the Board of Education enumerates the private benefactions in aid of university education in this country made during the year under review, which have been announced from time to time in these columns. Apart from the recent munificent gifts to Reading University College, these benefactions were not comparable in magnitude or importance with those recorded in the previous report. The introduction goes on to say:—"The small extent to which university work is endowed by private benefaction in this country is emphasised, if comparison is made with the measure of support in other countries. Thus, within a year of its foundation the Kaiser Wilhelm Society for the promotion of science in Germany had at its disposal a capital of half a million sterling, which is being devoted to the equipment of institutes at which men already eminent in their respective subjects will be installed. In France, M. Auguste Lautreuil left 284,000*l.* towards the promotion of science in that country. In the United States Mr. Rockefeller handed over 764,000*l.* to the Rockefeller Institute for Medical Research, which he had previously endowed with large sums. These three instances are sufficient to show how small is the endowment of research in this country as compared with others, and from what a disadvantage this country inevitably suffers in the advancement of learning and research, now more than ever before essential to the welfare and prosperity of the nation."

THE reports referred to in the above note show that nearly 33 per cent. of the income of the English colleges was derived from fees, about 15 per cent. from endowments, a little more than 14·5 per cent. from grants from local education authorities, and 28 per cent. from the Exchequer. In the case of Welsh colleges, nearly 25 per cent. of their total income was derived from fees, nearly 6 per cent. from endowments, 6 per cent. from local education authorities, and 53·5 per cent. from the Exchequer. As a result of an increased Treasury grant the total annual income of the Welsh university colleges rose from 50,000*l.* to about 65,000*l.* The total number of students of all kinds for 1909–10 was returned as 22,187 in England (of whom 8174 were full-time students) and 1710 for Wales. No students taking courses for matriculation have been included amongst the full-time students. The total numbers of degree students in England rose from under 4400 to nearly 4900. In Wales the numbers increased from 1175 to 1191. The number of post-graduate students in the English universities and colleges concerned grew from 1052 to 1255, while in Wales it fell from 45 to 37. The number of part-time students of all kinds in England reached the figure of more than 13,700. Only about 1200 of these were reading for degrees or attending post-graduate courses.

THE new calendar of Armstrong College, Newcastle-upon-Tyne, directs attention to the fact that the faculty of science in the University of Durham is seated entirely at Armstrong College. In addition to pure science the college gives instruction in engineering (mechanical and civil), electrical engineering, mining, metallurgy, naval architecture, and agricultural science. The agricultural department of the college directs the Northumberland County Agricultural Experimental Station at Cockle Park, and the Durham County Station for Dairy Research at Offerton Hall. For the purpose of forestry instruction the college is in possession of 900 acres of wood at Chopwell, in the county of Durham, and its zoological equipment includes a laboratory of marine biology at Cullercoats, on the Northumbrian coast. Amongst prospectuses of technical institutes which have reached us may be mentioned those of the Sir John Cass Technical Institute, Aldgate, and the Northern Polytechnic Institute, Holloway. At the Sir John Cass Institute several new departures are being made. The curriculum of students in the fermentation industries now includes courses on "Brewing and Malting" and the "Micro-Biology of the Fermentation Industries." In the physics department, lectures and demonstrations will be given on "colloids," which will deal with their relation to technical problems. The special courses on liquid, gaseous, and solid fuel in the metallurgy department have also been extended, and will include laboratory work of fuel analysis and on gas analysis. There are also special features in the work of the Northern Polytechnic, and one of importance is the day school of building, which provides a practical course of training for those about to enter any profession or business connected with the construction of buildings, with surveying, or with municipal engineering. The course of work in the school provides instruction in both the principles and processes of building work, and should be of interest to parents who intend to place their sons in the architectural or surveying professions, and to builders whose sons are destined to take a future share in the management of a business.

THE eighth report of the Commissioners for the Exhibition of 1851 to the Home Secretary has been issued as a Blue-book [Cd. 5723]. The last report was published in 1889. The report proper runs to some twenty-six pages, the remaining part of the volume of 132 pages being given over to appendices, which include copies of leases, the charter of the Imperial College of Science and Technology, general regulations, accounts, and so on. Full details are given of the various steps taken by the commissioners to carry out their object of forming a centre at South Kensington for institutions engaged in the promotion of science and art, and more especially in their application to industry. As regards the consideration of future policy, the commissioners say:—"When we became free from the encumbrance of a heavy mortgage debt we were enabled to devote a considerable portion of our income to scholarships for scientific research. The remainder has been invested from time to time, so that we are now in a position to increase the scope of our activities. We have accordingly considered the uses to which we should apply our funds in the immediate future. It is not contemplated to disturb the existing provision of scholarships for purposes of research; but in our opinion a point has been reached when the capital resources of the commission should no longer be applied to assist in the erection of buildings at South Kensington, and when the balance of the income derived from our present funds should be so used as to give a further impetus to scientific and artistic training consistent with the objects of our charter. We believe that our income can be used to great advantage by the provision of scholarships and bursaries endowed, not for all time, but for limited periods, and directed specially to encourage not only research work, but also the training of 'captains of industry.' We shall, moreover, endeavour to include in any extension that we may hereafter devise for our scheme of scholarships some provision for encouraging the study of the fine arts on lines corresponding to those which have proved so efficacious in relation to science and its applications. In such assistance as we may afford from time to time to the solution of problems affecting the industrial welfare of the nation, we shall have regard principally to schemes which from their nature require support from other than ordinary sources."

THE first part of the Board of Education statistics of public education in England and Wales for the school year 1909–10, dealing with educational statistics, has been published (Cd. 5843). In his preface Sir Robert Morant points out that the Board has not for the year under review been able to make any substantial change in the statistics of technical institutions, evening schools, and allied classes. It is hoped, however, that when the proposed new regulations have come into operation, it will be possible to provide a series of tables relating to "further education," in which the various types of schools will be more clearly differentiated than is at present possible. As regards technical institutions—that is to say, institutions giving an organised course of instruction in day classes, including advanced instruction in science, or in science and in art, and provided with a staff and equipment adequate for the purpose and fulfilling other requirements laid down by the Board—there were 35 recognised during the year; and they provided 124 courses in which 736 teachers were employed. The number of students who attended at any time during the year was 2946, and on 2584 of these grants were paid by the Board. Of these 2946 students, 190 were under 16 years of age, 735 under 18 but over 16, 1284 over 18 but under 21 years of age, and 737 were over 21. In addition to these students of technical institutions there are many other students studying science and technology in day technical classes. In a series of tables the Board provides information of 230 courses held in 109 institutions in which day technical classes were recognised, but points out that "the 'day technical classes' to which the following tables relate constitute merely a small fraction of the whole number of day technical classes in existence in England." In the 230 courses mentioned there were 10,924 students taught by 983 teachers.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 4.—M. Armand Gautier in the chair.—Kr. **Birkeland**: The electrical constitution of the sun. A development of views put forward in two earlier communications. The photosphere is regarded as a sea of electric arcs. The bearing of these views on Laplace's nebular hypothesis is discussed, since, if matter is radiated under the action of electrical forces, it is not necessary to assume that at one time the nebula extended to the orbit of Neptune, and this reduces the force of Moulton's objections to Laplace's theory.—M. **Merlin**: Some theorems of arithmetic and an enunciation which contains them. Henri **Villat**: A mixed problem of the theory of harmonic functions in an annular area.—Ed. **Griffon**: A singular case of variation by budding in the peach tree. A description of the appearance of shoots of almond, bearing blossom, on a peach tree.—Marcel **Baudouin**: Human post-mortem actions on the human bones in the bone caves of the polished stone period.—Stanilas **Meunier**: An Egyptian meteorite recently presented to the museum. This meteorite appears to belong to a new lithological type, and will be described in detail in a later communication.

September 11.—M. Armand Gautier in the chair.—Émile **Picard**: An addition to a theorem relating to integral equations of the third species.—Armand **Gautier**: The mechanism of the variation of race, and the molecular transformations which accompany these variations.—A. **Korn**: An important class of asymmetrical nuclei in the theory of integral equations.—Tr. **Lalesco**: Theorem on characteristic values.—L. E. J. **Brouwer**: The theorem of M. Jordan in space of n dimensions.—A. **Blondel**: The various methods of measuring orientation in wireless telegraphy.—C. **Statescu**: Solutions of heterogeneous magnetic salts in a heterogeneous magnetic field.—P. **Mahler** and E. **Goutal**: The use of combustion under pressure for estimating carbon in steel. A modified calorimetric bomb, not enamelled, and having a capacity of 1 litre, has been used for the direct combustion of iron and steel in oxygen under a pressure of 25 atmospheres. The carbon dioxide produced is absorbed in a standard solution of baryta. The method is shown to compare favourably, as regards accuracy, with the usual methods, and has the advantages of rapidity and ease of execution.—Paul **Vuillemin**: Mutation of a hybrid transmitted to its descendants.—E. **Roubaud**: The Chæromyies, a new Diptera with larvæ sucking the blood of mammals.—H. **de Dorlodot** and Ach. **Salée**: The synchronism of the Carboniferous limestone of the Boulonnais with that of Belgium and England.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part ii. for 1911, contains the following memoirs communicated to the society:—

January 14.—C. **Runge**: The radio-activity of air from the open sea.

February 25.—H. **Weyl**: The asymptotic distribution of particular solutions in integral equations.—G. **Angenheister** and C. **Rohloff**: Meteorological observations in the South Seas, from the Samoa Observatory.

March 11.—R. **Gans**: The electron theory of ferro-magnetism, ii.—G. **Tammann**: The alterations in the properties of metals due to mechanical treatment.

The Business Communications of the society, part i. for 1911, contain the ninth report on the publication of Gauss's works, and the tenth report of the Samoa Observatory for 1910–11.

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THURSDAY, SEPTEMBER 28, 1911.

THE STONE AGE IN NORTH AMERICA.

The Stone Age in North America: an Archaeological Encyclopaedia of the Implements, Ornaments, Weapons, Utensils, &c., of the Prehistoric Tribes of North America, with more than three hundred full-page plates and four hundred figures illustrating over four thousand different objects. By W. K. Moorehead. Vol. i., pp. xii+457; vol. ii., pp. vi+417. (London: Constable and Co., Ltd.; Boston and New York: Houghton Mifflin Co., 1911.) Price, 2 vols., 1*l.* 11*s.* 6*d.* net.

MR. MOOREHEAD has produced two handsome volumes amply illustrated. They deal with a subject that has scarcely ever been treated as a whole. Special aspects of the use of stone by the older inhabitants of the American continent have formed the subject of monographs by Wilson, Abbott, Holmes, and others, but no one has ever ventured to deal with the entire field. Mr. Moorehead is an enthusiast for his subject, a condition of mind that inevitably lends a human interest to his book, while, almost as surely, it leads him into sundry exaggerations. He takes up the position of the strongly convinced advocate rather than that of the impartial judge. This attitude is one by no means uncommon in books produced in the United States on subjects depending upon induction and hypothesis, rather than upon observed facts. Nor is the attitude unknown in Europe; but the conditions differ in an important manner. On this side the literature of our prehistoric periods is already fifty years old; certain facts and a definite terminology have been generally accepted; the main grouping is again an accepted fact, and the result is that, to write intelligibly, the author of a new treatise is compelled to subscribe to these conditions. The common terminology may be right or wrong; it may, and often does, beg the question, but the system is practical, inasmuch as it enables the writer to state his arguments and the reader to understand them, without pausing to disentangle the meaning of the terms in which they are stated. The book can thus be read without impatience, and it may be with profit.

Now one of the perplexing features of the productions of the Stone ages is the marvellous similarity in form of the implements from the most widely separated districts. This is, of course, a commonplace, for everyone knows that, *e.g.*, implements from South Africa, from the laterite beds of Madras, and, say, from Trenton, New Jersey, differ only in the material of which they are made. In the later neolithic times, such similarities are perhaps even more marked, and, in some ways, more astonishing, though, at the same time, each country has its characteristic forms.

This being the case, surely it would be wisdom, and tend to the elucidation of the problems of early man, if the writers of new treatises would endeavour to make their local discoveries fall into line with the scheme already accepted in Europe—if they would master and adopt the classification to be found in the text-books of the subject. It is not claimed for a moment that the scheme or the classification is perfect, or even that it is the last word, but only that it exists, and is generally adopted, while in addition, it is the considered judgment of a great number of men who have given their lives to the study. Mr. Moorehead and his committee, who five years ago undertook the classification on which his book is founded, do not appear to have given any thought to this aspect of the question, and have treated North America as archæologically independent of the rest of the ancient world. From one point of view they are certainly justified. In the United States the Stone age was in existence so recently that both the methods of manufacture and the purpose of many stone implements are matters of fact. Here the field is their own, and they need no external help, but in the main we have no hesitation in saying that conformity with European scholars would have been better.

While we have thought it desirable to formulate this objection to Mr. Moorehead's method, we can commend the matter of his book. It is called an encyclopædia, and the term is not inaccurate, for it comprehends practically all the types of later stone tools found in Northern America. Its intention is to supplement the very remarkable "Handbook of American Indians," published by the Smithsonian Institution in 1907. This work, reasonably enough, did not treat the Stone age as a special subject, and hence the complement now before us was produced. One cannot but regret that no place has been found in these volumes for a complete statement of the evidence as to the discoveries of Mr. Abbott at Trenton, New Jersey. Controversy raged fiercely at the time, and weighty opinions were to be found on both sides. A book with this title should certainly have dealt with the matter.

It may appear surprising to us that the discoveries in the mounds of America, of stone implements, pottery, and the like, are disclaimed by the existing Indians, though a comparison of the relics with those in use by the Indians until late years shows them to be very similar.

Such disclaimers are, however, common enough among primitive peoples. The negroes of West Africa will have nothing to say to the stone implements and images dug up in their plantations. It is probable enough that even if one or the other possessed either history or trustworthy tradition, they would equally disclaim any knowledge of the remains. In Africa the pressure of a superior civilisation from the East and North has produced a constant shifting of the tribes during, say, the last two thousand years. During the same period, or even less, economic and other causes must have created something like a nomadic condition in North America. For these reasons it might well be that the existing tribes on a particular spot would know nothing of the origin of the ancient burial places among which they lived.

One feature in connection with North American stone implements that is clearly brought out in Mr. Moorehead's illustrations is the astonishing likeness between some of them and others from Mexico. On p. 93 of vol. i. may be seen a group from Kentucky showing this similarity very strongly. The likeness would not seem to be due to utilitarian causes, but rather to an artistic tradition. This is interesting in itself, but it also has a bearing on another point, perhaps even more interesting. On p. 162 of vol. i. is a curious group of chipped implements, some of them in the form of human profiles, while others are axes with curved sides expanding to a crescent-shaped cutting edge. It is well known that in passing from the use of stone to that of metal (often copper) the earliest metal axes are accurate copies of the stone type. Experience soon showed that hammering of the copper edge not only sharpened it, but, very naturally, widened it also, so that the natural result of the process was to produce a rounded cutting edge, with a curve from its two sides towards the butt. This resulting form, being at once more practical and more elegant, in turn became the type of copper or bronze axe.

These two facts, the presence of Mexican stone types, as well as types founded on a cast-metal prototype, in American Indian settlements, may well lead one to consider whether both one and the other had an origin further south than the United States. It may be contended that copper implements are common enough in the United States, and that there is no need to look further. But it is not of so much importance that the prototype should be of metal; it is that it should be of *cast* metal.

These are some of the many questions that are raised by the perusal of Mr. Moorehead's elaborate work. We can congratulate him on its encyclopædic character, a useful feature. The amount of material is amazing, and the exquisite implements from Tennessee in the Missouri Historical Society's museum will be a surprise to most people on this side. We could have wished that he had placed his figures somewhat nearer the text relating to them, and that his index had been a little better.

THE VULCANICITY OF OUR EARTH.

Die vulkanischen Erscheinungen der Erde. By Dr. K. Schneider. Pp. viii+272. (Berlin: Gebrüder Borntraeger, 1911.) Price 12 marks.

DR. SCHNEIDER opens his work by reference to what is found in many books on vulcanology and geology, namely, the part played by volcanic activities in the economy of nature. In consequence of volcanic action minerals of high specific gravity are brought to the surface, the contours between land and water may be changed, and new islands may be created. Since Tertiary times 3·96 mill. km.^{2} of land surfaces have been covered by volcanic ejecta. These accumulations have altered relative altitudes, on which climate, plant life, and other things depend. Valleys have been blocked, lakes formed, and river courses have been changed. At the time of an eruption a variety of gases and chemical products are brought to the surface, and many mineral deposits are closely associated with volcanic action. Although in many ways volcanoes have been beneficial to humanity, in their immediate vicinity they have been frequently associated with the loss of life and property. Volcanic explosions have excited the imagination, given rise to myths concerning subterranean deities or monsters, and indirectly have had an effect on literature and art.

At present we are told that on the surface of our world there is one active volcano to 1420475·5km.^{2}

We can regard volcanoes from a geographical, petrographical, chemical, and other points of view, and what has been done in each of these directions is briefly reviewed. The notes relating to the temperatures of lava and the average depth at which a rapid change might be expected in materials similar to those we meet with on the surface of our earth might easily have been extended.

Dr. Schneider's classification of volcanoes depends on their forms, and of these there are seven types. The names given to these types were quite as startling to me as was the word anhydrohepsepterion when I first heard it. It turned out to be a saucepan in which you can cook potatoes without water.

Pedioniten are fissure outflows like the Deccan Traps. *Aspiten* are characterised by the relationship of their height to an extended base, as, for example, Mauna-Loa. *Tholoiden* refer to forms with a gentle sloping base which runs inland from a coast and then suddenly rises with convex flanks to a rounded summit. *Beloniten* are illustrated by the needle-like peak of Mount Pelée. *Koniden*: these are mountains the flanks of which are convex-concave. A slight reference is made to this logarithmic curvature of volcanic profile which was first noticed in connection with Mount Fuji, but the lesson it teaches respecting the height of a mountain and the area of its base in relation to the material out of which it is formed, has apparently escaped notice. The relation of form to the size of ejectamenta, friction, wind, and the character of an eruption has not been overlooked. *Homaten*. In these the slope rises directly from the coast to the summit as in Hverfjell in Iceland. *Maare*. Here the volcanic neck has risen to the surface, clastic material has been spread widecast, and flat hollows have been created similiar to those in the crater lakes in the Eifel. Each of these types can also be found in the moon, and on our earth consists of materials with different physical structures. *Rheumatitische* material is that which flows like lava. The other materials may be clastic like lapilli and ash, gaseous and aqueous. Tertiary volcanoes are characterised by the prevalence of materials first referred to, whilst the materials of recent volcanoes are more clastic.

A chapter of considerable interest to geologists is one which gives an outline of voeanic action in Europe since Tertiary times. This, however, does not entirely overlook the vulcanicity which took place in earlier periods. The number of active volcanoes in the world during the Diluvium-alluvium period is estimated at 1081, whilst during historical times only 201 can be counted. These latter are grouped along great lines of dislocation in the larger features of the earth's crust. They do not occur in rows, but in relatively small zones. These are two out of eight laws formulated in connection with the geographical distribution of volcanoes, which is illustrated by numerous maps. The volume concludes with a catalogue of 367 volcanoes which have been active during historical times. This number, it will be observed, does not correspond with the one just given. Although we observe certain lacunæ in this catalogue, it is a very useful compilation for those interested in vulcanology.

Although geologists may object to Dr. Schneider's new terminology, they must not overlook the fact that they themselves have had many christening parties. Some thirty or forty years ago a distinguished president of the Geological Society, when he first heard of Belenites—a word not unlike Beloniten—interrupted the speaker by the remark, "Tut! tut! Belemnites in volcanic rocks indeed!" If we say nothing about the new language, then Dr. Schneider is to be congratulated on his work. JOHN MILNE.

BIOMETRICAL METHODS FOR PSYCHOLOGISTS.

The Essentials of Mental Measurement. By Dr. Wm. Brown. Pp. vii+154. (Cambridge: University Press, 1911.) Price 3*s*. 6*d*. net.

THIS volume is based on a research "devised for the purpose of determining to what extent correlation exists between certain very simple mental abilities, in cases where the individuals experimented on are, as near as may be, identically situated with respect to previous practice, general training, and environment; and how closely, if at all, these elementary abilities are related to general intellectual ability as measured by teachers' judgments, school marks, &c."

The groups of individuals tested were homogeneous as far as possible, and were selected from a London elementary school, a London higher grade school, from among women students of a training college, and men and women university students. The tests employed were fourteen in number. In two of them the subject was required to cross out as quickly and accurately as possible on a printed page certain letters (e and r in one case, and a, n, o, s in the other), in a third all the letters were to be crossed out. Speed and accuracy in the addition of single digits were measured in a fourth; while in the fifth, sixth, and seventh the ability to estimate the relative lengths of printed lines was tested in different ways, including conditions under which illusions are known to be produced. The power of memorising poetry and strings of nonsense syllables were examined in the eighth and ninth, while the tenth test was the *combinations methode* of Ebbinghaus. In this "the subject is shown a passage of continuous prose with one-third to one-quarter of the words replaced by blanks, and is asked to supply the missing word or words of similar significance." The eleventh and twelfth were marks obtained in the ordinary school curriculum for drawing, and the total school marks; in the thirteenth general intelligence was graded by the independent estimates of two different teachers, which were found to be very closely correlated together. In the fourteenth association time was measured by counting the number of words associated with a given word which the subject could write down in a given time.

The majority, but not all the tests, were applied throughout each of the six groups, and the statistical treatment of the records is very complete and satisfactory. The results for each group were, of course, kept distinct, and correlation coefficients were calculated between the result of each test and the result of each of the others, while to estimate the trustworthiness of each the correlation between the results of two separate applications of the test on each subject was measured. In addition to this, certain groups of tests were taken and the partial correlation coefficients calculated, *i.e.* the correlation between any two members of a group for constant values of the remaining members. As the probable errors are given for all the coefficients calculated, comparisons between them can be satisfactorily made.

Limitations of space forbid us from giving an account of all the conclusions drawn by the author, but two at least can be stated very simply and are worthy of note; firstly, that the *combinations methode* of Ebbinghaus is a good measure of mental ability. It correlates with "general intelligence" almost as clearly as "scholastic intelligence" (school marks) "does"; and secondly, mechanical memory, *i.e.* the power of memorising a number of nonsense syllables, is also fairly closely correlated with general intelligence. This research was published in the British Journal of Psychology for October, 1910. Together with the chapters which appear in this volume on the mathematical theory of correlation and on the history of the use of the theory in psychology, it formed a thesis approved for the degree of doctor of science in the University of London. The thesis, with chapters added on mental measurement, psycho-physical methods, and on the significance of correlation in psychology, constitutes the bulk of the present volume. Its object appears to be not so much to instruct the beginner in psychology on the best way of measuring psychical characters, but to introduce the professed psychologist to the biometrical methods of Prof. Karl Pearson and his school. The author shows a considerable grasp of the subject, and does not perhaps realise the difficulties of less mathematically minded people than himself. Thus the chapter on the mathematical theory of correlation, if intended for an introduction to the subject, could well have been expanded, rendered more elementary, and more amply provided with examples. It is by examples rather than by precept that people who are confused by algebraical symbols are able to learn to use the methods. Those who can readily follow the notation will find the book profitable to read and useful for reference, particularly as a good bibliography is appended. E. H. J. S.

ELECTRIC CRANES.

Electric Crane Construction. By Claude W. Hill. Pp. xx+313. (London: C. Griffin and Co., Ltd., 1911.) Price 25*s*. net.

A LARGE measure of flexibility in the supply of power is an essential feature in all hoisting machinery. Not only must the point from which the load is suspended be capable of movement in different directions, but the whole machine must be able to travel, and these requirements render electricity a particularly well-adapted agent for the working of such machinery. A modern book on cranes becomes thus quite naturally a book on electric cranes.

Mr. Hill's work is a thoroughly practical treatise on electric crane construction. The subject is so complicated and so many-sided that any attempt to treat it in a general way must be unsatisfactory, and the author has wisely decided to represent his subject rather by means of well-chosen examples of successful work than by a general treatise. The importance of scientific principles is, however, not overlooked; interleaved with the descriptive matter we find the necessary calculations as to stresses, stability, power required, action of brakes, and other matters capable of scientific treatment. The examples chosen comprise various forms of overhead travelling cranes, locomotive and portable jib cranes, derricks, sheer legs, transporters, revolving cantilever cranes, and cableways. Then follows a chapter on the power required for crane driving. From tests quoted by the author, it appears that the efficiency in many cases is remarkably high, reaching nearly 70 per cent.

In discussing starting torque and acceleration, the author also quotes from practical experience for hoisting, lowering, travelling, and slewing. Chapter x. deals with the design of crane structures. Here we find discussed the strength of struts, both on the basis of Euler's and Rankine's formulæ, the strength of lattice girders and various types of beams generally, the construction of cantilevers and cognate matters, all exemplified by very full diagrams and working drawings.

The following three chapters deal with design of machinery, frames, bearings, axles, and drums, brakes and toothed gear. Especially the last-named subject is very fully treated, including the question of permissible wear and the use of worm-gearing. Most readers will be surprised at the high efficiency obtained by this mode of driving, when the worm runs in an oil bath. The explanation given by the author is that metallic contact between the teeth does not take place, since the film of oil between the surfaces is not squeezed out even at very heavy pressure. This has also been the experience of motor-car designers who find for worm-drive efficiencies well above 90 per cent.

After a short chapter on hooks, ropes, and chains, we come to the electric and magnetic details beginning with the design of magnets. It is to be regretted that the author has adopted the hybrid system of units where induction is given as so many c.g.s. lines per square inch. In working with such a system one loses completely the connection with first principles, and the solution of any problem becomes simply a matter of blindly applying certain formulæ. As regards motors, the author deals very fully with the question of rating as influenced by the intermittent service, and he shows that crane motors should, as regards mechanical strength and commutation, be designed for the full load, but as regards heating for a very much reduced load. Only D.C. motors are discussed, the author holding that A.C. motors are unsuitable for crane work. This is perhaps too sweeping a condemnation. In many docks on the Continent polyphase motors are used, and with the advent of the A.C. commutator motor there is given every facility for using alternating current where no continuous current is available, and the author's recommendation of installing a converter for the power supply to the cranes becomes a useless complication.

A table on p. 302, giving from practical experience the annual working cost of seven different cranes, is very interesting. It shows that the cost of power taken at 1·5*d.* per unit is negligibly small. It amounts in the worst case to only 1·3 per cent. of the total cost, and in most cases it is about 1 per cent. Thus, with current purchased even at the usual lighting rate of about 4*d.* per unit, the cost of power is quite insignificant. This is due to the fact that the load factor of a crane is exceedingly small. The total energy given off by all the crane motors per annum only represents full output over about twenty to seventy hours per annum. The annual cost is almost entirely made up by interest, depreciation, and repairs, and the problem to be solved by the designer of cranes is not so much the saving of current as the production of a cheap and robust design.

GISBERT KAPP.

MORPHOLOGY OF THE VERTEBRATES.

Éléments de Morphologie des Vertébrés. Anatomie et Embryologie Comparées, Paléontologie et Classification. By Prof. L. Vialleton. Pp. xiv+790. (Paris: Octave Doin et Fils, 1911.) Price 18 francs.

THIS is an interesting and thoughtful introduction to the morphology of the vertebrata, very clearly written, well illustrated, and with several distinctive features. The author thinks, probably with justice, that the vertebrata are better subjects than the invertebrates for the illustration of morphological principles. Their structure is more thoroughly known and its relations to the conditions of life are more certain; the development of the chief types has been worked out in its main features; and we have, on the whole, more information in regard to the past history. Filiation is clearer among vertebrata than among invertebrates. For learning the lessons of morphology it is better to begin with one phylum than with many, and the most educationally profitable phylum is that with which students are likely to be most familiar—the vertebrata.

The plan of the book is as follows. After an introduction dealing with general concepts such as homology, the author devotes the first part to general embryology—the germinal layers, the early primordia, and the fundamental architecture of head and trunk and limbs. The second part deals seriatim with all the systems and organs, from the skin to the gonads, treating everything comparatively and embryologically. It is all very clear and careful, but in a book of the dimensions of this one we look for rather more criticism. To take but a single instance, we think Vialleton's conventional account of the pectoral skeleton of the Monotreme, with its episternum and absence of procoracoids, might have been improved without risk of dogmatism. We may notice here that there is a carefully selected bibliography at the end of each chapter, and that the references are punctiliously accurate.

The third part of the book gives a systematic account of the whole phylum of vertebrates, and takes due notice of the extinct forms. There are many interesting detailed expressions of the author's judgment, *e.g.* his treatment of the Ratitæ as a heterogeneous group derivable from at least three stocks, or his reuniting of Marsupials with Eutheria; but the outstanding feature in this section is to be found in the numerous carefully drawn up schemata showing distribution in time and probable affinities. There are twenty of these, condensing much reflection.

In the concluding section of his book, Prof. Vialleton deals analytically with the problem of the evolution of vertebrates. He discusses the origin of organs, and makes much of Kleinenberg's theory of substitution; he distinguishes between well-established genetic series and morphological series (so often mixed up together, *e.g.* in connection with the evolution of Equidæ); he recognises the importance of paying more attention to the phenomena of convergence; he gives an admirable discussion of correlation and of vestigial organs. Passing to the actual data bearing on the phylogeny of vertebrates, he marshals the palæontological facts in a masterly way, and discusses such points as the successive appearance of classes, the occurrence of generalised types and transitional types, the absence of the latter at phyletic bifurcations, the extinction of types, and the indubitable progress from age to age. Turning to embryological data we find an admirable critical discussion of the recapitulation doctrine, of which there is little left when the author has done. We cannot help feeling, however, that there is sure to be a rebound in a few years to some subtler rehabilitation of Haeckel's famous biogenetic law. The author believes in a good deal of polyphyletism, and he confesses himself a mutationist: *transformist* theories do not please him: "C'est l'évolution avec ses brusqueries et ses divergences qui constitue la réalité."

THE PRINCIPLE OF RELATIVITY.

Das Relativitätsprinzip. By Dr. M. Laue. Pp. x+208. (Braunschweig: F. Vieweg und Sohn, 1911.) Price 6.50 marks.

IT is almost impossible nowadays to glance through a journal containing original papers in physics without coming across something relating to the Principle of Relativity. This principle is an extension of that Newtonian relativity which enables us to treat machines on a moving earth as if they were at rest. The new extension covers the phenomena of optics, heat, and electromagnetism. It is sometimes called the electromagnetic principle of relativity, but as it contains also a mechanical principle it has now become usual to term it simply the Principle of Relativity. It asserts that physical phenomena generally do not depend upon rectilinear uniform translation through space; that, for instance, the optical isotropy of space is not affected by motion through it; that the velocity of light is the same in all directions and independent of displacement; and that it is therefore impossible to discover, say, the earth's motion of translation by any optical, electrical, or mechanical device. In fact, it is based upon the negative result of the Michelson-Morley experiment, and all other attempts to discover "æther-drift."

Einstein, who founded the modern relativity theory in 1905, based his arguments upon the impossibility of establishing an absolute time-scale, either as regards rate or as regards epoch, so long as the utmost limit of rapidity of signalling is imposed by the finite velocity of light. He showed how this limitation affects all measurements of length and time whenever the relative velocity dealt with approaches the velocity of light. The clocks in a moving system, synchronised by light signals, necessarily have a slower rate than those in a system at rest, in the ratio $\sqrt{1-\frac{v^2}{c^2}}:1$, where v is the relative velocity and c the velocity of light, and this applies whichever of two systems is regarded as being at rest. There is, in fact, no "absolute" time-scale.

Many conclusions from this principle appear far-fetched, even fantastic. Thus, not only electrons, but all matter possesses an infinite "mass" when moving with the velocity of light; mass is identical with latent energy; two particles projected in opposite directions with the velocity of light have a "relative" velocity which simply equals the velocity of light, and so on. In spite of such apparent absurdities, the Principle of Relativity has made what is no less than a triumphal march through the world's physical publications.

Dr. Laue's work comes, therefore, as a welcome contribution to what has become a matter of very living interest. He goes fully into the negative results of Michelson, Trouton, Brace, Rayleigh, and others, the positive results of Wilson, Rowland, Eichenwald, Lebedew, Poynting (misspelt "Pointing"), and Fizeau, and the theoretical work of Lorentz, Einstein, and Minkowski. He shows that there is no physical evidence against the principle, and that it has the advantage over other systems of accounting for the absence of æther-drift. In the analytical work, a vector algebra on the basis of Heaviside's notation is used, but it is made, after Minkowski's example, four-dimensional. A brief summary of operations with these "world-vectors" is of great assistance to the reader.

E. E. F.

OUR BOOK SHELF.

The Principles of Electric Wave Telegraphy and Telephony. By Prof. J. A. Fleming, F.R.S. Second edition (revised and extended). Pp. xx+906. (London: Longmans, Green and Co., 1910.) Price 28s. net.

WHEN reviewing the first edition of Prof. Fleming's book five years ago we pointed out that it filled to perfection the want for a thorough and exhaustive treatise on the subject of wireless telegraphy, and was sure of a warm welcome on that account. Since then the volume has been twice reprinted, and now there is issued a new edition largely rewritten and considerably improved. The rapid progress in electric wave signalling is indicated even in the title, which is now so worded as to cover the subject of Hertzian telephony, at the time of the first edition so much in its infancy as not to be worthy of inclusion. To this subject Prof. Fleming now devotes a short final chapter, in which he reviews briefly the special difficulties in transmission and summarises the present position. (In the last paragraph, by an obvious oversight, telegraphy is written in place of telephony.)

Much of the volume has had to be revised on account of the progress which has been made in all directions. The author has acted wisely in curtailing the historical portions and devoting himself mainly to the explanation of the scientific principles on which the art of wireless telegraphy is based, and on which the numerous instruments now used are founded. The purely historical side of wireless telegraphy is now more or less a matter of the past: it has entered into a period of development which if less sensational is of more benefit to mankind. From the more or less crude empirical art of ten years ago wireless telegraphy is now firmly based on a solid scientific foundation, exact methods of measurement have been developed, and steady progress, not less rapid because of its steadiness, is possible. Prof. Fleming's book still deserves to rank as the best existing treatise on the subject, at any rate in the English language, and if the same industry is shown in the future in keeping it up to date it should continue for long to hold this premier position.

M. S.

Die Anwendung der stereographischen Projektion bei kristallographischen Untersuchungen. By Prof. H. E. Boeke. Pp. viii+58+plate. (Berlin: Gebrüder Borntraeger, 1911.) Price 2.60 marks.

THE stereographic is the form of plane projection of the sphere ordinarily in use in crystallographic work, and during recent years it has come much into vogue, not merely for showing the zonal relations subsisting between the poles corresponding to the faces of a crystal, but also as a means of checking the accuracy of the calculations involved in the goniometric measurement of a crystal. Accordingly, various methods by means of nets or protractors have been devised to facilitate the use of the projection, many of which have scarcely yet found their way into the text-books. Penfield provided for English readers in a series of brilliant papers that appeared in *The American Journal of Science* a clear and concise account of the best and most practicable methods, and, moreover, designed various diagrams to aid the student in plotting the positions of the poles.

In the present volume Prof. Boeke aims at providing similar privileges for German readers. He gives a clear account of the properties of the projection, and discusses at some length its use as an aid in computation in the case of the several kinds of systems of crystalline symmetry, both geometrical and graphical proofs being given of the fundamental propositions. The application of the projection to crystal drawing and the determination of the optical characters are also explained. A pocket in the cover contains one of Prof. Wulff's stereographic nets, which are graduated in distance and azimuth referred to a pole in the equatorial zone for every other degree, the size of the sphere being the same as that selected by Penfield, viz. 14 cm.

The book is one that may be commended for the use of students of crystallography, but it might advantageously have included an adequate description of the properties and use of the gnomonic projection which at present is merely alluded to in a brief paragraph, even though some slight alteration of the title would have been involved.

Quaternions as the Result of Algebraic Operations. By Dr. A. L. Baker. Pp. ix+92. (London: Constable and Co., Ltd., 1911.) Price 6s. net.

IN this book the author establishes the principles of quaternions by the use of the six operations addition, subtraction, multiplication, division, reversion, and mean reversion. By the introduction of reversion, we pass from arithmetic to algebra. Complex functions depend on the recognition of mean reversion, the operands still being scalars; and when the operands are scalars and vectors, the method becomes generalised into quaternions.

The key of the argument is the conception of *mean reversion*, that operation which twice repeated reverses the quantity operated on. There is nothing new in this, but Dr. Baker applies the conception in an unusual way to the representation of a scalar as a sphere in space, which, as possessing perfect symmetry and therefore devoid of direction in space, is the only available ideographic symbol for a scalar. He finds that a mean reversed scalar is represented in all its properties by a directed magnitude in space, that is, by a vector. The algebraic representation of mean reversal is, of course, $\sqrt{-1}$, leading to the usual Argand diagram; and the same idea enters into the constitution of any vector. The argument that $ii=-1$ may be accepted as sufficiently sound; but it may be doubted if the rule for the product of perpendicular vectors, viz. $ij=k$, &c., can be rigorously deduced on the assumption that the operation of a vector α upon a perpendicular vector β must be the same in kind, but as far removed in detail from that which would have been used had β been parallel to α. We certainly prefer Hamilton's own somewhat metaphysical argument.

It is clear that Dr. Baker has no regard for the views of those self-styled purists who deny that a vector can have versor properties. Having established the well-known i, j, k rules, he develops in a satisfactory manner the important properties of quaternions, and ends his discussion by a useful account of the linear vector function. Students new to the method will probably find the argument in the earlier chapters difficult to follow; thereafter all is plain sailing.

C. G. K.

Lessons on Soil. By Dr. E. J. Russell. Pp. xv+132. (Cambridge University Press, 1911.) Price 1s. 6d.

A COURSE of lessons on soil provides an essential sequence to the formation of school gardens if it is desired to make the best use of the latter. Teachers contemplating such a course are strongly recommended to consult this excellent primer, in which Dr. Russell presents a series of lessons evolved from practical classes conducted for children in the higher standards at an elementary school and in an intermediate form at a secondary school. The earlier chapters contain simple experiments for observing the properties of clay, sand, and other soil constituents; pot cultures are introduced to compare the food value of soil and subsoil, as also the action of water in soils; methods are described for detecting the presence of soil organisms and for demonstrating the advantages of hoeing. Finally, the practical bearing of the lessons, which it should be noted are confined to soil physics, is indicated, not only with reference to agriculture, but also as they serve to explain the aspects of the countryside and other natural features such as the connection between stream, ford, and village. The primer is not only practical and informative, but is designed to arouse the inquiring instinct. It is the first volume of a new series contemplated by the Syndics of the Cambridge University Press.

LETTERS TO THE EDITOR.

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

The "Earthquake House" at Comrie.

I RECENTLY visited the "Earthquake House" at Comrie, and was sorry to find that, in the matter of repairs, it had been neglected for a long time, and was in a very dilapidated condition.

It may be remembered that this small building was erected in 1872, through the combined efforts of the British Association and Mr. Drummond, for the purpose of carrying on observations on the, then, frequent manifestations of seismic activity experienced in that district, and I believe the investigations made there, with the simple apparatus and methods employed, represent some of the earlier attempts to obtain definite data respecting the direction, duration, and intensity of seismic vibrations. From these and other early observations, I suppose, the modern science of experimental seismology has been evolved, and for this reason the building should always be regarded as of great scientific and historical interest, and its preservation a matter of common desire. Though the original wooden pins which were used have disappeared, some of the white sand that was placed on the floor some forty years ago is still to be seen there.

Mr. J. J. Macdonald, of the Commercial Bank, Comrie, has most kindly associated himself with me in an endeavour to obtain permission to place this property in the hands of a committee, and to raise funds for the purpose of protecting it and putting it in a proper state of repair. We propose to fence it in so that it may be preserved from the depredations of children and others (who now have free access to it) for all time.

Without now entering into the details of the trouble and correspondence our negotiations have entailed, I may say that the owner has kindly given us full permission to take such steps as may be necessary for the restoration and protection of the building, and that we hope to place it, as far as possible, in its original condition without delay.

An estimate has been submitted to us, and the sum required to carry out all the necessary work is about 30*l*.

May I ask those of your readers who are interested in this matter to subscribe towards this sum? Mr. Macdonald has kindly consented to act as treasurer, and all donations should be sent to him without delay. The names of those forming the committee, a list of subscribers, and the details of the work done, will be published later.

CECIL CARUS-WILSON.

Preston Vicarage, Faversham, September 11.

The Upper Trade-winds.

RECENTLY Herr Peppler[1] directed attention to the fact that the air-pressure gradient from the equator towards the subtropical zones, which is positive at the heights at which the anti-trade-winds blow, must be negative in still higher layers (±20 km.).

Owing to the low temperature of the stratosphere above the equator, the mean temperature of the whole air-column up to these heights is lower above the equator than above the subtropical zones, and Herr Peppler accordingly supposes that the air pressure at the top of the column is also lower.

Consequently, we may expect to meet above the anti-trade a wind blowing towards the equator, and it would be reasonable to call this wind the *upper trade-wind (Oberpassat; Vent alizé supérieur)*. The ascents of registering and pilot balloons made during the last two years at Batavia Observatory have given some proof of the existence of this upper trade-wind.

Regarding the air-pressure gradient, I compared the pressures recorded during the balloon ascents made on the *Otario* cruises in the North Atlantic, in ±30° N. latitude, with those found at Batavia in the corresponding southerly season. These mean pressures and differences follow hereunder:—

Height	Air Pressure Batavia 6° S	Air Pressure N. Atlantic ±30° N.	Difference
km.	mm.	mm.	mm.
12	164	157	7
13	139	136	3
14	119	117	2
15	100	99	1
16	86	85	1
17	74	74	0
18	63	65	−2

Though the records are few in number, the decrease and reversal of the gradient are conspicuous.

The numerous balloon-flight observations now made in Batavia (the results of which are just going to the press) have proved that the anti-trade reaches a maximum at a height of 12–15 km. (in the dry season lowest and in the rainy season highest). Higher up its strength decreases, and at heights of ±17 km. feeble southerly and westerly winds blow. Berson was the first to observe these winds in Central Africa.

The height at which I found them above Batavia, viz. ±17 km., corresponds exactly with that in which the pressure gradient passes the zero value.

Still higher up we must expect to meet the upper trade, and the explanation of the occurrence of these southerly and westerly winds simply is that they are feeble winds of variable direction occurring between two great overlying air currents, similar to those which are often observed in the layers between trade and anti-trade, or monsoon and trade.

Recently the ascent of a balloon of 2 kg.,[1] which reached 22 km., gave fair evidence of the existence of the upper trade, as may be seen from the wind directions and velocities given hereunder:—

	Height	Wind blowing from	Velocity in m. p. sec.		Height	Wind blowing from	Velocity in m. p. sec.
	km.				km.		
Anti-Trade	13	E 15 N	12·8	Upper Trade	17·5	E 85 S	4·6
	13·5	E 22 N	15·2		18	E 25 S	8·8
	14	E 32 N	15·2		18·5	E 7 S	13·6
	14·5	E 35 N	20·8		19	E 9 S	15·0
	15	E 34 N	21·2		19·5	E 4 S	21·1
	15·5	E 23 N	28·8		20	E 11 N	28·5
	16	E 4 N	24·0		20·5	E 3 S	27·2
	16·5	E 16 N	26·9		21	E	27·2
	17	E 15 N	7·5		21·5	E 9 S	30·4
					22	E 10 S	30·8

The present dry season is not advantageous for the discrimination of the upper trade from the upper easterly counter-wind, because, according to the difference observed between the dry and wet season, in this season pressure at those heights is lowest probably over Java and not over the equator. Consequently, the southerly components by which the upper trade differs from this counter-wind will be small.

In the rainy season (December-February), however, the contrary will be the case, and accordingly I expect to obtain in those months observations which will give stronger evidence of the existence of the upper trade-winds.

W. VAN BEMMELEN.

Batavia Observatory, August 20.

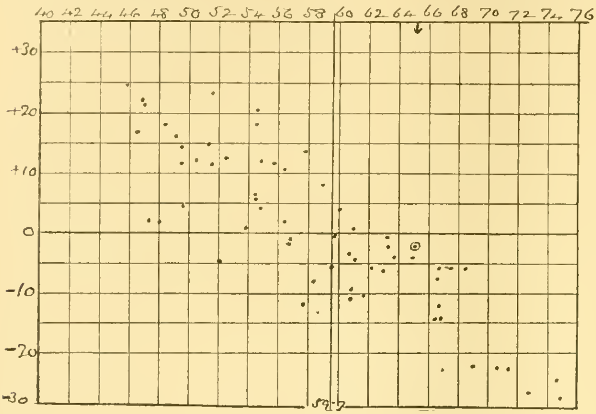
[1] Beiträge zur Physik der freien Atmosphäre. Bd. iv., Heft 1.

[1] This balloon reached as a registering balloon a height of 15·5 km. on July 18; at that height it burst, was found again and brought back, and after being carefully pasted, it was sent up again on August 3 as a pilot balloon, being observed from two points 1·9 km. apart.

Rainfall in the Summer of 1911.

ONE does not hear much of effort on the part of official meteorologists to supply long-range forecasts of months, seasons, &c. It may be said, the thing cannot be done; better to say, it cannot be done infallibly. My own experience leads me to think a beginning might now be made with what will no doubt some day be a familiar institution, like the useful but imperfect daily forecast.

The question may be asked, Could the remarkable qualities of this summer (so hot and dry) be foreseen in any measure? I consider there was reason to expect a very small rainfall (at Greenwich): and I would submit the enclosed rough dot diagram in support of this view.



Rainfall comparison of Greenwich summer.

It is got thus: the rainfall of spring plus summer (March–August) in each year, 1841–1910, is noted, and these values are added in groups of five (1841–5, 1842–6, &c.). Then each sum is compared, by the dot method, with the difference between it and the *fifth* after, a plus value meaning that the later sum is the higher, while a minus value means it is lower. (Each dot signifies one sum by the horizontal scale, and the difference by the vertical.)

Before this summer we had got to comparing the sum for 1903 (*i.e.* the group 1901 to 1905), which is 68·4 inches, with the difference between it and the sum for 1908 (*i.e.* 1906–10), which is 6 inches (68·4–62·4). Next we have the sum for 1904, which is 65·3 inches, and the value for 1909 has to be ascertained (*i.e.* the group 1907–11).

Find 65·3 in the horizontal scale (see arrowhead), and consider where the new dot is likely to go. (The encircled dot shows its actual position.) It will be seen that, wherever the sums have exceeded (say) 62 inches, the fifth sum after has been a lower value hitherto. Let us lessen the sum 65·3 by 1 inch, and see what we get. We have thus 64·3 inches as (say) an extreme upper limit for the group 1907–11. Now, the sum for 1907–10 was known, viz. 54·5; and 64·3 – 54·5 = 9·8 for March–August, 1911. The spring had 5·2 inches, so that we might look for a summer rainfall not over 4·6 inches. (The average is 6·7 inches.) The actual amount appears to have been 3·7 inches. The difference of the sums for 1904 and 1909 is – 1·9 inches; and the previous distribution of dots, indeed, points to a greater diminution than 1 inch.

ALEX. B. MACDOWALL.

Limits of Explosibility in Gaseous Mixtures.

In making experiments recently on the explosion of gases by means of an incandescent wire, I have obtained much wider limits of explosibility than those usually given. The following table shows the numbers obtained:—

	Limits with incandescent platinum wire Per cent.	Limits (Clowes) Per cent.
Marsh gas	2·5 to 24	5 to 13
Coal gas	4 to 28	6 to 29
Hydrogen .	3 to 75	5 to 72

In each case the gas was mixed with air. The explosion was carried out in a glass tube of about 10 c.c. capacity having a stop-cock at each end, and a mercury gauge of small bore attached to the middle of the tube. When the explosion occurs the mercury moves more or less sharply, according to the force of the explosion, but a distinct movement, apart from that due merely to the expansion caused by the heating of the wire, can be seen with the proportions of gases given above. The marsh gas was prepared from zinc methyl, as aluminium carbide, on treating with water, was found to give 33 per cent. hydrogen.

I am not clear as to why the limits should be wider than those usually obtained; possibly it is due to catalytic action of the platinum wire, or possibly the apparatus is more sensitive than that usually employed. The matter seems of interest in connection with colliery explosions. Using the same apparatus, I have obtained explosions with coal-dust and air, and with lycopodium powder and air, no other gas being present.

E. P. PERMAN.

University College, Cardiff.

Working Hypotheses *v.* Collection of Bare Facts.

PERHAPS it is desirable to explain that my review of Prof. Schuster's book published in NATURE of September 21 was written and sent to you before Prof. H. H. Turner had delivered his address to the British Association as president of Section A. Consequently, nothing in my review is a reply to, or has any reference to, Prof. Turner's excellent address. It would be discourteous to criticise an important pronouncement of a leader in science in any back-handed way. My statement and his are probably not really in opposition, though they to some extent emphasise opposite types of investigating activity.

OLIVER LODGE.

Use of Wind-furnaces in Smelting.

IT may interest your correspondent, Mr. George Turner (p. 381), to be reminded that wind-furnaces (furnaces without any blast but that of the wind) were used, at all events for lead smelting, much less than 900 years ago. Until some time in the seventeenth century the Derbyshire lead-smelters did not employ an artificial blast. They, like their predecessors in Roman times, built their furnaces on the tops of hills and facing the quarter of the prevalent winds. Dr. Percy in his "Metallurgy of Lead" gives extracts from Bishop Watson's "Chemical Essays" and from an earlier writer, Joshua Childrey, describing such wind-furnaces.

H. T. WOOD.

Royal Society of Arts, W.C., September 24.

Meteor-showers.

BESIDES the ordinary display of Orionids that occurs near the middle of October, a considerable amount of meteoric activity may be looked for about the beginning of the month. Indeed, the intensity of the earlier meteor-showers promises to be considerably greater than that of any of the subsequent ones in October. The following are computed particulars of two important meteor-showers that become due before October 6.

Epoch September 29, 3h. (G.M.T.), second order of magnitude. Principal maximum September 30, 18h. 25m. Secondary maxima September 29, 16h., and October 2, 16h. 25m.

Epoch October 5, 6h. 30m., third order of magnitude. Principal maximum October 3, 22h. 10m. Secondary maxima October 2, 2h. 45m., and October 4, 11h.

After these there will be meteoric quiescence until October 12.

JOHN R. HENRY.

2 Belgrave Villas, Rathmines, Dublin, September 26.

Habits of Dogs.

In reply to Dr. Kidd's question as to the disposition of dogs to carry hedgehogs in their mouths, I may say that a smooth-haired Irish terrier, "Tim," of which I had charge for some weeks in the early spring of the present year, speedily became an expert hunter of hedgehogs, and carried home five living ones in the course of a month. I am inclined to think that he came upon the first one in its winter quarters quite by chance; but on almost every subsequent occasion, when taken out for a run after dark, he quickly disappeared amongst the gorse and ling, and, eluding my daughters, returned home alone with a hedgehog in his mouth. On one occasion he had cunningly bitten off the ends of a number of the spines on the back of his captive, and on only one occasion did I see blood upon his lips.

H. C. Chadwick.

The Biological Station, Port Erin, Isle of Man, September 16.

With reference to the letter of Mr. Venables in Nature of September 21, it may interest your correspondent to know that the stimulation from formic acid taken by the mouth *is* "out of proportion to the effect which one would expect from the mere acidity."

Formic acid is given in medicine for states of debility, *e.g.* following influenza, and a tincture made from the whole ant (*Formica rufa*) is given in homœopathy for certain nervous and rheumatic states.

H. Fergie Woods.

"Appledore," Park Drive, Golders Hill, N.W., September 25.

THE TURIN MEETING OF THE INTERNATIONAL ELECTROTECHNICAL COMMISSION.

The fourth meeting of the International Electrotechnical Commission was held at Turin, and came to a close on September 16. For several reasons this meeting has established an international interest, not only for electrical engineers, but for mathematicians, engineers, and all interested in the standardisation of symbols used in mathematical literature and formulæ.

The opening business of the meeting consisted in the election of a new president; Dr. Budde, until recently the head of Messrs. Siemens and Halske, of Berlin, and probably the best known of the electrical engineers of Germany, was unanimously elected to fill the position in place of the retiring president, the eminent American physicist, Prof. Elihu Thomson. Colonel Crompton was re-elected as honorary secretary on the proposal of Prof. Feldmann, of Holland, who, in putting forward his proposal, referred to the St. Louis Congress of 1904, and the part Colonel Crompton took in urging the advisability of international cooperation in matters electrical. He said that Colonel Crompton was, in fact, the father of the International Electrotechnical Commission.

It was extremely satisfactory to note that Dr. Budde's election was proposed by the French delegates, which shows that at any rate any political differences which may exist between France and Germany do not extend to the more serene atmosphere of the scientific world.

The proceedings were formally opened by the reading of a report by the honorary secretary, Colonel Crompton, on the progress of the work since the last formal meeting, and more particularly since the informal meeting which took place at Brussels last year. He pointed out that whereas in 1908 there were only ten countries taking part in the Commission there were now twenty-one countries subscribing, each of which had formed its own local electrotechnical committee, in most cases with the direct aid of their respective Governments, and he thought it practically certain that at least three or four other countries were on the way to join, so that the movement might be called practically universal.

Prof. Elihu Thomson then gave an address as retiring president, and described the work carried out at the Brussels informal conference, and advocated that the work of the central office in London would be much lightened by the formation of a few international subcommittees additional to the one which already existed. He pointed out that the subject which required such continuous treatment by an international subcommittee was that of the standardisation of nomenclature and symbols used by mathematicians, engineers, and others, dealing with electrical questions, and he thought that the same might apply to the question of illumination as it was most desirable that the engineers engaged in illumination, not only by electricity, but by other means, should also standardise the expressions and formulæ they use. He emphasised the need of conducting the work of the Commission so that it may be a material assistance to the electrical industry, and so as not to retard progress or design in any way.

Two days were occupied by unofficial meetings dealing with the business in hand. A report on nomenclature was presented by Dr. Budde, the newly elected president, and after considerable discussion the amended list of terms and definitions drawn up in the two official languages of the Commission—English and French—was provisionally adopted. This list had been prepared by a subcommittee at a conference held at Cologne last May, and was thoroughly discussed and finally adopted at this meeting.

The next and very important matter was that of mathematical symbols. Here again the proposals put forward at the unofficial congress held at Brussels in 1910 were discussed, somewhat modified, and provisionally adopted; and a resolution was proposed by Dr. Budde, and seconded by Mr. Alexander Siemens, the president of the Institution of Civil Engineers of London, that the letters "I," "E," and "R" should be adopted to represent current, electromotive force, and resistance respectively in the simple algebraic expression of Ohm's law. It will be seen that in coming to this decision concessions were made by Germany dropping the letter "W" for resistance, and by Great Britain discontinuing the letter "C" for current. It is evident that this agreement on the symbols employed in Ohm's law will be a great convenience to all electrical students.

The discussion on symbols was a very thorough one, and the difficulties that appear likely to arise, at any rate amongst electrical engineers, are comparatively small compared with the difficulties of selecting suitable signs on account of the limited range of the type letters suitable for the purpose. For magnetic quantities either Gothic, Script, heavy-faced, or any special type was decided upon.

Although the matter was not in any way discussed at the conference, it appears likely that this difficulty could best be met by the substitution of a number of new symbols not necessarily representing letters of any type, but of a form and shape that they could be easily remembered and recognised, and which would be free from the present existing difficulty of causing great trouble to the composer in setting up his type and spacing his lines.

Eventually a subcommittee, consisting of one member each from Belgium, France, Germany, Great Britain, Holland, Spain, Switzerland, and the United States was appointed to continue the study of these international symbols.

The next interesting point dealt with was the vector diagrams in use for alternating-current quantities. It was agreed that in the graphical representation of alternating magnetic quantities advance in phase should always be represented in the counter-clockwise direction; in other words, the rotation of the vector should be to the left.

On the question of rating of electrical machinery and apparatus the proposals of the Brussels conference were adopted without modification as follows:—

1. The output of electrical generators is defined as the electrical power at the terminals.

2. The output of electrical motors is defined as the mechanical power at the shafts.

3. Both the mechanical and the electrical power are to be expressed in international watts.

In this work careful attention had to be given to the exact choice of the equivalent words in the two official languages. The convenient word "output" employed by English-speaking nations has no exact equivalent in French. In this case again a sub-committee, consisting of one member from those international committees interested in the subject was appointed to carry on further this question of the international rating of electrical machinery and apparatus.

It was decided that the next meeting of the Commission should be held in Berlin in 1913, the exact date to be announced later.

Mr. Gano Dunn, the president of the American Institution of Electrical Engineers, invited the Commission to hold an official meeting at San Francisco in 1915, on the occasion of the opening of the Panama Pacific Exhibition. On the motion of Prof. Feldmann, of Holland, seconded by Mr. W. Duddell, of England, the meeting thanked Mr. Dunn for the invitation, and stated its willingness to hold a meeting in San Francisco in 1915, and instructed the Central London Office to cooperate with the American Society in the organisation of an international electrical congress to be held at the same time.

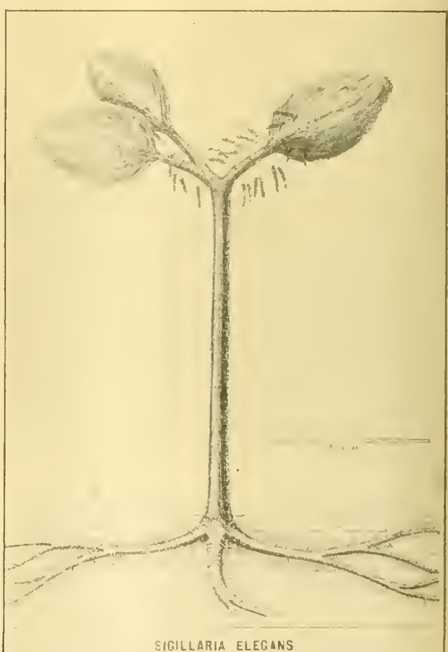
It is interesting to remark that at the meetings of the Electrical Congress, which was sitting at the same time, it was decided that for the future the irregular method of summoning international congresses at the time of the international exhibitions should be discontinued, and that in all cases where such exhibitions were held the International Electrotechnical Commission should be the body which should be invited by the country holding the exhibition to organise the electrical congresses, and in this way avoid much clashing and waste of effort.

Finally, the honorary secretary of the Illuminating Engineering Society of London, Mr. Leon Gaster, who was personally invited to attend this meeting at the invitation of the president, referred at some length to the desirability of standardising the terms and expressions used in connection with illumination. As stated above, this matter was dealt with by Prof. Elihu Thomson in his address. Mr. Gaster gave very cogent reasons why the present loose methods of expressing standards of light and of measuring these same standards should be discontinued, and that it was just as desirable in this kindred science of illumination that all nations should understand one another, as in the case of the electrical art and industry. Mr. Gaster's suggestions were strongly supported by Dr. Kennelly and Dr. Clayton Sharp, who are president and past president respectively of the Illuminating Society of the United States, and the suggestion that the various national committees be requested to put themselves in communication with their respective illuminating societies was unanimously adopted.

There is no doubt that at this full meeting of the International Electrotechnical Commission during the week in which the delegates worked together much international courtesy was shown, a great many pleasant friendships were made, and undoubtedly every additional international meeting of the kind greatly helps on the cause of solidarity between men of science of the world. The meeting room certainly contained a collection of men second to none in the electrical world for intellectual capacity; and that the meeting passed off so smoothly and so much work was done in a comparatively short time showed that the selectors of the delegates had also considered their diplomatic qualities, which had also been carefully studied by the countries which had sent them to the meeting.

PLANTS OF COAL-MEASURES.[1]

THE fossil flora of the Upper Carboniferous rocks of Belgian Hainaut is in many respects similar to that of our British coal measures, though many species occur in Belgium which are unrecorded from Britain and *vice versa*. Those who are interested in the systematic study of British Carboniferous plants



SIGILLARIA ELEGANS
Restauration d'apres MM. Grand'Eury et Kidston 1901.

will therefore find much that is of interest in Dr. Kidston's description of the collections, preserved in the Brussels Museum, from this coalfield. In all, 191 species, included in more than fifty genera, are enumerated. It is scarcely necessary to add that the author's high reputation for the accuracy of his deter-

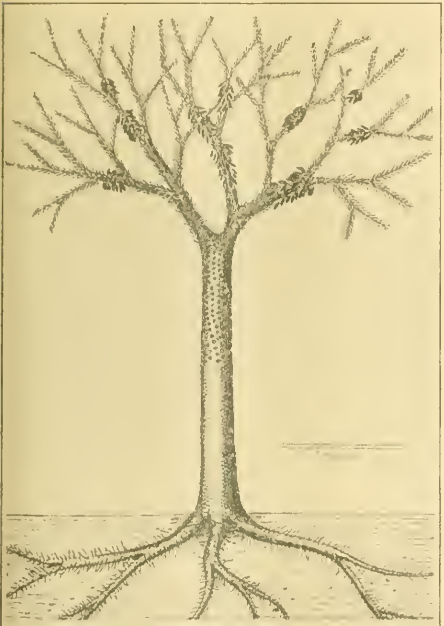
[1] Extrait des Memoires du Musée royal d'Histoire naturelle de Belgique. Tome iv, "Les Vegetaux Houillers recueillis dans le Hainaut Belge et se trouvant dans les Collections du Musée royal d'Histoire naturelle à Bruxelles." By Dr. R. Kidston, F.R.S. Année 1909. Pp. iv+282+xxiv plates. (Bruxelles: Polleunis et Centerick, 1911.)

minations and the completeness of his tables of synonymy is fully maintained in this large memoir.

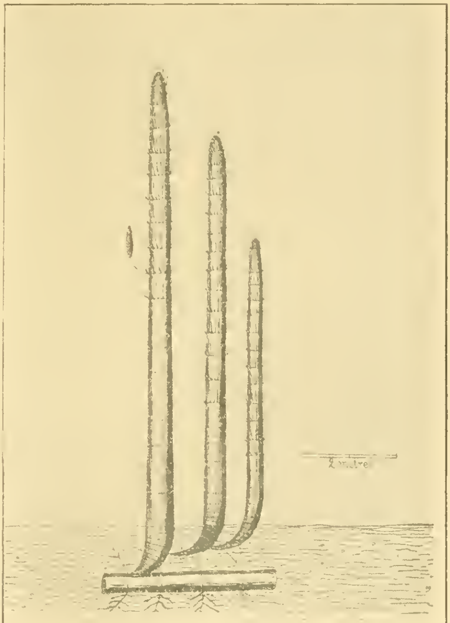
The work is in the main an enumeration of the species represented in the collection, with lists of synonyms. In the case of many of the rarer or more difficult species, the author has added notes of a critical nature which are often of great value. We may, however, regret that he has not seen his way to give a description of each genus and species involved. Such diagnoses would have added very greatly to the value of the work. As it stands it resembles the shell of a nut without the kernel, and in practice one will require to make use of another work containing such descriptions, in conjunction with that now under discussion, whereas one volume might have sufficed. We do not overlook the fact that in the case of a considerable number of genera, including Renaultia, Sphenophyllum, and Asolanus among others, as well as certain species of Sphenopteris, Sigillaria, and the like, none of which are new to science, a full diagnosis has been included. But in the majority of cases the author has apparently thought any description unnecessary, even where no figure of the plant is given.

The number of new genera and species discussed is remarkably small. We notice only one new genus, Boweria, and two new species, both of Lepidodendron and Sigillaria. These with a couple of new seeds complete the list of new plants. The new genus is proposed for the reception of a widely distributed plant formerly known as *Renaultia schatzlarensis*, since its sporangia now prove to be annulate, and the genus Renaultia is reserved for certain plants with exannulate sporangia. Turning to the new Lycopods, *Lepidodendron simile*, of which, however, no diagnosis is given, appears to approach *L. lycopodioides*, Sternb.; and *L. belgicum* sp. nov., a stem in the Ulodendroid condition, which is fully described, has also some points of resemblance to Sternberg's species. The two new Sigillarias are both members of the straight-ribbed section with distant leaf scars, and of the type of *S. laevigata*, Brongn.

These and many other fossils are illustrated by twenty-four large plates from excellent photographs, reproduced with exceptional clearness. In the text there are forty-one smaller illustrations, all of a high average. Among these are twelve careful restorations from the author's own pencil of some of the most characteristic types of Carboniferous vegetation, such as *Sigillaria elegans*, a Lepidophloios, and *Calamites suckowi*, which are here reproduced. These embody the results of the author's lifelong practical experience of Carboniferous plants, and they are also interesting from the fact that in some cases they differ very remarkably from the restorations which are now to be found in most of our text-books. Without expressing any opinion on the accuracy of Dr. Kidston's drawings, we must, however, add that if these are faithful portraits of the plants of the period in question, the Carboniferous vegetation must have been even more weird in aspect than we had imagined.



LEPIDOPHLOIOS
Restauration d'après M. Kidston 1901.



CALAMITES SUCKOWII
Restauration d'après M. Kidston 1901

Turning next to some further points of interest, we notice that the author, after many years' consistent use of the term Calamocladus for one particular type of Calamite foliage, has now apparently abandoned it for the alternative Asterophyllites, which usually commends itself to Continental workers. The point may appear to be a small one, but any change of importance as regards nomenclature at the hands of the leading authority on the systematic study of Carboniferous plants in this country is worthy of note. Among the plants more fully described, on which new contributions to our knowledge are offered, we would particularly direct attention to the stems and cones of *Calamites paleaceus*, Stur., *Selaginellites Gutbieri* (Gœpp.), *Pinakodendron ohmanni*, Weiss, and *Sphenophyllum majus* (Bronn). The memoir concludes with a discussion on the age and horizon of the Hainaut basin.

In conclusion, the Belgian palæobotanists may be congratulated on this noteworthy addition to the literature on their fossil floras, and on their good fortune in having secured such an authority as Dr. Kidston to fulfil the task.

To the author we would add our congratulations on the successful completion of a volume which must have occupied his attention for many years past, and will always rank high in the annals of systematic palæobotany. We may also express the pious hope that some day our own British Carboniferous flora may receive an equally adequate treatment at his hands.

E. A. N. A.

THE ELECTRICAL EXHIBITION AT OLYMPIA.

THE important lesson to be learned from the Electrical Exhibition at Olympia is that rapid strides are being made towards a period of hygiene in our daily lives for which electricity will be wholly responsible. During the last six years a large number of electricity supply companies and corporation electricity departments have reduced their price for energy for heating, cooking, and similar domestic purposes to about one penny per unit, and manufacturers of cooking and heating apparatus have been developing this side of the industry with commendable rapidity. The large percentage of firms exhibiting and demonstrating domestic appliances, together with the comparative absence of heavy electrical machinery at Olympia, sufficiently indicates the aspect of electrical supply which is receiving the most attention. A factor in this important problem has been the development of cheaper wiring systems, a development purposely directed to securing the smaller consumer. In this direction also is to be noted the tendency towards the production of smaller and cheaper meters, cheaper service boxes, main switches, and other auxiliary apparatus.

Another factor which is helping to render the installation of electric light more economical, and therefore further within the reach of the smaller user, is that, owing to small devices, such as lamp-holders, switches and fuses being manufactured in large quantities, and practically to a few standard designs, the cost of these is now far less than it was a few years ago. This brings us to mention what is perhaps the most remarkable sign of the development of the electrical industry to the ordinary thoughtful observer outside the industry itself. Fifty years ago, or even less, electricity, except in so far as its applications to telegraphy were concerned, was practically an abstract science, fascinating no doubt on account of its potential developments, but scarcely a serious factor in engineering. Now, however, not only is electricity a most important agent in practically all branches of engineering, but the manufacture of electrical plant and apparatus has assumed the proportions of a great industry. It is the commercial aspect of this industry which is so very clearly brought home to the visitor at the exhibition, especially in the case of those smaller pieces of electrical apparatus which form the bulk of the exhibits. The manufacture and sale of these has developed into an enormous trade, and one can see that the exhibitors at Olympia are not only engineers and electricians, but are business men and traders, in the widest acceptance of these terms.

To return to the actual exhibits. It will be noticed that one of the most outstanding features of the exhibition is the improvement in electric lamps. Only a few years ago the metal filament lamp was an object of scientific interest, the difficulties of even squirting the filament not then having been overcome to the extent of producing a lamp with any considerable degree of capability to withstand rough usage. Some of the metal filament lamps shown now are exhibited under conditions designed to illustrate that they are as strong mechanically as the carbon filament lamps which they are rapidly superseding. Several manufacturers are now making filaments of drawn tungsten, and the *clou* of the exhibition, from the electrical engineer's point of view, is a 16-c.p. 220-volt Osram lamp, which has a filament only 0·015 mm. diameter, and yet possesses wonderful mechanical strength. Other lamps are shown, fitted on two model tramcars, which are allowed to run down inclines and collide with one another. Before the moment of impact, the lamps are purposely switched off, as it is when the filaments are cold that they are more brittle; yet the lamps withstand this rough usage without any damage, and are again lighted automatically as they are propelled up the inclines to enable the operation to be repeated.

The standardisation to which we have alluded applies to a considerable extent to lamp shades and reflectors, and concurrently with this the old haphazard way of installing lighting systems is giving way to more precise methods. Shades and reflectors of the Holophane type, designed to effect even distribution of light, are exhibited as stock articles by several firms, and much information is available at the exhibition in this hitherto little considered detail of electric lighting. The most careful arts of the glassworker are now employed to give effect to the investigations of the student of optics in the production of diffusing globes and reflectors which, by conservation and redirection of the rays of light, prevent waste and give maximum effect in any desired direction.

The adaptability of electricity to artistic fittings is also well demonstrated in an exceedingly fine show of models to suit almost every style of architecture of the English and Dutch schools. There is also a display of some very dainty French crystal pendants, together with reproductions of the genuine old Dutch lighting fittings of the sixteenth and seventeenth centuries.

A new development that may be mentioned is in connection with the mercury-vapour lamp. A "light transforming reflector" is being introduced, made of a material which becomes fluorescent under the action of the light from the lamp, and increases the number of red rays; although this has not actually solved the problem of converting the light from the mercury-vapour lamp into a pure white light, it is at any rate a step in the desired direction.

The visitor who proposes only to spend a short time at the exhibition in which to form an idea of the numerous domestic applications of electricity to which we have alluded will find a large number of these concentrated in the "Electric Home." This is a suite of rooms consisting of drawing, dining, bed, and bath rooms, together with a kitchen and scullery, efficiently and beautifully lighted. In the kitchen demonstrations of electric cooking are being carried out, and are under the direction of a first-class cook. Electric laundry work is also shown.

A COUNTRY IN THE MAKING.[1]

THE Argentine Republic has recently celebrated the centenary of its existence as an independent State, and, in the national "stocktaking" which inevitably belongs to such an event, considerable attention has been given to education, as a result of which we have two large volumes of statistical records, and a third volume of monographs, on the various grades of educational work that come under the direction of the State.

Prior to its escape from Spanish control, such education as there was in the country was under clerical, and, for the most part, Jesuitical direction. In the ancient (Argentine) city of Cordova, the foundation of which by Peruvian Spaniards dates back to 1573, the Jesuits established a high school (*Colegia maxima*) in 1610, which Pope and King combined to raise to the dignity of a university very few years later. The university was for two hundred years the sole representative of higher studies. It was secularised in 1800, and a sister university was set up at Buenos Aires in 1821 by the recently organised Government.

It is interesting to note how world-wide was the influence of Napoleonic ideas. There was then no Department of Public Instruction, and the new university was entrusted with the duty of educational administration in the city and district. After various experiments in constitution-making, however, the influence of the great republic of the north made itself felt, and in the federal form of government which was completely adopted in 1860, the duty of providing primary schools was put upon the local legislatures, and a central Ministry of Public Instruction was also formed. It was not, however, until Sarmiento's presidency (1868–73) that the country really woke up to its educational needs. Sarmiento had been an exile for some years, and during that time Chile had sent him to Europe and the United States to study educational systems. He had met Humboldt, Guizot, Cobden, and Horace Mann, and entered upon his presidential period full of great projects for the development of national education. His influence led to greatly-increased grants from the central exchequer to the provincial governments, and to the establishment of a great training college for teachers on the model of similar institutions in the United States.

The degree of progress which has been attained in the provision of primary schools, and the vast difficulties of the Government, are best illustrated by the comparative number of children between six and fourteen who could not read or write (*illettrés*) in 1895 and in 1900. There were in the former year 57 per cent., and in the latter 32·6 per cent. Education is compulsory between six and fourteen; we may suppose that the children in school do not learn to read within a year, and so reduce the 32·6 to approximately 28 per cent.—not a bad result if we keep in mind the enormous territory and the sparseness of the population, immediately the precincts of the large towns are left behind. Uruguay is the only other South American State which comes approximately near to such a result; the number of illiterates rises to 80 per cent. in Brazil and 90 per cent. in Venezuela. In spite of what has been accomplished in the sphere of primary education, the cost to the State is very small in comparison with what is paid for the higher schools and universities.

Most of the secondary schools are under the direct control of the Central Government. They follow a five-year course preparatory to the university. As is the case in Austria, it is worthy of note that psychology is a subject of instruction in the last school year. The schools in Buenos Aires are magnificently housed; their equipment is costly, and their staffs are ample. The five schools cost the city more than 100,000*l.* in 1908. But in the smaller towns things do not go so well. The subjects are appropriated to chairs (*catedras*), the holders of which must give at least three hours a week instruction. They are for the most part occupied by local professional men, whose main interests are not, of course, in the school. There are two State high schools for girls, in Buenos Aires and in La Plata, but the majority of girls are educated in conventual institutions. The Jesuitical seminaries also attract many of the sons of the wealthier classes.

There are now three universities in the country, a third having been founded by the State of La Plata in 1906. This last foundation follows the United States model, with a supervising president who brings unity into the system of government by more or less independent faculties such as obtains in Cordova and Buenos Aires. All the universities are handsomely provided with funds. In 1908, Cordova received 55,000*l.*, Buenos Aires 90,000*l.*, and La Plata 86,000*l.* from the national exchequer. Nor is capital expense spared. The State has recently voted 1,200,000*l.* for various university buildings, including a new hospital for the medical school at Buenos Aires, and buildings at Cordova in celebration of the tercentary of its foundation.[1]

Vigorous life and a profound belief in education are obvious everywhere. Technical schools, a new public school on the English pattern, magnificent museums and libraries such as our great provincial cities may long yearn for in vain—all these are pointed to with legitimate pride. Here and there in the record one comes across interesting bits of heterodoxy, which bear witness to a healthy independence of view. "J'estime que l'institution des Kindergarten est une véritable hérésie pédagogique et un crime de lèse-enfance." This is startling, to say the least. Nevertheless, the volumes fill one with admiration for the pride and faith in the future of their country which animates their authors and the administrators whose work they record.

J. A. GREEN.

[1] "République Argentine. Recensement général d'Éducation levé le 23 mai 1909." By Albert B. Martinez. Tome i, "Population Scolaire." Pp. xlii+418. Tome ii, "Statistique Scolaire." Pp. lxxiii+344. Tome iii, "Monographies." Pp. ii+702 (Buenos Aires, 1910.)

[1] Cf. article "Argentine Republic," Macmillan's Cyclopædia of Education."

DR. F. W. PAVY, F.R.S.

ON September 19 the death occurred of Dr. Frederick William Pavy, F.R.S., in his eighty-third year. Dr. Pavy was born in Wiltshire in May, 1829, and was educated at Merchant Taylors' School. He subsequently entered Guy's Hospital, where he had a distinguished career, and in the course of his graduation at the London University took the exhibition and gold medal in materia medica, the gold medal in medicine, and honours in other subjects. He became a doctor of medicine in 1853. He studied physiology in the laboratory of Claude Bernard, in Paris, and soon began that prolonged research into the relation of sugar to the animal economy, in reference to the causation and treatment of glycosuria and diabetes, which terminated only with his life.

Dr. Pavy's first communication to the Royal Society was in 1855, and was entitled "An experimental inquiry into the nature of the metamorphosis of saccharine matter as a normal process of the animal economy." In this he gave reasons for believing that the sugar formed in the liver is not entirely destroyed by combustion in the body, but is changed by means of fermentation. This was followed in 1858 and 1860 by accounts of an "Experimental inquiry into the alleged sugar-forming function of the liver." In these he demonstrated that the large amount of sugar found in the blood returning from the liver was not, as Bernard supposed, present during life, but was really the result of a transformation of the glycogen taking place with great rapidity after death.

In subsequent papers he showed the influence upon the formation of sugar in the blood, of the injection of alkalis, and of acids, into the circulation. Claude Bernard had shown that a lesion of a certain part of the fourth ventricle would cause glycosuria; in 1859 Pavy, in a communication "On the lesions of the nervous system producing diabetes," demonstrated that the same change in the urine was brought about by removal of the superior cervical ganglion, or the division of the sympathetic trunk in the neck. He referred this appearance of sugar to an alteration in the vasomotor apparatus of the liver. In 1863 he was led to ask why the gastric secretions did not in health digest the gastric mucous membrane itself; and from a series of ingenious experiments he drew the inference that this was due to the circulation in the stomach walls of an alkaline blood which was sufficient to neutralise the acid gastric juice, coming into contact with the mucous membrane.

In the same year, Dr. Pavy was elected a Fellow of the Royal Society, and so far as communications to this society were concerned he appears to have rested on his oars for several years. Not that he was idle; far from it. He was for a time demonstrator of anatomy at Guy's Hospital. Within two or three years of graduation, he was appointed lecturer on physiology and comparative anatomy, and he continued his lectures on physiology until 1878, for the last five years in conjunction with Dr. Pye-Smith. In 1859 he was appointed assistant physician to Guy's Hospital, and in 1871 he became full physician. In 1862 appeared his work entitled "Researches on the Nature and Treatment of Diabetes," and he soon acquired a large professional practice among sufferers from that complaint.

Dr. Pavy did not, however, confine himself to the subject of diabetes; he did valuable work in connection with the forms of functional albuminuria, and he wrote a "Treatise on the Function of Digestion." This was followed in 1874 by a "Treatise on Food and Dietetics," which was a standard book for many years. In 1890, at the age of sixty-one, he retired from hospital work at Guy's, but he still enjoyed a large private practice, held the offices of censor and Harveian orator at the Royal College of Physicians, and continued unintermittingly and with dogged perseverance his researches upon the destination of sugar and other carbohydrates in the animal system. In 1875 he read a paper before the Royal Society "On the production of glycosuria by the effect of oxygenated blood on the liver," and in the following ten years he read as many papers bearing on the carbohydrates and diabetes. He made many practical additions to the chemistry of the subject, and his introduction of an ammoniated cupric test in the volumetric estimation of sugar was undoubtedly of great value.

Dr. Pavy has made numerous other communications to medical journals on these subjects; he published in 1894 a "Treatise on the Physiology of the Carbohydrates," and in 1908 delivered three lectures "On the pathology and treatment of diabetes viewed by the light of present-day knowledge." In all this later work he insists on the fact that carbohydrates can be both derived from, and converted into, proteid, as one of great importance in relation to diabetes.

Dr. Pavy's work was well known abroad, and he was the recipient of several honours. He was a corresponding member of the Société d'Anatomie of Paris; and in 1908 the Academy of Medicine of Paris awarded the Godard prize to his work on carbohydrate metabolism on diabetes. In 1901 he was awarded the Baly medal by the Royal College of Physicians of London.

FREDERICK TAYLOR.

NOTES.

EXHAUSTIVE tests have been made during the last two weeks by Mr. A. W. Sharman with instruments invented by him for telephoning through water without wires. A small telephone station has been erected in a room in an hotel on the cliffs at Pegwell Bay, and the other station has been fitted up on a motor-boat cruising in various parts of the bay. The microphone used in speaking is connected in series with a battery of four or five dry cells and an impulse coil, the coil being of special construction and giving very short induced currents of high potential, which are communicated to the water by two wires connected to the terminals of the coil and terminating themselves in plates buried in the sand or submerged in the water. Two similar plates, connected direct with a very low resistance telephone receiver, enable the speech to be "picked up" at distances of a mile and more. The speech transmitted through the water has been very distinct, and the system has shown good possibilities of its being used as a means of verbal communication between two ships, such as a battleship and a submarine. The effect is very directional; and another advantage is that, with a small tuned buzzer, telegraphic signals can be transmitted through the earth or water for a distance of several miles; the primary energy required is extremely small, four watts sufficing to telephone over a distance of two miles. Experiments are also being made in combining with the Sharman instruments a sensitive telephone receiver invented by Mr. T. Thorne Baker, with which it is hoped the present range may be increased by 50 per cent. or more.

THE naval dirigible, an experimental airship which has been building at Messrs. Vickers' works, Barrow, for the Admiralty, during the last two years, was wrecked on Sunday, September 24, while being towed out into the centre of Cavendish Dock in preparation for a flight. The vessel, which is of the Zeppelin type, is 510 feet long, 45 feet in diameter, and of a capacity of 20,000 cubic metres. The rigid framework, containing seventeen separate gas-bags, is constructed of a new alloy known as "duralumin." Each of the gondolas, fore and aft, contains a 200 horse-power Wolseley motor, the motor in front driving two propellers on either side, and that in the rear driving one propeller placed behind the gondola. The accident started so soon as the order to begin to veer the bow round towards the centre of the dock was obeyed. The ship bulged and broke by her seventh, eighth, and ninth gas-bags, approximately in the middle. The outer fabric fortunately held, enabling both portions to be secured and eventually returned to the shed, without injury to the crew, though several men were obliged to swim for safety. The exact cause of the accident is unknown, nor is it likely to be made public. Structural weakness would seem to account for it, coupled with the fact that the keel, which originally ran the length of the vessel between the two gondolas, had been removed in order to lighten her.

The Aëronautical Society of Great Britain at a special general meeting held on Monday, September 25, passed resolutions repealing its old constitution, under which it has been governed for forty-five years past, and substituting a new one, which provides for the creation of a technical side in addition to the lay or members' side. Fellowships and associate fellowships are to be granted to those respectively of considerable eminence and of an acknowledged position in the science of aëronautics, and special encouragement is to be given to students, for whom there is a separate grade. The growth of aëronautical engineering as a profession is the chief cause for this change, which, it is hoped, will give a much needed fillip to aëronautical industry, besides protecting and fostering its interests. The new council was also elected at the meeting, and is composed of the following:—A. E. Berriman, Griffith Brewer, Captain A. D. Carden, T. W. K. Clarke, B. G. Cooper, J. W. Dunne, J. Dunville, J. H. Ledeboer, Captain E. M. Maitland, F. K. McClean, Lord Montagu of Beaulieu, A. Ogilvie, M. O'Gorman, F. Handley Page, Colonel H. E. Rawson, and Colonel F. S. Stone.

News has been received at the Royal Geographical Society that the International Geographical Congress, which was to have been held at Rome next month, has been postponed until the spring of 1912.

The Secretary of State for the Colonies has appointed Sir Ronald Ross, K.C.B., F.R.S., professor of tropical medicine in the University of Liverpool, to be a member of the Advisory Medical and Sanitary Committee for Tropical Africa, in succession to the late Sir Rubert Boyce, F.R.S.

Mr. A. P. Trotter informs us that his name has been attached to the Report of the British Association Committee on Practical Standards for Electrical Measurements without his authority, and doubtless as the result of a mistake. But it compels him to state that he withdrew from the committee in July, 1910, because he strongly disagreed with some of its resolutions and with the mode in which the business was conducted.

Circumstances have arisen which have led to the abandonment of the arrangements made to hold the autumn meeting of the Iron and Steel Institute in Turin. The meeting will be held, therefore, at the Institution of Civil Engineers, Great George Street, Westminster, on October 5. Among the papers which have been submitted, a selection of which will be read and discussed, may be mentioned:—Reports on the iron-ore resources of Italy: (*a*) Sardinia, by Ing. L. Testa, (*b*) Brembana Valley, by Cav. G. Calvi, (*c*) central Italy, by Ing. A. Ciampi, (*d*) southern Italy and the island dependencies, by Prof. G. la Valle; on the mechanical influence of carbon on alloys of iron and manganese, by Prof. J. O. Arnold and Mr. F. K. Knowles, of Sheffield; on the autogenous welding of metals, by Dr. Francesco Carnevali, of Turin; on the application of electric energy to the manufacture of iron and steel in Italy, by Cav. Ing. Remo Catani, of Rome; on the present state of the metallurgical industry of Italy, by Signor Comm. Luigi Dompé and Cav. Francesco Saverio Pucci, of Milan. Papers will be submitted also by Mr. E. Adamson, of Sheffield; Mr. L. L. Fermor, of Calcutta; Prof. Federico Giolitti, of Turin; Prof. F. Giolitti and Dr. Francesco Carnevali, of Turin; M. L. Grenet, of Argenteuil, France; and M. V. A. Kroll, of Luxembourg.

Dr. C. H. Wind, professor of theoretical physics at Utrecht University, died on August 7, after a long illness, at the age of forty-three. Prof. E. v. Everdingen, director of the Royal Netherlands Meteorological Institute at de Bilt, sends us the following particulars of Dr. Wind's career and scientific work:—Cornelis Harm Wind was born at Groningen, and studied physics and mathematics there and at Leyden and Berlin (1886–95), and physical chemistry with van 't Hoff at Amsterdam (1895). He was then appointed lector in theoretical physics and physical chemistry at Groningen. In 1902 the Government, desiring to encourage the application of theoretical physics to the solution of meteorological problems, appointed Wind as director of the Meteorological Institute at de Bilt. As such he reorganised the practical work, devised schemes for extensions in terrestrial magnetism, seismology, and kite work, and introduced many improvements in the regular publications. In 1904, however, when the time for theoretical work had scarcely arrived, he was called upon to take the chair of theoretical physics at Utrecht, and accepted the invitation, not without much hesitation. Wind's theoretical work of the Groningen period promised a brilliant career. His work on magneto-optics led him to predict an analogue to Kerr's phenomenon, afterwards verified by Zeeman. Haga and Wind's experimental researches on diffraction of Röntgen rays induced him to investigate the explanation of diffraction phenomena generally. Other researches consider Gibbs's phase rule, the kinetic theory of gases, and the second law of thermodynamics. Also one part of Bosscha's text-book of physics was written by him in this period. Unhappily, at Utrecht his health began to give way and prevented further development in this direction. Nevertheless, he continued to show great interest in geophysical problems as a member of the board of visitors of the Institute for Marine Investigations, afterwards also of that of the Meteorological Institute. Those who met him at the meetings of the Permanent International Council for the Investigation of the Sea will remember his activity in organising the hydrographical work. His many friends and colleagues who remember his keen interest in their affairs and work whenever they asked his advice know that, though his life was too short, it was not in vain.

In his pamphlet, "The Stone Age and Lake Lothing" (Norwich: Norfolk News Co., Ltd.), Mr. J. Chambers says:—"My intention was to write a brief notice of the flint implements I found lately when excavating in the bed of Lake Lothing, at Lowestoft." Beyond a few remarks on various methods of identifying stone implements, the author's intention has not been carried out. His remarks on the history of the lake are interesting, but he leaves the very subjects on which he has some valuable first-hand information to dabble in place-name speculations, the value of which may be estimated by his list of "acknowledged authorities."

In the September issue of *Man* Messrs. W. L. H. Duckworth and L. R. Shore describe a collection of crania derived from the peat deposits, which are now deposited in the Cambridge University Museum. While, as regards the mammalian fauna, the type from the peat deposits is certainly distinctive, there is great diversity in the cranial forms. Two of these crania tend to intrude among those of the prehistoric age; but this association is with examples the Palæolithic origin of which is not universally accepted. It seems at the same time certain that this collection contains examples somewhat unusual when judged by the three standard tests—the calvarial height index, the bregmatic angle, and the lambda angle—when compared with modern European crania. In view of the doubts still expressed by some authorities regarding the crania from Galley Hill and Brünn, the problem of the connection of them with the peat deposit examples must remain somewhat uncertain.

The Museums Journal for September contains an interesting article by Mr. H. Stuart Page on the evolution of English pottery, with valuable suggestions for the preparation of a type collection. He begins his survey with the old English slip-ware made at the end of the seventeenth and the beginning of the eighteenth centuries. He points out that the advent of Oriental porcelain entirely changed the outlook of the English potter. This was introduced by the East India Company when the custom of tea-drinking was becoming established in this country, and we can easily realise how wonderfully beautiful these thin, white, glossy, transparent vessels must have appeared to people who were then daily using the home-made coarse utensils. From a valuable chart appended to this paper we can understand the subsequent course of evolution. In dealing with the preparation of a type collection, Mr. Page warns his fellow-curators that they must not attempt to compete with private collectors in purchasing specimens which from their rarity have acquired a high fictitious value. Only the educational needs of a museum should be kept in view, and a collection of less than a hundred pieces carefully selected, arranged in the position for which they were designed, and fully labelled, would, he suggests, be sufficient for the purpose. As the Board of Education is now prepared to give financial aid in the formation of such type collections, it is the duty of curators to select their examples with discrimination. Such a scheme should commend itself to those museums where space and funds are limited, and in those places where a large number of specimens already exist; the idea could be carried out so as to serve the place of an index to the main collection.

In *Phytopathology* (vol. i., No. 3), Mr. J. R. Johnston states that the *Bacillus coli* (the common microbe present in the intestinal tract of man and most animals), when inoculated into coconut plants, is capable of destroying the soft tissues. The *B. coli*, or a form indistinguishable from it, is also the cause of "bud-rot," a disease of the coconut plant.

Judging from the report for 1910, the Sarawak Museum seems to be doing its work, in the matter of the fauna and flora of Borneo, in a thoroughly efficient manner. In addition to duplicates, the museum contains 40,975 named specimens of Bornean animals, referable to 5852 species and subspecies. Besides these, there are between 4000 and 5000 forms not yet properly named. His Highness the Raja has sanctioned the building of a new wing, which when complete will make the museum two-thirds as large again as at present. Arrangements have been made for the publication of a Sarawak Museum Journal, of which the first part was expected to appear in February last.

Much interesting information with regard to the economic products of India is to be found in the report of the Industrial Section of the Indian Museum for 1910–11, more especially in the part dealing with the work of the laboratory. Among the items, reference may be made to the analysis of a sample of Para rubber, the yield of *Hevea brasiliensis*, grown at Darjiling, this rubber being of good quality. On the other hand, rubber from *Ficus altissima*, grown in Assam, proved unsatisfactory. The tree in question is referred to as *Ficus altissima*, Bl., var. *typica*, King; but such a reference, even if it be generally used in botany, is incorrect, as *Ficus altissima typica* (to use the zoological form of nomenclature) is clearly the original type described by Blanford. Experiments as to the suitability of Indian fish-oils for the dressing of jute are likewise discussed, and it has been found that such oils, which in some cases must be diluted with mineral oil, would be satisfactory for this purpose if they could be produced at a sufficiently low price. An outbreak of beri-beri in Bengal led to the analysis of samples of rice, which showed that while husked rice contained from 0·6 to 0·8 per cent. of phosphoric anhydride, "polished" grain contained an average of only 0·4 per cent., which in some samples was reduced to from 0·26 to 0·22 per cent.

To *The American Naturalist* for September Mr. T. Barbour contributes a translation of an important article, by Dr. P. N. van Kampen, on the zoogeography of the East Indian Archipelago, originally published in Dutch in *Natuurkundig Tijdschrift voor Nederlandsch-Indië* for 1909. By means of maps of the distribution of mammals, amphibians, and fresh-water fishes it is shown that Wallace's line "has no value as a zoogeographic boundary," and that nearly the entire eastern half of the archipelago must be regarded as a transition area between the Oriental and Australian regions, the boundaries of which cannot be defined. After reference to the theory that the Australian fauna came from South America, it is concluded "that in post-Cretacean times there was a broad connection between the three Greater Sunda Islands and Asia on the one hand, and between New Guinea and Australia on the other; that, further, also between the Sunda Islands and New Guinea a connection must have existed, which was really less easy to pass over." Celebes is considered to possess an impoverished Indian fauna, due to the absence of free connection with the larger western isles, this poverty being most noticeable in the case of fishes. Its fauna may be the result of the consolidation of smaller islands, which were supplied by feeding lines from islands to the south, north, and east. "It is peculiar that the truly Indian character of Celebes remained unsuspected so long; while, on the other hand, no one doubted, but rather laid stress upon, the Australian relationship of that vast easterly island, New Guinea, the fauna of which is fully as Indian as that of Celebes is Australian." An African element is supposed to be represented in Celebes by the black ape (Cynopithecus) and the babirusa, the former being considered to be related to the baboons and the latter to the wart-hog. The evidence for this seems, however, inconclusive.

The new regulations for recruitment of the Indian Imperial Forest Service are published in *The Indian Forester* (August), with some cogent criticisms not altogether favourable. The substitution of several recognised training schools in place of a definite establishment at Oxford does not meet with favour, but the appointment of a member, retired or active, of the Indian forest department as a controlling director is regarded as a hopeful arrangement. Coincidently the number contains a communication issued by the Government of India revising the regulations for the training of provincial candidates at the Forest College, Dehra Dun.

A revision of the small liliaceous tribe Nolineæ, intermediate between the Yucceæ and Dracæneæ, has been prepared by Dr. W. Trelease, and is published in the Proceedings of the American Philosophical Society (vol. l., No. 200). The author recognises four genera by the inclusion of the monotypic genus Calibanus, founded on Hooker's *Dasylirion Hartwegianum*. Ovary and fruit furnish characters distinguishing the genera Nolina, Calibanus, Beaucarnea, and Dasylirion. The species are pronounced xerophytes with a succulent caudex; some of them reach tree size, as *Nolina longifolia* and *Beaucarnea gracilis* that are illustrated. The focal centre of the tribe lies on the Mexican tableland, with a distribution southwards to Central America and northwards to California and Colorado. Half the species are assigned to Nolina, and only seven are placed under Beaucarnea.

Among the sixty-eight parts mapped out in connection with the Clare Island Survey, one of the earliest and a most interesting number is the graphic account of the lichens contributed by Miss A. Lorrain Smith. The region of rock, moorland, and sea coast on Clare Island and the adjacent mainland is particularly favourable to their development. The seaward rocks are clothed with black *Verrucaria maura*; *Ramalina scopulorum* and *Ramalina cuspidata* grow within reach of the spray, and *Physica parietina* gives colour to the boulders; proceeding inland, *Lecanora parella* and *Lecanora atra* are first prominent, and then *Lecidea rivulosa*. The peaty soil carries fine growths of Cladonia and Stereocaulon, and in the grass species of Peltigera are abundant. The present list, not regarded as exhaustive, enumerates 280 species, of which only about thirty were previously recorded for the county, while the new records for Ireland approximate to this figure. The rarer species include *Arthopyrenia leptotera*, *A. microspila*, *Arthonia subvarians*, *Microthelia dissepta*, and the alpine *Pertusaria gyrocheila*.

The reopening of the old alluvial goldfield in eastern Sutherland was referred to in Nature of July 13 (p. 51). It was then remarked that gold was being obtained, but whether it occurs in paying quantities had still to be proved. Information recently received from the field shows that the experiment has been a financial failure, but fresh attempts are being made at another locality.

The twelfth half-yearly review of mining operations in South Australia records the further development of the Tanami Goldfield in the Northern Territory, and states that instructions for the provision of a battery have been given by the Minister for Mines. The most important mineral product of South Australia is copper, and owing to its low price during the half-year copper mining had not been active. Further progress is being made in the development of the carnotite lode at Radium Hill, and the manufacture of gas fire-blocks has begun a fresh use of the extensive china-clay deposits of South Australia.

In the September number of *The Scottish Geographical Magazine* there appears a paper on the plant geography of Ardgoil, a public park of the Corporation of Glasgow, comprising some 14,000 acres, bordering on Loch Long and Loch Goil. Maintained in its natural condition of a Highland estate, it offers an excellent field for the study of such problems; and Mr. T. Nisbet's paper, read to the geographical section of the Royal Philosophical Society of Glasgow, is an excellent example of the useful work which can be done in local investigations. The present distribution of trees and plants is compared with the records in early statistical accounts, and the controlling influence of the greater hillside and glen population which existed a century and more ago is pointed out.

In the Proceedings of the Royal Irish Academy Prof. G. A. J. Cole describes the glacial features in Spitsbergen, and compares them with such as are to be seen in Ireland, where we associate with the waning of the Irish Ice age. The general appearance of aridity in the form and manner of weathering in Spitsbergen is very striking, and the action of penetrating water and repeated frosts leads to a rapid destruction of the rock, often forming cirque-like basins on the hill-slopes. Such cirques, illustrations of the arid type of weathering, Boulder-clay, and fluvio-glacial deposits are well shown by photographs taken by the author, who discusses the possibility of somewhat similar conditions having existed over Ireland during the Glacial period.

A correspondent asks what is "teart land," for the investigation of which the Development Commissioners have made a grant. The use of the word "teart" in connection with certain soils was referred to in Nature of November 3, 1910 (p. 25), and of May 11, 1911 (p. 364), both times in reference to Mr. C. T. Gimingham's very promising work on problems presented by such lands. Dr. E. J. Russell informs us that the word is used to denote certain pastures in Somersetshire on which cattle "scour," or get diarrhœa badly, whilst on other pastures round about they remain perfectly healthy. Botanical examination of the pastures reveals nothing that can account for the scouring, nor is there any evidence of disease organisms. Only the Lower Lias formation is affected, alluvial pastures all round a Lias pasture being quite sound. The whole problem is very baffling and extraordinary, but it is typical of many other pasture problems which require investigation.

In the August number of *La Géographie* M. Paul Mougin discusses the snowfall in Savoy. The material available includes many references to the deficiency or excess of snowfall in different years, and by research among the documents preserved in the official centres of the province a large amount of information has been collected which reaches back for many years. But such data are but approximate, and are only available for exceptional years; nevertheless, from 1773 onwards the dates of the earliest and latest snowfalls have been recorded at Annecy. Taking the mean dates for each twenty-five years, there seems to have been a maximum annual duration of snow in the period 1801–25, since when it has decreased. It is pointed out that this corresponds with the maximum extension of the glaciers in 1818–20, and do not contradict their retreat, which commenced after 1863. From 1853 the depth of snow falling in each year has been recorded at Annecy, and since 1900 the Administration des Eaux et Forêts has considerably increased the number of observing stations. From such data M. Mougin discusses the increase of snowfall with altitude, and the marked increase recorded in passing from north to south. There are also localities of exceptionally heavy snowfall which are not on the highest parts of the mountain range.

The interesting weather charts of the North Atlantic for September 7–13, prepared from radio-telegrams and other data, and published in the first issue of the valuable monthly meteorological charts for October by the Meteorological Office, show that the distribution of barometric pressure was subject to considerable variation. The chief features were the movement of high and low systems, generally of small intensity, across America to the Atlantic, and their subsequent tracks across the ocean. At the close of the period the eastern half of the Atlantic was under the influence of a very large high-pressure system extending from Greenland and Iceland southward to the edge of the tropics, and the office was enabled to predict successfully a continuance of these conditions for some days. On the same chart it is notified that the French Meteorological Office has commenced the dispatch of wireless messages from the Eiffel Tower, at 11h. a.m. daily, for the benefit of shipping in the Atlantic. The reports consist of barometric readings, wind direction and force, and state of sea at six stations in western Europe, Iceland, Azores, and Miquelon (Newfoundland), to which a general summary of the weather is added, *e.g.* "Anticyclone over central Europe, fine weather general; depression west of Iceland, travelling toward the east."

IN view of the extensive use which is made of sulphur as an insulator in electroscopes used in ionisation observations, a note in the August number of *Le Radium*, by Mr. F. W. Bates, of the University of Montreal, on the effect of light on the insulating properties of sulphur will be read with interest. Mr. Bates finds that when exposed to light sulphur becomes slightly conducting, the conductivity increasing as the intensity of the light increases. This property, he finds, is shared to a small extent by ebonite, but amber appears unaffected by light. He considers that the importance of the subject justifies a more extended study of it, and this he has commenced.

PROF. A. RIGHI has two interesting papers in vol. xiv. of the *Mem. della R. Accad. di Bologna*. The first deals with the ionisation produced by the magneto-kathode rays. It is found as the rays are more strongly developed, by increasing the axial magnetic field, that the ionisation at a given point in their path is diminished. The explanaton of this effect follows simply from the mode of formation of the rays; the field holds in loose combination pairs of oppositely charged ions which would otherwise escape from each other's attraction, the number of free ions in the discharge tube is therefore diminished. Sir J. J. Thomson has shown how complex are the phenomena in the region in which the canal rays are usually studied; it therefore seems possible that other plausible explanations could be given of the observed effects. The second of the two papers deals with less explored ground, viz. the influence of a magnetic field on the sparking potential. The results here are so complicated that Prof. Righi thinks more data will have to be collected before an explanation can be given. As the magnetic field is increased the sparking potential falls to a minimum, then rises to a maximum, and finally decreases very slowly. The magnetic and electric fields are parallel. Of other papers of physical interest, one by Prof. Amaduzzi deals with the photoelectric effect in selenium, while Prof. P. Burgatti treats of the vortical motion of a liquid, using vector analysis.

WE have received from the Patent Office Library a new "Subject List of Works on Chemistry (including Alchemy, Electrochemistry, and Radio-activity) in the Library of the Patent Office." It is a work of 218 pages, and supersedes a list published in 1901. A valuable feature of the list is the use of the dates of the volumes as one of the chief items in the scheme of classification; under this system it is easy to follow the gradual development of a subject or process, and new publications fall naturally into their proper places at the end of the series. The classification is somewhat complex, and some practice would be needed to trace quickly the volumes that one wished to consult; but this is perhaps inevitable in view of the bewildering array of books, journals, theses, dictionaries, and pamphlets which compose the literature of chemistry.

A PAPER by M. Paul Sabatier on hydrogenation and dehydrogenation by catalysis has recently appeared in the *Revue Scientifique*. Originally delivered in the form of a lecture to the German Chemical Society, the paper contains a review of the new and important branch of organic chemistry which has been developed during the past twelve years by the author and his colleagues. The catalytic action of the metals, and especially of finely divided nickel, has been utilised in a very large number of organic changes, and has proved of peculiar value in the addition and removal of hydrogen; more recently the catalytic influence of a number of oxides, such as thorium dioxide, has been investigated, and has proved to be of great service in effecting processes of condensation, such as the conversion of acids into ketones, and of alcohols into thiols, esters, ethers, and amines. The summary now given is both opportune and useful.

THE solubility of hydrogen in copper, nickel, and iron is the subject of a communication by A. Sieverts to the current number of the *Zeitschrift für physikalische Chemie*. The solubilities were studied for pressures up to $1\frac{1}{2}$ atmospheres, and over the temperature range 400° C. to 1600° C. For a given temperature and pressure it was found that the amount of gas taken up per unit weight of metal was independent of the metal surface. At constant temperature the solubility in both solid and liquid metal is approximately proportional to the square root of the gas pressure; at constant gas pressure the solubility of the hydrogen increases with the temperature, a sudden increase in the amount absorbed taking place at the melting point of the metal. As a consequence of the latter property, there is a spitting when the metal solidifies, copper giving off at its melting point about 2 volumes of hydrogen, iron 7 volumes, and nickel 12 volumes.

THE August issue of the Journal of the Franklin Institute contains a paper by Dr. Charles Baskerville on the chemistry of anæsthetics. In the case of chloroform especially, and to a less extent in the case of other anæsthetics, it is important not merely to ensure the initial purity of the material, but also to store it under such conditions as to prevent the formation of deleterious substances. The deterioration of chloroform is mainly due to oxidation, as shown by the equation

$$CHCl_3 + O = COCl_2 + HCl.$$

This change is usually checked in the case of anæsthetic chloroform by the addition of alcohol; and it has been shown that the initial oxidation of the mixture proceeds entirely at the expense of the alcohol, and that the chloroform is not attacked until later. Nevertheless, it is desirable to restrict oxidation by storing the liquid in small bottles which can be opened as required, and to make use of anactinic glass; it has even been suggested that the liquid should be stored in contact with nitrogen, and drawn off by means of a syphon, in order to avoid all risk of oxidation.

AN article in *The Engineer* for September 22 deals with hydraulic excavation on the Panama Canal. The method has been borrowed from hydraulic gold-mining as practised in California, and has been used on the largest scale in the area extending southward from the lower locks at Miraflores to opposite Corozal. Some 330,000 cubic yards of alluvial material were disintegrated between October and February last. The chief difficulty experienced during the progress of the work was the frequency with which limbs and trunks of cocoanut trees, washed from the mud several feet below the surface of the ground, were drawn into and choked the suction pumps. When this occurred, a coloured workman dived to the mouth of the pipe and extracted the débris. The cost sheets indicate that the economy of this method of excavation is undoubted.

AN illustrated description of the Trollhättan Hydroelectric Power Station, Sweden, appears in *Engineering* for September 22. This station will represent, when completed, an aggregate of 100,000 horse-power, half of which has just been installed. The Swedish State now controls the entire water-power of the Göta River, which connects Lake Vänern, the largest lake in Sweden, with the sea, there being a difference in level of 144 feet, of which 108 feet occur in the Trollhättan Falls. The present low-water volume is 11,520 cubic feet per second, and the high-level volume of water is about 32,400 cubic feet per second. When Lake Vänern is regulated, the State will be able to reckon on an aggregate of not fewer than 200,000 horse-power at the Göta Falls. The district is at no great distance from Gothenburg, and is in the midst of a populous part of the country. Francis turbines of a nominal capacity of 10,000 horse-power and a maximum capacity of 12,500 horse-power have been installed. The generators produce three-phase current, twenty-five periods, and 10,000 volts. The energy is distributed partly at 10,000 and partly at 50,000 volts.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES FOR OCTOBER:—

Oct. 1. 12h. 4m. Uranus in conjunction with the Moon (Uranus 4° 44′ N.).
4. 5h. 0m. Venus stationary.
5. 15h. 0m. Uranus stationary.
10. 6h. 28m. Saturn in conjunction with the Moon (Saturn 4° 27′ S.).
11. 17h. 52m. Mars in conjunction with the Moon (Mars 4° 21′ S.).
17. 12h. 0m. Mars stationary.
,, 19h. 0m. Neptune at quadrature to the Sun.
19. 12h. 0m. Uranus ,, ,,
21. 15h. 55m. Sun eclipsed, invisible at Greenwich.
22. 4h. 0m. Venus at greatest brilliancy.
23. 9h. 0m. Mercury in superior conjunction with the Sun.
,, 11h. 31m. Jupiter in conjunction with the Moon (Jupiter 2° 40′ N.).
27. 14h. 0m. Neptune stationary.
28. 20h. 40m. Uranus in conjunction with the Moon (Uranus 4° 48′ N.).

ANOTHER NEW COMET, 1911*f*.—A telegram from the Kiel Centralstelle announces the discovery of a new comet by M. Quénisset, at Juvisy, on September 23. Its position at 10h. 25m. (Juvisy M.T.) was

R.A. = 14h. 24·8m., dec. = 75° 4′ N.,

and its daily movement was +3·8m. in R.A. and −2° 11′ in declination.

We also learn that this comet was discovered independently by Mr. Francis Brown, of Lee, S.E., on Sunday, September 24, at 9 p.m. Mr. Brown gives its position then as R.A. = 14h. 37m., dec. = 73° 40′ N.

The magnitude of the new comet is given as 7·5, and, as it is situated so high up in Ursa Minor, it should not prove a difficult object.

DISCOVERY OF BORRELLY'S COMET (1905 II., 1911*e*).—According to a telegram from the Kiel Centralstelle, the credit of rediscovering Borrelly's comet, for which, as we mentioned in last week's issue, M. Fayet has just published search-ephemerides, belongs to Mr. Knox Shaw, of the Helwan Observatory, Egypt, who found it in R.A. 3h. 46m. 20s., dec. −32° 54′, at 15h. 5m. (Helwan M.T.) on September 19. The discovery was probably made on a photograph taken with the Reynolds 30-inch reflector, which, it will be remembered, was the first instrument to secure a recognised photograph of Halley's comet; the magnitude is given as 13·0.

M. Fayet gave three ephemerides based on the assumptions of perihelion passage taking place on December 18·6, 14·6, or 22·6; the observed position is more nearly in accordance with the first of these. He also shows that by the middle of October the quantity $1 : r^2\Delta^2$ will be as great as it was at the time of the comet's maximum brightness in 1905; after that it will increase considerably, from 0·57 to 1·90, so that the conditions of this return will be much better, for southern observatories, than at the previous apparition.

THE KIESS COMET, 1911*b*.—Numerous observations of comet 1911*b* are published in No. 4525 of the *Astronomische Nachrichten*, all of which direct attention to the diffused nebulous character of this object. On August 11 Herr Ernst, at the Königstuhl Observatory, found the diameter to be 12′, the coma appearing slightly elongated in the direction N.-S., and the nucleus being easy to see.

Dr. Konkoly at O'Gyalla found the three hydrocarbon bands to be very bright, their relative intensities, reckoning from the red, being 0·6, 1·0, and 0·3; a short continuous spectrum passed through the middle of the lines.

Dr. Holetschek gives a list of brightnesses of the whole comet and the nucleus as observed at Vienna, the maximum brightness, 5·5 mag., of the former occurring on August 3, although the greatest estimated magnitude of the nucleus, 7·0, was recorded on July 18.

Photographic observations at Innsbruck indicated possible changes in the extent of the tail on successive nights, and Herr Prey records tails up to ½° in length. Considerable changes of form are also recorded by M. Quénisset, who reproduces an excellent photograph of the comet on a plate accompanying the September number of *L'Astronomie*. This was taken at Juvisy on July 29 with an exposure of 78m., and shows a tail 5½° long issuing as a hard, fine streamer from the centre of the coma; but M. Quénisset records that on August 6, when the tail was fainter and 2½° long, it was strongly eccentric, and certainly appeared to emerge from the northern edge of the coma.

In *La Nature* for September 23 Dr. Mascart discusses the observed form and spectrum of this comet, and directs attention to the method of repeated copying by contact for the purpose of strengthening the fainter details on comet photographs. The advantage accruing from this process is well illustrated by two reproductions of one of the photographs of Halley's comet which he took at Tenerife in April, 1910. That direct from the original negative is very weak and shows little tail, whereas the one from the recopied negative is much stronger and shows a fair amount of tail.

BROOKS'S COMET, 1911*c*.—M. Quénisset also reports that he has taken several photographs of Brooks's comet, which is now such a prominent object in Boötes. Photographs taken on August 24, 25, and 27, the last with 5h. exposure, show a head having a diameter of 12′ or more in a direction perpendicular to that of the tail; the latter feature shows a length of 4°, and is slightly divergent.

THE SPECTRUM OF MOREHOUSE'S COMET (1908*c*).—Count de la Baume Pluvinel and M. Baldet have a paper in No. 2, vol. xxxiv., of *The Astrophysical Journal* in which they discuss twenty-eight negatives of the spectrum of Morehouse's comet, which they photographed at the Juvisy Observatory during October and November, 1908.

The discussion is a very thorough one, in which the authors show that the spectrum of the comet agrees excellently with the spectrum discovered by Prof. Fowler. The doubling of the bands in the cometary as in the laboratory spectra is very striking. The four band-spectra disclosed are attributed by the authors to carbon monoxide, nitrogen at low pressure, cyanogen, and carbon; in addition, there are some fainter radiations, not yet origined. While cyanogen and carbon were restricted to the head, carbon monoxide and nitrogen were distributed throughout the comet. The bands were also studied from the point of view of "series," and the authors find them classifiable into a "strong" and a "weak" series. An excellent reproduction of the spectrum accompanies the paper.

METEOR OBSERVATIONS.—A number of observations of bright meteors are reported in No. 4525 of the *Astronomische Nachrichten*. Mr. Denning gives the paths and velocities of eleven meteors seen in July and August, Prof. Konkoly reports 200 meteors seen at Nagy Tagyos during the July and August swarms, and Herr Dziewulski gives particulars of two bright meteors seen at 11h. 55·6m. (M.E.T.) and 11h. 57·6m., respectively, on July 6. At Cracow the apparent paths were 317°, −2° to 350°, +10° and 307°, +23° to 327°, +46°, respectively; the first lasted ten seconds, and was three times as bright as Venus, while the second was as bright as Venus and endured for four seconds.

Mr. W. Moss reports that he observed a first-magnitude meteor at South Kensington at 10h. 1m. on September 20. The meteor was moderately rapid, yellowish in colour, and left no trail. Its apparent path was from 40°, +40° to $52\frac{1}{2}°$, $+32\frac{1}{2}°$.

THE BRITISH ASSOCIATION AT PORTSMOUTH.

SECTION L.

EDUCATIONAL SCIENCE.

OPENING ADDRESS (ABRIDGED) BY THE RIGHT REV. J. E. C. WELLDON, D.D., PRESIDENT OF THE SECTION.

An Educational Review.

IT is my duty, as it is my pleasure, to express my cordial thanks to the council of the British Association for the honour it has done me in asking me to occupy the presidential chair of the Educational Section at the annual meeting. It has remembered what I was almost beginning to forget—that I was once a schoolmaster. Yet perhaps he who has once been a schoolmaster can never entirely lose the scholastic temper or, at least, I am afraid, the scholastic manner. Some slight comfort, however, I find in reflecting that there is probably no profession which has been adopted and, I must regretfully add, has been abandoned, by so many distinguished men and women as the educational. It happened to me at one time to examine for a special purpose all the lives recorded in the "Dictionary of National Biography"; and the number of the persons who were there stated to have been more or less constantly engaged in tuition was not less surprising than pleasing to an old schoolmaster. Apart from such persons as were born, in the proverbial phrase, with a golden spoon in their mouths, it is safe, I think, to assert that one out of every three or four eminent Englishmen has at some time or other been a teacher. Nor is this the truth in England or in Great Britain alone; it is true everywhere. Not to speak of lifelong educators or of persons whose principal work was done in education, there occur to me the names of such men as Isocrates, Aristotle, Origen, St. Jerome, Cardinal Wolsey, Erasmus, Milton, Rousseau, Thomas Paine, Dr. Johnson, Diderot, Cardinal Mezzofanti, Mazzini, President Garfield, Emerson, and Carlyle, who were all content at one time or other to make a scanty living by teaching.

Perhaps the fact that so many persons have taken up education simply as a means of livelihood is the reason why there have been so many educational failures. In no profession have good men and good women done so much lasting harm, or have done it so often without being aware of it, as in education. For an educator, like a poet, is born; he is seldom made: if he is deficient in discipline or insight or sympathy, they are hard to win by practice; harder still is it to win the passion for young souls; yet the educational profession demands enthusiasm above all other qualities; and I used sometimes to say to young candidates for office at Harrow that, unless a man honestly felt he would sooner be a teacher of boys than a Cabinet Minister, he would not be a master altogether after my own heart.

Yet the educational profession in itself, if it is not the most striking or shining in the eyes of the world, may be said to be the most inspiring and the most satisfying of all professions. It is the only profession which is naturally and necessarily concerned with all the three elements of man's composite nature, his body, mind, and spirit. It aims immediately and instinctively at the two highest objects of human aspiratinn, viz. the diffusion of knowledge and the promotion of virtue. Nor does any schoolmaster rise to the full height of his own calling unless he realises that his true object is to prepare his pupils, in all their faculties and in all the relations of their after-lives, for good citizenship. I cannot help thinking that a teacher who ignores or neglects the spiritual side of his pupils falls as far short of the scholastic ideal as if he were to think little or nothing of their bodies or their minds. The educational profession, when it is rightly understood, is capable of conferring signal benefits upon the community at large. There is an Oriental apologue which tells that in a time of grievous drought, when the king had vainly called upon the wizards, astrologers, and magicians to bring down rain upon his country, one humble unknown man at last stood forth to pray, and at his prayer the heaven above grew dark with clouds, and there was a great rain; the king desired to know who and what was he that had prevailed alone with God, and the answer was, "I am a teacher of small boys."

Education, as has often been said, is to-day in the air. More and more deeply the civilised nations of the world, and among them, at last, even Great Britain, are coming to realise that in the future the battle will be, not to the swift nor to the strong, but to the highly educated. It is the nation of the highest intelligence and widest cultivation which will assert its pre-eminence in the coming days.

But before any attempt can be made to criticise the existing educational system or want of system in Great Britain, and especially in England, it is necessary to state the principles underlying all true progress or reform in education. In the briefest possible language they are, I think, these:

(1) That every child shall enjoy the opportunity of developing in full measure the intellectual and moral faculties with which God has endowed him or her.

(2) That no difference of opportunity, or as little difference as possible, shall exist between the richer and the poorer classes of society.

(3) That the supreme object of education is to provide good citizens—citizens who, in Milton's stately language, will be able to "perform justly, skilfully, and magnanimously all the offices, both public and private, of Peace and War."

(4) That, as the personal influence of the teacher is a potent factor in education, it is the business of the State to ensure the highest possible efficiency, not only of intelligence, but of character, in the men and women who adopt the educational profession as their life-work.

It seems to me that all the educational questions of the day may naturally be ranged under these four heads. The first includes physiology and psychology as subjects directly bearing upon the teacher's art, the study of individual character, the size of classes, the specialisation of studies, the opportunity of self-culture, the time-table and the constituents of the curriculum, above all, the practical insight by which a teacher discerns, and the sympathy by which he or she encourages, the signs of genius or talent, even when they are overlaid by many faults and failings in a pupil. There is no more humiliating reflection than that teachers have so frequently been blind to the promise of distinction in their pupils. Of the public schools especially it is only too true that they have been, and in some degree still are, the homes of the average and the commonplace. They have applauded mediocrity if it conformed to the rules made by the masters for boys, and the yet stricter rules made by boys for one another; they have been not only oblivious, but even contemptuous, of such conduct as was felt to be a departure from, if not a reflection upon, the established norm of public-school life.

The second head includes such difficult matters as the *carrière ouverte aux talents*, the ladder set up from the lowest educational standard to the highest, the provision of scholarships, the equalisation, so far as possible, of the conditions under which boys and girls compete for pecuniary and other rewards, the danger of social exclusiveness in schools and colleges, and the appreciation of qualities, other than mere learning, as adapting students for their parts at home and abroad in after-life.

Under the third head, if it be granted that citizenship is, or ought to be, everywhere the educational goal, it follows that the teacher may not unfairly claim from the State the opportunity of giving such an education to children, especially in the wage-earning class, where parents are tempted to take their children away from school at an early age in the hope of making them contributors to the family purse, that it may not be hopeless to implant in them a certain knowledge, and with it that love of knowledge without which education, so soon as it ceases to be compulsory, is only too apt to become a negligible factor in the citizen's life. It follows, too, that where the interest of the State is not wholly connected with the interest of the parent, or the class, or the Church, some degree of regard for the State will ultimately prove to be a not unjust condition of receiving public money.

Yet, again, a sense of the importance attaching to the personal and professional qualities of the teacher leads almost necessarily to an insistence upon official registration as a condition of undertaking educational work, upon the training and testing of teachers by all such means as are suitable to prepare them for their responsible duties, and upon pension schemes for facilitating the retirement of teachers when they have lost or are losing their vigour and have earned a period of repose. For education is a science; it is exacting, as all sciences are; and while the educational profession needs to be made as attractive as possible, especially in days when so many other professions enter into competition with it, and while it loses attractiveness if teachers, both men and women, are compelled to retire from it at too early an age, yet it is obviously wrong to sacrifice the many to the individual or the scholars to the teacher by obliging a schoolmaster or mistress to continue in office when he or she is no longer able to perform the duties of the scholastic calling with full efficiency.

More than forty years have elapsed since the passing of the Education Act of 1870. That Act was a signal legislative achievement; it still reflects lustre on the names of Mr. Gladstone and Mr. Forster. In the intervening years it has been subjected to severe controversy, not so much on educational as on ecclesiastical grounds. It has undergone some grave modifications at various times, especially in 1902. But, after all, the main principles embodied in the Act of 1870, viz. that education is a national concern, that the children are the greatest asset of a State, and that it is the interest no less than the duty of the State to provide, or to see that provision is made, for the education of all children in elementary or other schools, have not been, and in all probability will not be, seriously challenged.

The Act of 1870 has proved to be a great moral reform. It lifted the nation as a whole to a new level of self-respect. For the child who has acquired even such elementary learning as is popularly symbolised by the "Three R's" is a higher being than the child who cannot read or write. The elementary-school teacher, not in denominational schools alone, has been a missionary of civilisation, and, I think I may say, of Christianity, in many a dark region of many a populous city. I have been told that to the influence of the Board Schools in East London was traceable a marked advance among children in kindness to the lower animals. Any disparagement or depreciation of the Education Act of 1870 is little less than treason to the moral interests of the people at large.

But it is permissible to inquire what fresh light has been shed by the experience of forty years upon the established system of elementary education in England.

Perhaps the two dangers most evident at the present time are the tendency of the Board of Education towards bureaucratic control over all the schools coming under its jurisdiction, and the habit of imposing upon the local education authorities, whether by Act of Parliament or by ordinance of the Board of Education, a number of new duties without ensuring any corresponding increase of the public funds which are placed at their service.

It is idle, and it would probably be foolish, to resist the concentration of educational authority in the Board of Education. There are signs that the Board will before long exercise a direct influence even upon the great public schools. But who or what the Board of Education is remains somewhat of a mystery. It is too apt to mean a subordinate individual acting in the name, but without the knowledge, of his superiors.

The Board may have stereotyped elementary education overmuch; it may have laid down too rigid rules or have administered its own rules with too much rigidity; it may have set an excessive store by results which could be easily tested by examination, forgetting that the best and most lasting results of the teacher's influence are just such as cannot be easily weighed in the examiner's balances. But there can be no doubt that the control of the Board has exercised a wholesome influence upon the less satisfactory schools. It assures at least a minimum of efficiency. But the maximum of efficiency lies beyond the power of the Board. It depends upon the close, intimate, sympathetic, personal relation of the teacher to his or her pupils.

Nor, again, is there any doubt of the advantage arising from the gradual pressure of one and the same education authority, not only upon all schools of the same type, but upon schools of different types in the educational field. It is well that elementary schools should within certain limits exhibit something like uniformity of system; it is well, too, that the ladder by which students rise or may hope to rise from the lowest to the highest rungs of educational competency should be so set up as to make the process of climbing them no more difficult than it must needs be. But freedom, spontaneity, individualism, have been the rule in all departments of English life. No power can be more chilling in its effect upon intellectual enthusiasm than the dead hand of a code. Individualism with all its faults is better suited than the rigidity of the French or the formality of the German educational system to the hereditary genius of the English people. It is necessary, therefore, that the control of the Board of Education, while it is definite, should be as elastic as possible.

Again, the State has laid upon the local education authority the duty of supplying the necessary accommodation in elementary schools, except so far as it is supplied in non-provided or denominational schools through the agency of voluntary subscriptions. But it has scarcely taken account of the difficulties lying in the way of an education authority which can issue no precept of its own. Every education committee in England to-day is harassed by the obligation of persuading a body so hard-hearted as a city council, which is naturally inclined to look upon economy with more favour than upon education. The antagonism between the schools and the rates remains constant. Happy indeed is the education committee in a city where the council rises above the temptation of regarding education as an extravagance or a luxury.

The provision of free meals for hungry children is an admirable reform. For if children under the law must go to school, they cannot go with any advantage if they are hungry. But free meals cost money; and the money spent upon the meals may easily be deducted from the total sum which is spent, or ought to be sepent, upon education.

Not less admirable a reform is the physical inspection of children in elementary schools. Educational as well as medical science has learnt that hygiene is a powerful factor in the success of schools. But it is necessary to pay for a doctor's time and a doctor's skill; and if the physical welfare of the children is improved by medical attention, it is possible that their mental welfare may be impaired for lack of money.

It must be added that, in proportion as Education Committees undertake and prosecute the benevolent work of caring for the crippled and afflicted children of the country, their just demands upon the public purse will necessarily become more pressing.

Upon the whole I am not disposed to criticise the education which is given in the different standards of elementary schools. It is not, I think, ill adapted to the twofold object of preparing the children for their normal duties in after-life, and of offering to especially intelligent children the chance of rising to a higher position than that in which they have been brought up. But no teaching, however reasonable in itself, can be properly imparted where the classes of children are too large. If I have learnt any lesson by my educational experience, it is that difficult cases—and these are the cases which try the teacher's skill—need a great deal of individual time and thought. I used to feel, when I was a schoolmaster, that there were not more than two or three of my pupils whom I did not think I could have helped and possibly saved, had it been in my power to spend sufficient thought and time upon them. It is overcrowding which is the difficulty in schools as well as in homes; and I do not believe that any schoolmaster or schoolmistress can do full justice to a class of more than twenty or at the most twenty-five small children.

But this, again, is a matter of expense, and as a matter of expense it touches the rates.

Upon the whole, too, I do not regret the substitution of Education Committees for the original School Boards. It is true that the ideal picture of School Boards consisting of educational experts who cared pre-eminently or exclusively for the educational needs of their city is naturally pleasing to the imagination. But the School Board, with its power of invading the public purse, lent itself to friction with the civic authority. At present the Education Committees connect the education of a city by a direct personal chain with its civic administration; and if the civic element upon the Education Committees should ever seem to fail in educational knowledge or interest, the opportunity of coopting educational experts, and among these experts men and women who might often shrink from the ordeal of a hotly contested election, would seem to afford a sufficient guarantee against indifference.

But after some careful consultation with persons who in Manchester and elsewhere have studied for many years the problem of public elementary education, I have been led to the conclusion that the reforms needed at the present time are principally the following:

The control of the Board of Education over local education authorities has become too strong and too stringent. It is probably stronger and more stringent now than it has ever been since 1870. It would be wise, I think, to leave or to place greater administrative power in the hands of the local education authority. Local authorities understand local needs. So long as they do not depart from the general principles laid down by the Board of Education, they should be free to expend each its share of the public monetary grant in the way which they hold to be best for their own communities.

I see no need for a dual system of inspectors in elementary schools, and I think it tends to the interference of H.M. inspectors with details upon which their judgment is sometimes more confident than their knowledge is profound.

It is difficult in speaking of inspection to refrain from all allusion to the notorious circular letter which was issued some time ago in the name of Mr. Holmes. That letter was not, I think, so wrong in sentiment as in language. Inspectors chosen from the ranks of the elementary-school teachers may be deficient in breadth of sympathy, as other inspectors educated in the ancient universities may be deficient in practical experience. It is much to be hoped that the unnatural contrast between the antecedents of two classes of inspectors will pass into the background, and that the duty, which lies upon all education authorities, of appointing the best men or women as inspectors, whatever anyone's antecedents may have been, will regulate all appointments in the future.

The period of a child's school life is now too brief. There should, I think, be a universal minimum age at which children may leave school. It should probably be fourteen years. But whatever that age is, it should be absolute. It should be wholly independent of local by-laws, of the passing of standards, or of attendance at school before the age of fourteen.

The question of evening schools is fraught with difficulty. To make attendance at such schools compulsory would be to run a serious risk of over-pressure. It is probable that sympathetic cooperation between local education authorities and the employers of labour in the locality will in this matter afford the best hope of success. For it is the interest of the employers themselves that their employees should not cease to improve themselves in knowledge so soon as they leave the elementary schools.

The need of the local education authority for increased financial help out of public funds was recognised, I think, in Parliament during the debates on the last Education Bill. The State cannot make fresh demands upon the education authorities without granting them fresh funds. Yet there can be little doubt that the feeding of necessitous children and the care of the epileptic, feeble-minded, and crippled children will soon or late become duties imposed by Parliament on all local education authorities.

Lastly, the connection between the elementary school and the university or the technical school should be made complete. At present the elementary school provides education for children up to their fifteenth year. The university or the technical school does not admit pupils under sixteen years. But education, when it is once broken, is hard to resume. The educational system, if it is to be efficacious, must be continuous.

A public elementary system of education must be complete in itself, so far as it prepares children physically, intellectually, and morally for the affairs of life. But it must not lose sight of the possibility that some, and those the most promising, of the children educated in elementary schools will deserve to rise to a higher than an elementary educational standard.

It is probable that the ascent of pupils from one class of school to another will become more usual in future years. This ascent will be effected or facilitated, as to some extent it already is, by the provision of free places, bursaries, exhibitions, and scholarships. Even now boys educated in elementary schools have attained the highest honours in the ancient as well as in the modern universities. Some such boys have won admission to the public schools, and among these schools to boarding schools as well as to day schools. Whatever amount of social exclusiveness may still apparently linger in that most truly democratic of English institutions, a public school, it seems to me impossible that in a democratic age there should ultimately remain any school which will not open its doors to pupils who are drawn from every social section of the community. In the education of girls, the schools of the Girls' Public Day School Company and other similar schools, whether publicly or privately governed, have done much to mitigate, if not to dissipate, the social differences among girls living in the same locality.

But the agencies by which children of comparatively poor parents have in the past been enabled to receive an education in the schools, and indeed in the universities, of the rich are, I am afraid, coming to be gravely abused. Scholarships and exhibitions were designed to remedy the disadvantage of the poor, not to accentuate the privilege of the rich. To confer pecuniary rewards upon boys and girls whose parents can well afford to dispense with them is to foster a double abuse. It is to spend money where money is not needed, and to withhold money where it is needed. Yet in the public schools, and to some extent in the universities, scholarships and exhibitions tend to become the perquisites of the rich. In the field of secondary education the competition for scholarships and exhibitions has become so severe that scarcely any boy in the examination for them stands a chance of success, except at the cost of three or four years spent beforehand in an expensive preparatory school. But as rich boys are the only boys whose parents can afford this preparatory expenditure, it follows that rich boys are generally the successful candidates for scholarships and exhibitions. The evil is scarcely capable of exaggeration. It were bad enough that a rich boy, if he competed on equal terms with poor boys, should obtain a pecuniary reward which they do, and he does not, need for educational purposes. But when it is the rich alone who enjoy the opportunity, or the most favourable opportunity, of winning the pecuniary rewards which were justly intended for the poor, a case for drastic reform seems to be made out.

At the ancient universities the sons of rich parents, although they are generally eligible for such prizes as scholarships and exhibitions, do not possess the same advantage in competing for them. More, too, has been done in the universities than in the public schools to provide means by which the sons of rich parents may enjoy the distinction without the emolument of a scholarship. But it is an urgent matter that, alike in the colleges of the universities and in the public schools, the pecuniary benefits, by which alone deserving boys can rise above their hereditary surroundings, whether bursaries, exhibitions, or scholarships, should be strictly confined to the sons of the poor.

Here perhaps it is permissible, as it is certainly natural, to enter a protest against the established tyranny of examinations. Examination was once the obvious remedy for favouritism. But a mere examination in knowledge can never test some of the highest qualities which fit men and women for the service of the State. In India even more than in Great Britain the failure of examinations is conspicuous. A facility for answering questions upon paper is easily associated with grave defects of intellect and character. In proportion, then, as favouritism ceases to be a public danger, examinations will, I think, lose something of their fatal authority. It is difficult to doubt that in the future candidates for public office will be required to pass a qualifying examination, but that the election will, at least in some degree, turn upon qualities which are not so easily tested by examination in writing.

Nor is this the whole evil. There is only too much danger that examinations may create a false ideal of educational success. The object of all education, as I have said, is to prepare pupils for the civic duties of mature life. It is not the intellectual attainment of the young at the age of thirteen or eighteen or even twenty-two, it is rather the service which they render to the State in the maturity of their powers, which is the proof of the teacher's influence upon their lives. The preparatory schools, which have become such important features in the field of secondary education, have done much useful work. The decadence of bullying and perhaps of other evils in public schools is largely due to the elimination of quite young boys from public-school life. The years of a boy's life from nine to twelve, but not, I think, to a later age, may well be reserved for the preparatory school, as the years from thirteen to eighteen for the public school. But the forcing process which is sometimes applied to young boys in preparatory schools, not only in their lessons but in their games, is fraught with serious peril. A preparatory-school master, if he thinks of his own school alone, may do even worse harm than a public-school master by sacrificing the future of his pupils to the present. When I was a headmaster, I knew of one preparatory-school master who tried to win boys to his school by offering what he called pre-preparatory scholarships to boys of eight or nine years of age, in the hope that these boys might after a time serve as advertisements for his preparatory school by winning scholarships from it at the public schools. But preparatory-school masters are not alone in fault. It is, I am afraid, easy to think of headmasters who have attained what I can only call an ill-deserved reputation, because their pupils have won numerous scholarships and exhibitions upon leaving school, when those same pupils had been mentally exhausted in youth, and their after-life in no way answered to the promise of their early days. "By their fruits ye shall know them": but the fruits of a true education are seen not in the spring but in the summer or the autumn of a well-spent life.

It is with reference to the final goal of education that the subjects suited to the secondary curriculum must be judged. If the possible subjects are too many, it becomes necessary to strike the balance between utility and culture, and so to decide which subjects are indispensable and which may fairly be subordinated or postponed.

The most striking change which has come over secondary education has arisen from the number of subjects now claiming admission to the curriculum. Scarcely more than fifty years ago the headmaster of a public school was almost at his wits' end to fill up the time-table of his pupils. Dr. Arnold was appointed to the headmastership of Rugby in 1828, and Dean Stanley says of him that "he was the first Englishman who drew attention in our public schools to the historical, political, and philosophical value of philology of the ancient writers, as distinguished from the mere verbal criticism and elegant scholarship of the last century." He adds that, "besides the general impulse which he gave to miscellaneous reading both in the regular examinations and by encouraging the tastes of particular boys for geology and other like pursuits, he incorporated the study of modern history, modern languages, and mathematics into the work of the school, which attempt, as it was the first of its kind, so it was at one time the chief topic of blame and praise in his system of instruction." Other public-school masters followed suit, but they followed slowly. What the system of education had hitherto been may be judged from Malim's "Consuetudinarium," which specifies no subject of instruction except Latin, with a little Greek grammar in the sixth and seventh forms. The dancing-master was a more ancient and more honourable figure in some public schools than any mathematical master. Mathematics, in fact, were not introduced into Eton until 1836. Other subjects in addition to the classics came even later.

But within the last fifty years, not only mathematics but the English language and literature, foreign languages, natural science in its various branches, history and geography, have become competitors with the ancient classical languages for recognition in the curriculum of public schools. There is no one of them which is not worthy of such recognition. But the average intelligence of a public-school boy has remained the same, and the average length of his life in the public school has been diminished by as much as one-half. It has become necessary, therefore, to make a selection between the subjects which might well, if they could, be taught to all boys alike. Nor is this truth less applicable to girls than to boys.

It may be thought that not enough attention has been paid to the order in which particular subjects are taught. The number of subjects imposed upon a child of ten to twelve years is at times not less alarming than forbidding. Psychology suggests the adaptation of particular subjects to the awakening of particular powers at different ages. Even in literature there is a natural affinity which is too often disregarded between books and the ages at which they ought to be read. How many children have read "The Pilgrim's Progress" at too late, or have read "Hamlet" and "Paradise Lost" at too early, an age for true appreciation! In literature as elsewhere discrimination is the watchword of educational success.

From these considerations it seems to follow that the scientific educator must choose certain subjects as the basis of secondary education, and I venture to think that these subjects should be as nearly as possible common to boys and to girls. Other subjects can be left to the choice of particular students at a later period of their lives. Not all subjects are possible or useful to all students. Soon or late, then, uniformity of teaching must give way to specialisation.

Yet education loses a great part of its value unless it ensures to all educated men and women what may be described as a common educational property. It is desirable that they should not only all learn some things which are worth knowing, but that they should learn the same things. For upon community of information or of interest depends the sympathy of all educated people. If one person knows nothing but French, a second nothing but chemistry, and a third nothing but mathematics, it is evident that they possess no common stock of knowledge; no interchange of sentiments or ideas is possible between them. All sound secondary education, then, postulates a broad basis of common knowledge, or, in other words, a certain body of knowledge which is possessed by all students in common. Upon this basis must be built a superstructure varying in accordance with the needs or capacities of the pupils.

What, then, are to be the basal subjects of secondary education?

They must be few, they must be suitable to the tender years of school life, they must be practically useful, and yet they must possess the element of culture.

Religion, of course, will be one, for it is the paramount factor in the discipline of character.

The study of mathematics possesses the unique merit that it shows what proof is; it distinguishes certainty from probability; it evidences the narrow limits within which certainty is possible.

Natural science in its various branches is especially valuable as cultivating the faculty of observation. Scientific facts can be generally tested by experiment. It is only the pupil who has learnt at least the elements of natural science that begins to feel at home in the world in which he or she lives.

But among educational subjects the palm, I think, belongs to language, if only because language is the subject which stands, by its character as well as by its origin, in the most intimate relation to human nature. Men and women are not generally concerned with questions which can be absolutely and ultimately determined. Most questions in life are probable, but not certain; it is "probability," as Bishop Butler says, which is "the very guide of life"; and such, too, are generally linguistic questions. They do not admit of certainty; they can be decided only probably; and the decision of them requires tact, judgment, and feeling. That is the reason why the school of languages is called Literae Humaniores at Oxford. Language is the one pre-eminently human or humane study.

But it is evident that different languages, as instruments of education, may stand on different grounds.

English boys and girls cannot afford to be ignorant of their own language or literature or history. For they use every day the English language; their minds are fed by English literature; and the past history of their country affords them guidance in the present and the future.

Foreign languages, on the other hand, are practically useful in the relation of Englishmen to other nations. It is possible that these languages will become less important as the English language spreads over the world. But for the present at least a knowledge of some modern language is desirable, not only as a means of mental discipline, but also as a means of intercommunication. One modern language at least, then, may fairly be regarded as entering into the basis of secondary education; and that language at the present time would naturally be French, although much is to be said for German and something for Spanish.

The educational difference between languages and other subjects is, I think, more clearly marked than the difference between one language and another. Whatever intellectual benefit is derivable from an ancient language may in a greater or less degree be derived from a modern language. But it has been shown by many writers, as, for instance, by J. S. Mill in his rectorial address at the University of St. Andrews, that a classical language, like ancient history, if only in virtue of its remoteness from present interests, possesses some educational advantage, and this advantage is particularly clear when an ancient language stands in the relation of Latin to the Romance languages or to any considerable number of languages in actual use. Latin must therefore enter into the general curriculum, and I attach great value to keeping Latin as a subject of general study in secondary schools. For the prejudice of parents in the present day against dead languages is unhappily strong. I have spent much of my time in trying to convince parents that their sons would be better educated by the study of Latin, if not of Greek also. It is for this reason that I regret the somewhat pedantic insistence upon pronunciation of Latin according to a method which, whether it be historically correct or not, will certainly tell against the universality of Latin as a subject of study. I do not believe the modern pronunciation is correct; but whatever may be the philological value of that pronunciation, I feel no doubt that the artificiality, as it seems to parents, of the non-English way of pronouncing Latin will, like the artificiality of the Greek type, create a prejudice in many minds against the study of Latin. Nor is this all; for the study of Latin loses a good deal of its practical value if every or nearly every Latin word is by the method of its pronunciation divorced from the corresponding word in English. It does not really matter in the present day how Latin is pronounced. Latin is no longer a medium of oral communication, even amongst scholars. The vital matter is that Latin should be one of the subjects constituting the permanent basis of education in all secondary schools.

Apart from these subjects, viz. religion, English, French, Latin, mathematics, and natural science, there is none, I think, which can justly claim a part in that knowledge which I have ventured to describe as the common property of all boys and girls in secondary schools. It is, in my judgment, a happy circumstance that preparatory-school masters have practically decided to relinquish the teaching of Greek, and to concentrate their efforts upon such subjects as form the natural basis of secondary education.

But upon the basis so constituted the teacher will try to erect a varying superstructure, by offering as wide a range as possible to individual tastes. For if the secret of education lies in discovering what a pupil's capacity is, and so in helping him or her to cultivate it, education must pass soon or late from the common basis of subjects to specialisation. It is not my business now to decide how the principle of specialisation should be applied. That is a problem which the individual schoolmaster or schoolmistress must work out for himself or herself. The two points upon which I would venture to insist are the common educational property and the wide elasticity allowable so soon as this common property has been gained. But I am of opinion that, while specialisation is allowable and desirable in the later years of a boy's or girl's life, it should never be complete. The dying out of double degrees in the Universities of Oxford and Cambridge has always seemed, and still seems, to me unfortunate. For it means that nobody now gets so thorough an education as was possible if the student applied himself through his life at school, as well as at the university, both to classical and mathematical studies. The amplification of the several studies may have justly affected the course of education in the universities; but it is my deliberate conviction that a boy or girl whose time is wholly or mainly given to one subject only during school life loses a signal opportunity of obtaining a generous education.

It is tempting to me as an old schoolmaster to linger on the field of secondary education. But the limit of time at the disposal even of the president of a section forbids me to think of adverting to more problems of secondary education than the two following:

Public opinion has always been divided in the education, whether of boys or of girls, between boarding schools and day schools. Adam Smith in his "Theory of Moral Sentiments" went so far as to say "that the education of boys at distant great schools, of young men at distant colleges, as well as ladies in distant nunneries and boarding schools, seems in the higher ranks of life to have hurt most essentially the domestic morals, and consequently the domestic happiness, both of France and of England." The complete severance of a boy or a girl, except during the holidays, from parents and family is evidently, or may evidently prove to be, an evil. It tends to undermine some of the graces of character; it produces in boarding schools the same defects, but perhaps, too, the same merits, as are observable in celibate religious institutions, like monasteries and nunneries. There is too much tendency, especially among parents of the wealthy class, to feel that they have done their duty to their children in paying their children's school fees, and to hand them over to the schoolmaster or the schoolmistress without any thought of the influence which the home ought to exercise upon young lives. It is reasonable to suppose that, if the sense of parental responsibility could be revived, fathers and mothers would be more anxious than they are now to keep their children at home in the early years of their lives. Preparatory day schools, at least in the great cities, will, I think, acquire a growing importance. But at present the choice between boarding schools and day schools for boys, and in a less degree for girls, is largely determined by pecuniary considerations. For in truth the great public boarding schools are such characteristic features of English life among the upper social class, they have gathered to themselves such a wealth of tradition and influence, they are so deeply rooted in the confidence and affection of the English-speaking world, that it would be difficult, if not impossible, to replace them. Nor can it be doubted that the education given in these schools, however rough and ready, however deficient in some respects it may have been, has yet done much, in Canning's bold ecclesiastical phrase, to produce "a supply of persons duly qualified to serve God both in Church and State," and has tended to foster some of the qualities by which the English race has attained its sovereign position in the world.

Again, there is the question of co-education. For if the early education of boys and girls may, as I have argued, safely proceed on the same lines, it may be held that they can well be educated together. Nor is there any valid educational reason why boys and girls should not be educated together, as they are in the United States of America. In England itself they receive their early education, and they are beginning to receive their academic education, together. It is at least conceivable that co-education throughout the period of school life may come to be the rule in day schools. In boarding schools, however, where the life is ordered on somewhat artificial principles, co-education would almost certainly create problems which would enhance the difficulties of the master or mistress. I do not, therefore, anticipate that co-education in schools will assume a large importance in English life.

So far I have tried to indicate a few of the problems calling for the attention of persons who are engaged or interested in secondary education. Here at least I may claim to speak with some degree of experience. It is with hesitation that I approach the subject of the highest education as given in the universities, especially in the Universities of Oxford and Cambridge.

The elasticity which is characteristic of English life has in the last half-century created a number of local universities beside the two ancient universities. It would be unwise, even if it were feasible, to aim at assimilating the ancient and the modern universities. It is not impossible that the modern universities will lead the way in educational reform. The dead hand of the past lies heavily upon the historical seats of learning. No fact of educational history seems to be stranger than the inability, perhaps I ought to say the unwillingness, of the universities to reform themselves. It might have been anticipated that a home of learning would be a seat of powerful reforming energy. It has not proved to be so. The Universities of Oxford and Cambridge have been reformed more than once, but the reform has come from without and not from within. Whether the present Chancellor of the University of Oxford will succeed in persuading the university of which he is the distinguished head to reform itself without waiting for the action of Parliament is a question on which it would be unsafe for me to venture an opinion. But his plea for reform is itself a proof that reform is needed. It will not, however, be unfitting that I should insist upon the value, and the ever-increasing value as I think, of the work belonging to the modern universities in the great cities of the land—can I be wrong in saying pre-eminently to the Victoria University of Manchester? History seems to suggest that the association of a seat of learning with a great centre of industry may produce the best results, in so far as it imparts culture to industry and practicality to learning. The modern universities have appealed with striking success to the generous instincts of local patriotism. They have shown the possibility of gathering an earnest body of teachers, and through them of imparting a genuine intellectual culture to a large number of students, without imposing artificial restrictions upon their studies. They have proved the possibility of uniting men and women upon equal terms in the same academic institutions. The Victoria University has aimed with conspicuous success at solving the difficult problem of uniting the teachers who belong to the different branches of the Church in a common faculty of theological learning. In some of these respects if not in all, the Universities of Oxford and Cambridge will probably follow suit. It can scarcely be doubted that the time is not distant when Oxford and Cambridge will open their doors to students without insisting upon the so-called compulsory study of the Greek language. I speak as one who more than a quarter of a century ago argued against the policy of requiring some knowledge of two dead languages from all students as a condition of entrance into the ancient universities. Such a requirement may have been possible, and even reasonable, when educational subjects were few. It cannot be maintained when those subjects have been greatly multiplied. For the result is either that the study of two dead languages, or at least of one among them, is little more than a farce, or that it causes an unhappy disturbance at a critical period of a boy's intellectual life. Nay, I should be tempted to say that to boys who have received their education on the modern sides of public schools the obligation of acquiring some smattering of Greek knowledge is both a farce and a nuisance.

Nobody feels more keenly than I the intellectual benefit of studying the Greek language and literature. It is my sincere hope, as it is my firm belief, that, when Greek rests upon its own intrinsic merits as a factor in human culture, the study of Greek, if it is less general, will not be less profound than it has been. But times change, and compulsory Greek as a universal subject is unsuitable to the present time, not because it is useless in itself, but because it bars the way more or less against other studies which are still more important. The universities enforce their law upon secondary schools. The schools must teach what the universities require; they cannot teach, or they can only teach within a fixed limit, what is not required at the universities.

In my own mind, however, the abolition of compulsory Greek is only a step to a change in the intellectual atmosphere of the universities. I hope that Oxford and Cambridge will cease to insist upon Greek; but I hope that, when they cease to insist upon Greek, they will require from all students the evidence of some serious learning in some subject or subjects of higher education. Nobody who is conversant both with the ancient and with the modern universities can fail to be aware of the difference in their tone. The atmosphere of a modern university is intellectual. Men and women come there as students; they come to learn, and they do learn. At Oxford and Cambridge the atmosphere is much more social; and the number of undergraduates who can in any sense be called serious students is but a fraction of the undergraduate body. The time is, I hope, approaching when a degree conferred by the Universities of Oxford and Cambridge even upon a passman will be a certificate of a certain definite proficiency in some recognised subject of academic study. For it seems to me that the ancient universities in conferring degrees without an adequate guarantee of knowledge are largely responsible for the indifference of English society as a whole to the value and dignity of learning.

No doubt there is force in the plea that the universities cannot afford the pecuniary loss which would result from the policy of excluding passmen, or of pressing hardly upon them. It may be answered that no pecuniary consideration can justify a university in ceasing to be primarily a learned body. But women students are more earnest than men; and if the universities grant degrees, as I hope they will, to women equally with men, they will probably find that they will receive as much money from the addition of the serious students, who will then belong to them, as they now receive from those students who are not serious at all.

The Universities of Oxford and Cambridge have made frequent appeals for pecuniary support. Education—especially scientific education—is expensive, and it tends to increase in expensiveness. But I have sometimes wished that, before money is poured into the exchequers of the universities, a commission, composed of men who are fully sympathetic with academic culture and yet have been trained in the habits of business, could issue a report upon the use now made by the universities and by the colleges of the funds which they severally command. I am of opinion that such a commission would not prove unable to suggest the possibility of large economies which might be carried out without impairing the efficiency of the universities as seats of learning, or even of the colleges as homes for the students whose proper object in their academic life is to acquire learning.

All that remains is to offer an opinion in some few brief words upon some subordinate matters of academic education.

There is something to be said in favour of, but more perhaps to be said against, the proposal for two concurrent kinds of degrees, the degrees of Bachelor and Master in Arts and of Bachelor and Master in Science. For the academic degree possesses a recognised advantage as setting one and the same hall-mark upon all persons who possess it. It would be less distinctive, and therefore less valuable, if its significance were not uniform. Nor does there seem to be any valid reason against conferring the degree of B.A. and M.A. upon all students who have shown themselves to possess a certain uniform culture, whatever special study or studies they may have pursued and whatever degree of excellence they may there have attained, after satisfying the requirement of culture demanded from all persons who aspire to the possession of an academic degree.

Again, it is desirable that every university should be free from theological restrictions. I look forward, therefore, to the time when the Universities of Oxford and Cambridge will recognise Nonconformists no less than Churchmen as eligible, not only for degrees, but for lectureships and professorships in the technological faculty. There is a broad distinction between the study of theology and the profession of theological beliefs. It is no hardship upon a student that he should be examined in theology so long as he retains his complete freedom of theological opinion. That theological recognition should be accorded to none but persons of particular views upon theology is in conflict with the highest interests of theological learning. At present the Universities of Oxford and Cambridge are the close preserves of the Church of England; the natural result is that the modern universities tend to become the preserves of Nonconformity, and neither class of university is benefited by the consequent one-sidedness of theological study.

The co-education of men and women in the universities, whether ancient or modern, is already an established reality. The only difference is that co-education is recognised in the modern, and is not recognised in the ancient, universities as necessarily leading to an equality in the matter of degrees. The real objection to placing women on an equality with men in their relation to a residential university is the difficulty of finding room for a number of female as well as male students within the precincts of the same university. On that ground alone there is some advantage in universities or colleges for women only, such as the Royal Holloway College; but experience has shown that colleges for women do not flourish except in close relation to a university in which the education of men is carried on, and I feel no doubt that the granting of academic degrees at Oxford and Cambridge to women as well as to men is merely a question of time.

No critic of the ancient universities, and certainly no one who has spent some happy years there as an undergraduate and a Fellow, can forget that the social as well as the intellectual side of the life is a part of its privilege and benefit. But that social intercourse would lose something of its value if students of different classes and different creeds did not mix freely. It is too often forgotten, in the zeal for ecclesiastical propaganda, that one element of education lies in teaching people who do not agree to work together. To make the least, and not the most, of personal differences is a factor in the life of universities. It is for this reason that I do not look with any great favour upon the institution of special colleges set apart for Churchmen or for Nonconformists or for men of poor and humble circumstances. It is better that such students should, as far as possible, associate with other students; for in such proportion as undergraduates of religious feeling or of strenuous self-denying character are educated by themselves, there is a diminution of their valuable influence on the mass of the undergraduate body. There might as well be Conservative Colleges and Liberal Colleges as colleges of a special and exclusive theological character.

Colleges are expensive features of academic life, and they tend to become more expensive; but the expense is justified by the benefit which the students may receive from the influence of their teachers upon their lives. But if colleges are to exist as integral parts of the university, there should be a sufficient number of Fellows and tutors living within their walls. No feature of modern life at Oxford or Cambridge is more pitiable than the spectacle of a married don coming into his college at a late hour of the evening, with his carpet-bag in his hand, to fulfil the statutory obligation of sleeping within the walls. No deep personal interest or influence of a tutor in the lives of his pupils is possible in such circumstances as these. If only it were possible to defer the opportunity of marriage until a man has rendered some years of service by residence within the walls of his college, and then to grant it only to men whose service the college wishes to retain, the collegiate life of the ancient universities would be less likely to lose its effective value.

But when all is said, how great is the charm of the ancient English universities! They are unique; they exercise a lifelong spell upon pupils who have spent three or four years within their ancient walls; they foster, even if unconsciously, a noble sense of patriotic duty; they haunt the memory; they are fruitful in high and generous and sacred inspirations.

What is the spirit of a university? How is it born? How does it operate? Why is Cambridge in a special sense the home of mathematics, and Oxford of letters? Why is it that Oxford finds so many, and Cambridge so few, representatives upon the public Press? Cambridge, it seems, has played the greater part in the thought, and Oxford in the life, of the nation. But why is it that Cambridge has given to the world sons more famous, it may be, than any whose names belong to the sister university—Bacon, Newton, Cromwell, Milton, and Darwin? Why, above all, is Cambridge in so pre-eminent a degree the university of the poets? Such names as Milton, Ben Jonson, Herrick, Cowley, Byron, Gray, Wordsworth, Tennyson, belong to Cambridge alone. Nothing can replace, nothing perhaps can greatly affect, the relation of the ancient universities to the country the ornaments of which they are. What is needed, and will be more and more needed as democracy extends its power, is to enhance the strength of the influence which the universities exercise upon the national life at large.

So I bring this imperfect review of the educational problem in its present aspects to a close by insisting in two or three final sentences upon the supreme dignity of the teacher's profession. The man or woman who elects to become a teacher chooses a great responsibility. It is well that teachers should be disciplined for their calling by a system of training in the educational art. The theory of education as set forth in the writings of great educators like Comenius, Froebel, Pestalozzi, Arnold, Thring, Fitch, and many others, should be well known to them, even if the practical side of education is best learnt, or can only be learnt, by practice. Education needs the best men and the best women. It must, therefore, be set free from such bonds as have tied it to the clerical profession; nor can I think it is ever well to exact religious tests of teachers, for tests are apt to affect tender consciences alone. If only teachers are asked whether they wish to give definite religious instruction or not, and are subjected to no drawback or disadvantage if they choose not to give it, I think the teachers in all grades of schools may be trusted not to abuse their sacred opportunity. They must teach their pupils to love learning and virtue, and to love them for their own sakes. They must remember that it is the personality of the teacher which is the chief source of his or her influence on the pupils. They must ever be trying to make themselves more and more worthy of their responsibility. "Thou that teachest another, teachest thou not thyself?" must be the motto of their daily lives. But where the educational profession is one in all its branches, where it is actuated by a due sense of responsibility, where it aims in season and out of season at cultivating habits of self-respect, self-sacrifice, patriotism, and religion in the children who will be the citizens of the future, where it remembers that the supreme triumphs of educational skill are good men and women, good fathers and mothers, good servants of the State and of the Church, there is no ground of fear for the country or the Empire.

CHEMISTRY AT THE BRITISH ASSOCIATION.

THE meetings of the Chemistry Section were of unusual interest and briskness, all the speakers copying the example of clearness combined with brevity so admirably set by Prof. Walker in his presidential address. The section had organised its programme carefully beforehand and the arrangements made were strictly adhered to: as was to be expected, the subjects discussed were largely of a physical chemical character. A feature of the attendance was the presence of a number of members from the Physical and other sections; it was evident that papers of a type likely to bring sections together and to provoke discussion between the sections are those most required at the sectional meetings of the association.

There still remains much to be done by those responsible for the organisation of the Association in the way of preventing overlapping; it was noticeable, for example, that several chemical papers were read in other sections which should properly have been brought before Section B. It seems a pity also for a section which is taking part in a joint discussion to arrange for a separate meeting of the section at the same time, as this procedure affords specialists an excuse for avoiding the joint meeting. They thus neglect the opportunity of realising how differently in many cases the same facts are interpreted by followers of another branch of science.

The sectional meeting room was at first situated in Fawcett Road, a considerable distance from the other sections; this position was found to be so inconvenient that a move was made to the Municipal College. It would appear important that Sections A, B, and G be housed in close proximity, so as to facilitate exchange of views between members of these sections. The section was supported by several foreign chemists of distinction.

The proceedings were opened with Prof. J. Walker's address, following which Prof. Carl Barus, of Providence University, U.S.A., read a paper on the diffusion of gases through water in which a novel and simple experimental method was described. The method consists in finding the temperature-pressure conditions for the flotation at a given level of a cylindrical cartesian diver, in which the gas to be examined has been imprisoned. Slides were exhibited showing the details of the apparatus and the mass-time graphs for the interdiffusion of gases through water. Whereas the graphs for a single gas are linear, those for pairs of gases are of indefinite variety, and the very curious result of a gas apparently diffusing against the pressure gradient is frequently met with. Such anomalous results are explained in terms of the partial pressures of the constituents of the imprisoned impure gas.

Dr. W. C. McC. Lewis dealt with the compressibility of mercury. He regards the usually accepted value as incorrect, since for mercury the difference between the latent heat of vaporisation as determined and calculated from a formula involving the compressibility is large. Dr. Lewis suggests as possible sources of error in the experimental determination :—

(1) Effects produced by a layer of absorbed air or moisture, or both, between the mercury and the walls of the vessel;

(2) That the liquid (molasses mixture) into which the piston was dipped before insertion in the mercury is not completely removed; and

(3) The unavoidable slip of the mercury past the piston.

All these effects act in the same direction; *i.e.* they give rise to too great a volume decrease, that is, to too high values of the compressibility.

Dr. J. F. Thorpe followed with a somewhat technical paper on the chemistry of the glutaconic acids, in which he quoted experimental evidence to show that the molecule of glutaconic acid must have a symmetrical structure, and that the cause of the identity of the α and γ positions must be of the same order as that determining the equality of the meta positions in the benzene ring. Some interesting conclusions based on the experimental study of the properties of the alkylglutaconic acids were also described.

In a discussion, Dr. Lowry differed from the author's interpretation of his experiments.

Mr. G. Le Bas gave a summary of an elaborate paper on the effect of constitutive influences on the molecular volumes of organic compounds at the boiling point; the subject is too complex to allow of a brief abstract.

The last paper, by Prof. R. Wegscheider, dealt with the influence of substituents on reaction velocities. The elucidation of the laws governing the transformation of organic compounds is to be found in the study of reaction velocities. Prof. Wegscheider has chosen for this purpose the esterification of asymmetric dibasic acids and the saponification of their esters. He finds there are at least two different properties of the substituting groups which act to determine their influence on reaction velocities. One of these is the influence on the electrolytic dissociation; the other is termed steric hindrance, though it is a function of several single properties. Laws for the esterification of dibasic carboxylic acids were based on these considerations and their behaviour in actual practice exemplified; though on the whole satisfactory, there are numerous exceptions, but this was to be expected, as the assumption, that one property only of the substituent influenced the reaction velocity, can only be a rough approximation.

A report on the present position of electric steel making was presented by Prof. A. McWilliam. This is in type, and can be obtained at the British Association offices. The report shows the progress in the electric steel melting industry made during the year, whilst the actual state of the industry can be judged from two tables, in which are shown the furnaces, capacities, and kind of work done by the firms of Kjellin, Röchling-Rodenhauser, and Héroult. In this country we have Héroult's furnaces of a united size of 25 tons. A list is given of the applications of the electric furnace. The report is mainly a statement of industrial advance, and is somewhat disappointing from the point of view of the chemist.

The commitee appointed at the Sheffield meeting with a grant to study the influence of carbon and other elements on the corrosion of steel, reports on the behaviour of a series of six pure iron-carbon alloys prepared by the coke crucible process at Sheffield University. Carbon exerts two types of influence on the corrodibility dependent upon the condition of the carbide in the steel. In the rolled and annealed specimens the corrodibility rises to a maximum at the saturation point (0·89 per cent. of carbon), and then decreases upon the appearance of cementite in the steel. In the hardened and tempered specimens the corrodibility rises continuously from 0·1 per cent. to 0·96 per cent. of carbon, no maximum being observed at the saturation point. It is considered that the finer the state of division of the carbide in the pearlite the greater the liability to corrosion when immersed in sea water.

The treatment previously undergone by the steel also influences the solubility in acid solution. Curves are given for steels treated in different ways, showing the effect of increasing proportions of carbon. It is established that the resistance offered by carbon steels when immersed in solutions varies considerably, acording as to whether the solution is of the sea-water type or is acid in character. Each case must therefore be considered separately, and it is impossible to specify any particular composition or treatment offering the best resistance to attack under all conditions.

Friday, September 1, was devoted to papers on indicators and colour. Mr. Tizard's paper on the sensitiveness of indicators will be published in full, and copies will be available at the offices of the British Association. His main conclusions are as follows :—An indicator is now regarded as a pseudo-acid or base: the undissociated molecule consists of two, or more than two, tautomeric forms in equilibrium. This conception does not affect Ostwald's method of treatment, provided that the tautomeric changes that may take place are practically instantaneous. From a physico-chemical point of view the ions may still be regarded as differently coloured from the "undissociated molecule," if it be understood by this expression not one particular molecular species, but the equilibrium mixture of the various forms which the indicator can assume in its undissociated form. Applying Ostwald's dilution law to the special case of indicators, it is easy to show that when the colour of an indicator in solution is exactly midway between the extreme colours of its dissociated and undissociated forms, then the concentration of hydrogen ions (C_H) in the solution must be numerically equal to the dissociation constant of the indicator. Further, if this be denoted by $K\alpha$, the colour change takes place mainly between concentrations of hydrogen ions of $10K\alpha$ and $\frac{1}{10}K\alpha$. It follows that the most useful indicators are those which have dissociation constants not very far removed from 10^{-7} (the concentration of hydrogen ions at the true "neutral point"), between 10^{-5} and 10^{-9}, for example. An indicator which is a very weak acid or base is of no more value than one which is very strong. It is of importance to know the dissociation constants of indicators accurately.

If the range of sensitiveness of an indicator is known, it is possible to deduce the "end-point" of an indicator: that is to say, the probable concentration of hydrogen (hydroxyl) ions in a titrating solution at the point where titration is usually stopped. The end points of indicators can also be found by direct experiment; as a rule it is, of course, only possible to stop a titration *between* certain concentrations of hydrogen ions, the extent of the range depending on a number of factors.

The accuracy of a titration of any acid by any base depends very largely on the proper choice of an indicator. This may be seen most clearly by drawing curves showing the concentration of hydrogen ions in a solution of a salt when small quantities of acid or base are added in excess. From such curves it can be deduced that an indicator which has a sharp end point in any particular volumetric operation gives an accurate result to within about two parts in a thousand.

Dr. Lowry gave a valuable paper on the origin of general and specific absorption, virtually an extension of the report of the Commitee on Dynamic Isomerism, which is doing work of extreme value in this difficult field. During the past year attention has been directed to the study of general absorption, and attempts have been made to determine the approximate positions of the inaccessible bands to which this type of absorption curve appears to be due. The method adopted depends on the fact that most of the optical constants of a substance increase with great rapidity when an absorption band is approached, and appear to tend towards an infinite value in the case of a sharply defined absorption-line. With carbon compounds the magnetic rotatory dispersion has been found a convenient property to discuss, and the measurements have been used to calculate the position of the heads of the inaccessible bands by which the general absorption is produced.

The chief conclusions drawn are that the optical properties of most saturated carbon compounds are determined by an absorption in the far ultra-violet. The dominant absorption is brought nearer to the visible region by introducing an ethnoid linkage, as in allyl alcohol, or a benzenoid nucleus, as in phenylethylcarbinol, but in none of the simple compounds investigated does it fall within the region usually photographed in the study of absorption spectra.

Mr. J. E. Purvis described the ultra-violet absorption spectra of the vapours of organic substances, as compared with their absorption in solution and in thin films, and discussed the results from a consideration of the movements of the atoms of the molecules being influenced by their nature, weight, type, and orientation. The vapour molecules have a greater freedom of movement and a considerable number of bands are produced. In solution the solvent acts partly as a constraint on the vibrations, partly as a barrier to the number of encounters, and partly as an absorbent of the radiant energy, so that the narrow absorption bands of the vapours are usually replaced by wide diffuse bands. In thin films the movements of the molecules are further restricted; the selective absorption is not unlike that in solutions, but the bands are shifted more towards the less refrangible regions.

Dr. P. V. Bevan introduced the subject of absorption and dispersion in metallic vapours. Following the work done by R. W. Wood in the case of sodium, he has measured the characteristic lines of other alkali metals. These all appear as absorption lines when white light is passed through the vapours of the metals; with increase of density of the metal more lines come into view. They form a series, getting closer together at the ultra-violet end of the spectrum. The bearing of the phenomena of dispersion in metallic vapours on the optical theory was discussed, particularly the views as to the nature of the atom and the vibrating systems that give rise to spectrum lines. Each line of the series is probably due to a special set of atoms, and there are indications that the complexity of a spectrum is not due to complexity of each individual atom, but to differences actually existent in the atom. There is a good deal of evidence leading in the same direction.

Rubidium and cæsium vapours are obtained practically pure by heating the chlorides with lithium, owing to the much greater temperature required for vaporising lithium than for the other metals.

The concluding paper read by Prof. Pope summarised work done jointly with Prof. W. H. Perkin on optically active substances which contain no asymmetric atom in the molecule. The demonstration of the somewhat involved conceptions employed was rendered intelligible by the use of models. The authors have synthesised 1-methyl*cyclo*hexylidene-4-acetic acid and resolved it into optically active components by means of brucine. It is proposed to distinguish this type of asymmetry as "centroasymmetry." The action of bromine and other substances on these acids was described; it is remarkable that no evidence of any optical inversion was obtained. It is noteworthy, further, that the long series of changes to which the centroasymmetric acids were subjected yielded products, which did or did not show optical activity precisely in accordance with anticipations based on the study of the solid models representing the substances concerned. This is an important demonstration of the fidelity with which constitutional formulæ depict molecular configuration, and should not be overlooked by physicists.

Prof. H. Euler, of Stockholm, opened the proceedings on the Monday with a brief paper on the velocity of formation of enzyme systems. The results described, though of a preliminary character, were significant as showing how the amount of a particular enzyme in an organism can be caused to increase by cultivating the organism for several generations under suitable conditions. Experiments on the formation of invertase and of enzymes fermenting glucose and galactose were described. Prof. Euler had been unable to train certain yeasts to acquire the power to ferment galactose. In discussing the paper, Dr. E. F. Armstrong expressed the belief that there was an essential difference between the power to acquire an entirely new enzyme and that of regaining an enzyme, which had not been required by the yeast for many generations, and so had fallen into disuse. The former was impossible, whereas many brewery yeasts were able to regain, as the result of training, the lost property of fermenting galactose.

In opening a discussion on the part played by enzymes in the economy of plants and animals at a joint meeting of the Chemical and Agricultural Sections, Dr. E. Frankland Armstrong gave a definition of enzymes, pointing out their connection with practically all processes of metabolism in living organisms, and emphasising their specific nature. One function of enzymes is to break down complexes in the cell; there is a necessity for some restriction of action; otherwise the cell would soon be killed. The safeguards of nature to prevent this were described. It was shown how the leaves of the cherry laurel, which give off hydrogen cyanide, or those of the Japanese laurel, which blacken, can be used to indicate that changes are taking place in the plant cell. The resting leaf can be stimulated into activity by a number of substances, of which toluene and chloroform are examples, which as a class are characterised by being chemically inert substances, and further by having but little affinity for water. It is suggested that such substances, to which the general name hormone is applied, are able to penetrate the cell and bring about hydrolytic changes within it. A large number of substances which act as very weak hormones are found in plants combined with glucose, as the so-called glucosides. It is believed that one function of glucosides is to act as hormones when a specific mild stimulus is required by the plant. Each glucoside requires an appropriate enzyme to hydrolyse it before its constituents can be effective as hormones. The speaker alluded to the wide distribution of glucosides in plants, and gave an account of work done in localising and studying their appropriate enzymes. Whereas the leaves of a plant contain, as a rule, an enzyme adapted only for the glucoside contained in them, the seeds of the same plant contain an enzyme or mixture of enzymes able to attack a variety of glucosides. The practical application of these researches to a number of problems in animal and vegetable physiology and agriculture was illustrated in detail. The discussion was general, and mainly turned on controversial points.

The rest of the morning was devoted to a paper by Mr. A. E. Humphries entitled "Some Points concerning the Treatment of Wheaten Flour." This contained one new point of very considerable importance. It has been found that the addition of very small amounts of salts, natural to flour or to the ash of wheat, increases the size of the loaf, though it has no effect on the production of gas in fermentation. In one instance the mere addition of water to flour, so long as it was made at a time substantially prior to dough-making, increased the strength of the flour to an extraordinary extent. Investigation showed that, following the addition of water, there was actual change of the organic phosphorus compounds of the flour into inorganic, and that further a still larger proportion of the organic phosphorus compounds are transformed during bread-making. The change is probably enzymic in character.

In conclusion, Mr. Humphries alluded to the difficulties millers have to face, and claimed that they should be allowed to make use of the advances in chemical knowledge in the treatment of wheats and flours.

Tuesday, September 5, was reserved for papers on colloids. A very admirable and fluent introduction on the general theory of colloids was given by Dr. H. Freundlich, of Leipzig. Colloidal solutions stand between the two extremes of true solutions and coarse suspension, such as formed by very sparingly soluble substances which do not react with the solvent. Colloidal metals, sulphides and hydroxides are termed "suspension" colloids or lyophobic sols; organic colloids, which approach more nearly to the true solutions, are lyophilic sols, or "emulsion" colloids. In the coagulation of suspension colloids the electric charge is of importance, and the addition of an electrolyte, by discharging the particles, facilitates coagulation. In the case of emulsion colloids, the individual characters of the substances concerned are the determining factors, electrical conditions being of far less importance. An account was given of the phenomena of adsorption, which the author is inclined to regard as an effect of surface condensation. Finally attention was directed to the bearing of colloid chemistry in a number of directions. A very full discussion followed, in which Sir Wm. Ramsay, Prof. Martin, Prof. Trouton, and others took part.

The ensuing paper by Dr. Barger dealt specially with some applications of colloidal chemistry and its theories to pharmacology. In a second paper Dr. Barger gave an account of the adsorption of iodine by the glucoside saponarin, which, on account of its being a pure substance of definite composition and molecular weight, affords a more favourable instance than starch for the study of the iodine colouration.

The colloid theory of cements was the subject of a very lucid paper by Dr. C. H. Desch. The explanation of the setting of calcareous cements, as caused by the crystallisation of the products of hydrolysis from a supersaturated solution, fails to account for the great mechanical strength of such cements. The colloid hypothesis proposed by Michaelis attributes the setting to the formation of a gel of calcium silicate, which subsequently hardens by loss of water and adsorption of lime. Microscopical examination confirms Michaelis's view. The only constituent of the cement which is acted on is the alite. The hydrolysis of the complex substances contained in the alite first sets free calcium aluminate, which separates in the form of crystals. This constitutes the initial set. The calcium silicate is more slowly hydrolysed, and the calcium monosilicate produced, being extremely insoluble, separates as a colloidal gel. A part of the calcium hydroxide liberated crystallises in large plates, and is readily detected by the microscope, whilst another part is adsorbed by the silicate gel. The gradual increase of strength which is characteristic of calcareous cements is a consequence of the continued adsorption, and of the physical changes in the structure of the gel.

The colloids formed may be examined and characterised by staining with dyes, such as methylene blue, patent blue, and safranin. The principal difficulty in the microscopical examination of cements has hitherto been the brittleness of the material, making it impossible to grind very thin sections, resulting in loss of clearness. This may be avoided by treating the cement as a metallographic specimen, grinding and polishing one surface only, and examining under vertical illumination after etching with weak acids or staining with other reagents.

A brief paper on the rate of coagulation of colloidal copper, by Mr. H. H. Paine, described the preparation of the solutions and their coagulation by simple salts; there is an initial period during which the solution remains clear. The rate of precipitation is proportional to the square of the initial concentration of the colloid; for varying amounts of the electrolyte the rate of coagulation is proportional to some power of the concentration of the salt.

Reports were presented by all the sectional committees, and a new committee was appointed by the section for the study of plant enzymes, with Mr. A. D. Hall as chairman and Dr. E. F. Armstrong as secretary. Dr. Orton reported on the transformation of chloro- and bromo-amines into halogen anilides, on the velocity of chlorination of anilides, and on the formation of nitroamines. The attention of the Electroanalysis Committee has been directed during the past year particularly to the application of the electrometric method to the titration of weak acids in such liquids as tan liquors.

GEOLOGY AT THE BRITISH ASSOCIATION.

THE proceedings of Section C (Geology) were not marked by any epoch-making paper, but a number of subjects of geological interest were dealt with. On Thursday (August 31) the section opened with the address of the president (Mr. A. Harker, F.R.S.), which was a scholarly and stimulating treatment of some aspects of modern petrology, in which the arguments of his treatise on "The Natural History of Igneous Rocks" were followed to further conclusions on the conditions of their distribution and genesis.

Of those who did yeoman service to the section, Mr. Clement Reid, F.R.S., came easily first, his intimate knowledge of the locality being freely drawn upon at two meetings, and a third being made notable by a masterly paper on the relations of the Glacial period to the plant population of the British Isles.

Following the president's address came Mr. Reid's paper on the local geology. Portsmouth, he pointed out, was the centre of geological features of considerable interest, in which the student was brought face to face with many difficult problems. The geological map showed bands of colour ranging east and west, which in a flat country indicated inclined strata having a well-marked strike, and Portsmouth was near the central axis of the Hampshire Basin. It was also close to one of the subsidiary ripples on the great earth-wave, which formed Portsdown Hill. The Hampshire Basin was a great synclinal fold, and the planing of this fold by river and sea rendered visible 6000 feet of strata within short distance of Portsmouth. The oldest rocks seen on the surface were the Wealden and Lower Cretaceous beds of the Isle of Wight. The Chalk which forms all the higher hills may be taken as a foundation, as it is the oldest formation which plays any obvious part in the geology of Portsmouth. The upper zones had been carved away before the deposition of the Lower Tertiaries, and much of the Lower Eocene was also missing. The lowest brackish-water clays have yielded no fossils near Portsmouth, but the London Clay includes an irregular, siliceous bed (Bognor Rock) which is very fossiliferous. Succeeding these come the Lower Bagshot beds, which are poorly displayed near Portsmouth, but thicken out at Alum Bay into a mass of current-bedded sands in which occur beds of lignite and lenticles of pipe-clay containing leaves of tropical plants. These sands pass up imperceptibly into the marine Bracklesham beds, which contain many drifted plants, and include a prolific marine fauna of tropical appearance. Following in regular succession comes the deeper water Barton Clay with its great variety of beautifully preserved Mollusca, followed by the Barton Sands, at the top of which it has been the custom in England to draw the line between the Eocene and Oligocene formations, because the succeeding strata are markedly different in character, and the junction is rendered conspicuous by an underclay and a swampy land-surface; but the line of demarcation is now drawn higher up to suit the general European classification. The Fluvio-marine series of the Isle of Wight and the New Forest form a well-marked natural group of strata consisting in the main of mottled clays and silts of lagoon and brackish-water origin, with subordinate bands of white tufaceous limestone and marl. Bands of marine origin are quite subordinate except at the top. The occurrence of scattered angular chalk flints at various levels seems to point to the proximity of dry land against which the strata abutted. The Fluvio-marine series carries the succession up to the Middle Oligocene. All the higher Tertiary strata have been destroyed, and the next deposit is of Pleistocene date.

The remarkable folds which have affected all the strata of the Hampshire Basin, from the evidence of the Portsmouth district, are in the main newer than the Middle Oligocene. But evidence obtained lately in Devon seems to show that the folding was of Upper Oligocene or of Lower Miocene date. That is to say, these disturbances date from the same period which saw so much folding, disturbance, and mountain-building throughout Europe, and originated the chief Tertiary basins. The Miocene and Pliocene periods have left no legible traces in this neighbourhood, and all we can say is that during these periods were initiated the curious courses of the rivers of the district. The intricate channels and harbours of the Hampshire coast are the product of this long denudation combined with oscillations of land-level. The Hampshire and Sussex coasts yield particularly clear evidence of the curious alternations of climate which characterised the Pleistocene period. The ice-sheet did not extend so far south, but there is abundant evidence of two cold periods separated by a milder stage. Man must have seen many of the later of these changes. He certainly hunted the reindeer on Salisbury Plain, and probably hunted the seal and walrus amid the pack-ice of the Portsmouth coast.

Prof. S. H. Reynolds gave a description of further work on the Silurian rocks of the Eastern Mendips, in which the results of opening a series of fresh trenches were detailed. The fossils obtained showed that the sandy mudstones to the south-east of the Moon's Hill Quarry are of Wenlock rather than of Llandovery age. The strike of these Wenlock rocks is completely discordant with that of the underlying Old Red Sandstone, and precludes the possibility of a conformable passage from Silurian to Old Red Sandstone. No trace has been found of a Ludlow fauna. The dip of the Wenlock rocks is such that they clearly overlie the andesite of Moon's Hill.

Dr. A. R. Dwerryhouse outlined his recent investigations on the glaciation of the north-east of Ireland. He concluded that the area including the Antrim basaltic plateau, the Silurian uplands of County Down, and the Mourne Mountains had been completely overriden by the Firth of Clyde glacier, during the retreat of which the drainage of the district was impounded and a number of lakes formed. The overflow channels of these lakes have left "dry gaps," which mark the various stages in the shrinkage of the ice, the earliest of which appear on the flanks of the Mourne Mountains at an elevation of 1200 feet. Many interesting examples of the diversion of rivers by morainic material occur, and the changes in the history of the Lough Neagh area were outlined. It has been stated that the Antrim plateau was glaciated by local ice after the retreat of the Firth of Clyde glacier; but Dr. Dwerryhouse had failed to find any direct evidence of this, though the valleys of the Sperrin Mountains to the west were occupied by local glaciers.

The Glacial period and climatic changes in north-east Africa was the subject of a paper by Dr. W. F. Hume and Mr. J. I. Craig. They predicted a southerly shift in the system of westerly moist winds of the northern hemisphere due to the ice-cap by several degrees, with a decrease in temperature below the normal. These winds, which now barely touch the north coast of Egypt in winter, would then impinge upon the loftiest portions of the Red Sea mountain range. Evidence of this increased rainfall is found in the gravel terraces on their western slopes, the materials of which could only have come from the hills to the north-east. The precipitation was most active where the range was highest. Further evidences of such a westerly current are to be found in the existence of calcareous tufas on the borders of the eastern scarp of Kharga Oasis and elsewhere. The authors also found evidence of changes in the monsoon effects during the Glacial period. It is known from the investigations of the Meteorological Department of India that an increased snowfall in the Himalayas in spring exercises a measurable prejudicial effect on the Indian monsoon of the present day, and the enormously greater ice-covering of the Glacial period would exercise a more powerful inhibition on the monsoon of that period. The more extensive ice-sheet of East Africa, by preventing the abnormal heating of the land in summer, would act further in the same direction, and it is extremely probable that the monsoon current partook of the southerly displacement. The general result would be a decreased precipitation over Abyssinia and a much reduced Sobat, Blue Nile, and Atbara, which at the present account for 96 per cent. of the flood proper of the Nile. The study of the alluvial muds of the Lower Nile indicates a much smaller rainfall in Abyssinia about 14,000 years ago, previous to which the mud-laden waters of the Abyssinian Nile system do not seem to have reached Egypt. Mr. Grabham confirmed this conclusion by evidence from the Sudan of an earlier, moister climate further south than now is the case.

Friday, September 1, was devoted to a joint meeting with Section E (Geography), which was opened by a discussion on the former connection of the Isle of Wight with the mainland, the subject being introduced by Mr. Clement Reid, F.R.S. Mr. Reid pointed out that the Solent and Spithead occupy parts of a wide river-valley in which terraces of gravel slope up to 400 feet, though in the centre of the valley they pass actually beneath the present sea-level. These gravels have a very peculiar composition, and the higher terraces are full of Greensand chert, and contain fragments of Palæozoic rocks belonging originally to the West Country. The old idea that these cherts came from the central area of the Weald has been found to be untenable, and it has now been found possible to trace these stones to their origin, and so unfold a beautiful example of river development and river destruction. When first earth-movements formed the Tertiary basins of Hants and London, each of these basins was closed by harder rocks to the west, and was occupied by an eastward-flowing river, the Thames and the Solent. The valley of the Thames seems merely to have deepened, retaining all along approximately its original course. The valley of the Solent, on the other hand, ran for some distance parallel to the sea, and at no great distance from it, the result of which was that the sea finally broke through the narrower ridge of chalk which once ran continuously from the Needles to the Dorset coast, thus diverting the Frome and all the western rivers from their natural course to the Solent, and isolating the Isle of Wight. This flank attack had still other effects, for the Lower Avon was then only a short river, having a gentle fall of many miles before reaching the sea somewhere near Portsmouth. Subsequently it reached the sea by a short, steep, direct course, and consequently, as the Lower Avon flowed over soft Tertiary strata, it lowered its bed so rapidly as to cut back its valley and capture the whole of the drainage of Salisbury Plain, which previously had continued its natural course to Southampton Water. Clear evidence of this diversion and alteration of drainage areas was forthcoming in the high-level gravels of the Vale of Wardour, containing peculiar fossiliferous Purbeck cherts, which went straight across the present Avon Valley and were found on its west side, showing that when the rivers flowed some 300 feet higher they were tributaries of Southampton Water. Thus the great River Solent had all its headwaters cut off, and was divided into several separate river-basins, each with its own outlet. This happened in late Pliocene times. These flank attacks are still going on further west, and if they continue much longer the breach at Lulworth Cove may widen and deepen in the same way, so that with slight submergence the so-called Isle of Purbeck may become a true island exactly comparable in its geological structure with the Isle of Wight. Though at this early period the Isle of Wight was cut off from the mainland, it was probably at first only separated by a small stream and marshes, and was sometimes an island, sometimes part of the mainland, as the sea-level varied. The final isolation took place at quite a recent period, as the Isle of Wight was probably the ancient Ictis or Vectis of classical writers, to which the ancients traded for tin, and which is described as being cut off at high tide, but connected at low tide by a narrow causeway. The causeway was probably the ledge of Bembridge Limestone which swept across what is now the Solent from Yarmouth to Hurst Castle, and was intact 2000 years ago. It has now been destroyed by the attacks of the sea, and was apparently impassable at the Roman occupation, for the roads then led to a ferry further east and out of the run of the sea.

Dr. J. W. Evans thought that the submergence which was the immediate cause of the separation of the Isle of Wight was connected with the disappearance of glacial conditions from this country. The presence of accumulations of ice appears to cause a local lowering of the earth's crust accompanied by compensatory elevation in adjoining areas which, like the south of England, were unglaciated. When the ice passed away these movements were reversed in direction, as is now seen in Scandinavia. The period of elevation in our southern coast coinciding with the maximum of the glaciation of the British Isles was one of great precipitation, and it was then that the river valleys were excavated, or at least deepened, the submergence of which had given rise to our magnificent harbours. The discussion was continued by Profs. W. W. Watts, E. Hull, and others, and Mr. Clement Reid, in replying, pointed to the angles at which the tributary streams entered the main valley as confirmatory of his views. The slope of the ancient river-course from the Purbeck outcrops to the sea was almost that of the present river. Pebbles of Purbeck chert were now in a different drainage area from their source.

The earlier hours of Monday were devoted by the geologists to a joint discussion with Sections E and K on the relation of the Glacial period to the plant population of the British Isles, a report of which will be given by Section K (Botany). At 12 o'clock Section C reassembled in its own room, when papers were read by Mr. W. B. Wright and Mr. A. R. Horwood. Mr. Wright, in describing the Lower Carboniferous of the Bundoran district of South Donegal, gave an account of recent investigations by officers of the Geological Survey on the fossils of this area. The Lower Limestone has a conglomeratic base resting on the gneiss, the Lower Limestone Shale being completely absent. The study of the brachiopods and corals showed that the Carboniferous beds of this area were throughout of Viséan age, and leads to an interesting stratigraphical result, for it establishes palæontologically for this area the transgression invoked by Jukes, on purely lithological grounds, to account for the anomalies of the Lower Carboniferous series in various parts of Ireland. It shows, moreover, that this transgression reached the Bundoran district about the end of Tournasian or the beginning of Viséan times.

Mr. W. B. Wright also directed attention to the existence in a number of inland lakes in South Donegal and the Western Isles of Scotland of submerged pine-tree stools in position of growth. They occur at a level several feet beneath that of the outlet, which, being in many cases over broken rock or boulder-clay, precludes any explanation of a rise in the water-level due to peat growth. These cases are unquestionably similar to some described in Sweden, and are probably due to a drier climate, during which the lakes rarely had any overflow. He pointed out, however, that the mere presence of forests in the catchment basin might, by checking drainage and promoting transpiration, have in itself caused the partial drying of the lakes.

Mr. Horwood's papers dealt with some new Rhætic fossils from Glen Parva, and with the shell-layer in Mollusca.

On Tuesday, September 2, Mr. R. W. Hooley read a paper on the discovery of remains of *Iguanodon mantelli* in the Wealden beds of the Isle of Wight, in which the existence of two forms, a smaller and a larger, as in Belgium, was revealed. These variations he attributed to sexual rather than to specific differences. He exhibited a model in wood of the pelvic bones which showed a remarkable balance, and the bones gave evidence that the animal was fitted for bipedal progress, the pressure of the heavy tail upon the pelvic bones enabling it easily to assume an upright position.

Prof. E. S. Moore, of the State College, Pennsylvania, described beds on the border of the Appalachian system which comprised a complex series of impure limestones and sandstones forming a transition between the Cambrian and Ordovician, which included calcareous and siliceous oolites and beds of chert and limonite. The oolites form thin and irregular beds covering an area of more than forty square miles. The calcareous variety probably owes its origin to a mixture of sand grains and calcium carbonate, and to the fact that there were frequent alternations from a condition of deposition of limestone to a disintegration, solution, and redeposition of this rock. The evidence for this conclusion is found in the fact that the oolites occur in a complex mixture of calcareous sandstone and limestone, with alternations to thin beds of limestone-conglomerate, and also that sand grains or fragments of sandstone usually form the nuclei of the concretions. The siliceous oolites originated by replacement of the calcareous concretions, because they occur together, and the former grade into the latter. The source of the silica is to be found in the chert nodules and in the sand grains occurring in the limestone. The chief solvents for the silica are believed to have been organic acids and meteoric water.

Following this paper Prof. Moore gave a lecture on the pre-Cambrian beds of Ontario, illustrated by a fine series of lantern-slides. The Rev. Dr. Irving described a freshwater limestone in the Lower Eocenes of the northern flank of the Thames Basin, and a remarkable greywether or sarsen stone, and Mr. T. Ross Thomson exhibited lantern-slides to explain the various forms of the Wealden ostracoda.

Dr. W. F. Hume, of the Egyptian Survey, described the first meteorite recorded in Egypt, and exhibited specimens. It fell in the neighbourhood of the Alexandria-Cairo Railway, about 44 kilometres E.S.E. of Alexandria, and was seen by numerous natives. All accounts agreed that the stones fell out of a clear sky from the northwest, appearing as a white cloud variously estimated from 1 to 3 metres long. The meteorite exploded, breaking into several fragments, the fall being accompanied by a thunderclap. Numerous specimens were obtained from localities lying in a north and south line, the extreme points of which were separated about 1½ miles from each other. They are all characterised by an intense black and highly polished varnish of iron oxide, coating a green granular rock resembling a dunite, and probably mainly olivine.

In addition to the older committees of research, new committees were appointed to deal with excavations on Creechbarrow Hill, Dorset, and in the Coralline Crag at Sutton, at the base of which chipped flints had been recorded.

The instruction and pleasure of the geologists was much enhanced by excursions to the Portsmouth Waterworks and the Isle of Wight. Saturday's full-day excursion, under the able direction of Mr. G. W. Colenutt, was very successful, and enabled the members to see the lowest beds of the Wealden anticline at Brook Point and the wonderful sections of vertically tilted Chalk and Tertiaries at Alum Bay.

AËRONAUTICS AT THE BRITISH ASSOCIATION.

THE feeling produced by the discussion on the principles of flight, which took place at Portsmouth on September 4 at a joint session of the Sections of Mathematical and Physical Science, and Mechanical Science, of the British Association, is one of disappointment. The expressed purpose of Mr. A. E. Berriman, who opened the meeting, was to ask for the serious attention of matured scientific minds to be directed to a variety of specific problems that have suggested themselves to students of aëronautics during the recent development of flying-machines; but the discussion following his thoughtful and suggestive paper practically ignored the lines for debate that he had indicated, and the net result was to produce a mass of mainly irrelevant remarks.

The subjects to which Mr. Berriman confined his remarks were:—

(1) A consideration of the efficiency of the aëroplane as represented by the ratio of thrust to load, suggesting certain basic formulæ, and insisting on the relative importance of skin-friction.

(2) The necessity for evidence showing how the effective angle of a plane and its effective dimensions might be measured.

(3) The question of stability.

In reference to these subjects, he said that an hypothesis that aëroplanes were supported in flight by the inertia of the air led to the necessity of finding plausible expressions for mass acceleration. Two dimensions of the mass of air deflected were plausibly functions of the span and the chord of the plane; the third, which defined the depth of the stratus engaged and was known as the "sweep," was taken as the empirical function of the chord. Acceleration was obviously a function of the angle of the plane, and it was suggested that the angle should be measured by "the angle of deflection" at the point of intersection of two tangents drawn to the entering and trailing edges of the plane.

In order to extend the premises to cover a plausible expression for the resistance to flight and power expended, it was necessary to adopt a value for skin-friction. At present Zahm's formula was adopted, but the matter needed further research. Skin-friction was of such fundamental importance in aërodynamics that it was imperative to put it upon an accepted basis analogous to the position occupied by normal pressure. The coefficient of flight, representing the resistance per unit load, might be shown to be independent of speed, and to depend on the angle of the plane, and, further, to have a minimum value depending on the coefficient of skin-friction.

On the present hypothesis the minimum coefficient of flight obtained with planes of a very small effective angle—about 5°—such as would necessitate flying at much higher speeds than had hitherto been realised. The existence of an angle of least resistance was very important in connection with the problem of variable speed machines. Body resistance in a practical aëroplane was a supplementary resistance to that of the planes, and should always be considered as such.

Turning to the question of stability, in practical aëroplanes natural stability, both longitudinal and lateral, was mainly based on the principle of the dihedral angle. The acentric centre of gravity, in which the principal masses were placed well below the centre of pressure, was frequently suggested as a stabilising influence, but the permanent existence of a couple between the centre of gravity and the centre of pressure indicated liability to pronounced oscillation and did not find general favour.

Apart from the question of stability, progress in flying-machine design was mainly a problem of increasing the efficiency of the machine. The need for further information on such subjects as the effective angle of the plane, sweep, skin-friction, and other similar problems that come within the province of research work in physical science, was all-important. If the aëroplane of the future was to carry heavy loads and to fly far and fast, it needed to be more efficient than the aëroplanes of to-day.

Dr. W. N. Shaw, who followed, spoke of the dangers to aviators that lay in the constant fluctuations in the speed and direction of air-currents, and pointed out that over sea the oscillation of the wind speed was generally less than that over the land.

Prof. Petavel discussed the various suggested means of obtaining stability from the practical aviator's point of view, and stated his opinion that, given an aëroplane with a fair proportion of natural stability, the experience and control of the pilot might be very well left to supply the rest.

The subject of motors was broached by Mr. Beaumont, who said that, so far as the engine itself was concerned, it was very questionable whether any great increase in either the mechanical or dynamic efficiency could be made: and Sir William White, in the course of some general remarks, stated that the question of propeller efficiency must be dealt with, as in the case of ships, experimentally, by means of models.

THE INSTITUTE OF METALS.

THE annual autumn meeting of the Institute of Metals was held at Newcastle-on-Tyne on September 20–22. The Lord Mayor (Sir W. H. Stephenson), in offering a welcome to the institute, said the institute has made substantial progress with the objects it has in view, to serve the industries connected with the non-ferrous metals in a similar manner to that in which the Iron and Steel Institute has served the iron and steel trades. Research work to meet the needs of industrial development is clearly needed. Such work is constantly in progress at the National Physical Laboratory and in the universities and the university colleges. The Institute of Metals affords a means of communication among the many workers in the field covered by its activities, and the knowledge acquired by research can thus be applied to practical work. An important research which illustrates the services which such an institute may render is being carried out by the Corrosion Committee. Sir Gerard Muntz, in acknowledging the welcome, referred to the research on the causes of corrosion in condenser tubes. He said that a plant which should imitate as closely as possible the conditions obtaining in a marine condenser is being erected at Liverpool, and will be ready for inspection and testing in a few weeks. It is intended to investigate the conditions obtaining under Admiralty and commercial conditions, and it is believed that a large number of the baffling problems connected with corrosion can be investigated adequately. Generous assistance has been given by the University of Liverpool, but additions to the research fund are urgently needed, as the work, to yield useful results, must extend over a period of two or three years. Several papers were afterwards read and discussed, and the following brief summaries will indicate their scope.

Mr. J. L. Haughton and Prof. T. Turner contributed a paper on volume changes in the alloys of copper with tin. The work described is a continuation of previous researches on the changes in length which occur in a cast bar during and after solidification. The method employed has been that of applying an extensometer to one end of a cast bar while the other was kept fixed. The apparatus employed has been modified in order to allow a single operator to observe both pyrometer and extensometer readings at the same instant, and to record these results by means of a chronograph on a paper tape. There are four maxima in the expansion curve, and three of these, with about 10, 46, and 65 per cent. of tin respectively, agree with the "crystallisation interval" as determined from the accepted equilibrium diagrams.

The aim of a paper by Dr. W. M. Guertler, on the electrical conductivity and constitution of alloys, was to direct attention to the property of electrical conductivity in its bearing upon the practical determination of the constitution of alloys. The relationship between concentration, temperature, and any given property—electrical conductivity, specific volume, magnetism, &c.—is best brought out by the employment of a coordinate system, as in the equilibrium diagram. The converse problem is one of great importance, viz. that of obtaining the equilibrium diagram (when it is unknown) by projection from these surfaces on to the basal plane. The best method for the determination of the equilibrium diagram is known by the name of "thermal analysis." Dr. Guertler discussed the limitations of "thermal analysis," and in particular explained why it fails in those cases where, as so often happens in practice, a state of complete stable equilibrium is unattainable within a comparatively short interval of time.

In a paper by Mr. D. R. Pye, on the mechanical properties of hard-drawn copper, the lack of any satisfactory definition of standard hard-drawn copper was pointed out. Experiments were described confirming a suggestion made by Mr. A. P. Trotter that the tensile strength per square inch diminishes with increase of diameter according to a linear law. It was also shown that the elongation at fracture for similarly manufactured wires depends very much on the diameter, being considerably greater for larger sizes of wire. It was suggested that a satisfactory definition of hard-drawn copper wire would fix a minimum tensile strength per square inch given by the formula

$$T = 30 - 20D,$$

and a minimum elongation per cent. at fracture given by the formula

$$e = 5D,$$

where D = diameter in inches.

In a paper by Mr. George Hughes, on non-ferrous metals in railway work, he placed on record some of the methods of working, and uses pertaining to, the non-ferrous metals in locomotive and carriage construction. A short account of the bearing metals used under the name of white metals was included, together with a note on non-ferrous metals and alloys used in the railway carriage department.

The main object of Mr. C. A. Edwards's paper, on further notes on the nature of solid solutions, was to deal with points of interest raised in the discussion on a previous paper by Mr. Edwards on the same subject, and to stimulate further discussion.

The paper by Prof. H. Louis, on the failure of a brazed joint, gave an account of the investigation of the cause of a failure in the braze of a steam-pipe on a steamer, undertaken at the instance of the Board of Trade. The failure was due to corrosion following certain well-defined lines in the brass, and he traced the cause of these lines to the presence of small quantities of lead and tin in the original brazing spelter. The lead-tin alloy, separating out between the crystals of brass, formed planes of weakness that gave access to the corroding solutions, and this brought about the gradual corrosion of the entire brazing material.

A paper by Dr. Walter Rosenhain and Mr. S. L. Archbutt, on the alloys of aluminium and zinc, described a detailed investigation of the constitution of the alloys of aluminium and zinc which was undertaken in connection with an extended research on the light alloys of aluminium. A series of cooling curves were taken at a slow rate of cooling, and in many cases the ingots of the alloys were subjected to prolonged annealing before the cooling curves were taken. The microscopic examination of the cooled alloys was supplemented by the study of specimens which had been annealed and quenched at definite temperatures. The results were embodied in an equilibrium diagram which differs from the diagram of Shepherd; these differences result from the discovery of the existence of the definite compound Al_2Zn_3, which has a stable existence only between 443° C. and 256° C.

It was urged by Mr. Paul T. Bruhl in a paper on the corrosion of brass, with special reference to condenser tubes, that so important a subject as the corrosion of brass by sea water should induce steamship companies to keep records bearing on the subject. The conclusions arrived at by the author were:—That the presence of air or an increase of temperature up to a certain point accelerate corrosion. That iron, nickel, and small amounts of lead are injurious; tin up to about 1 per cent., large amounts of lead, and aluminium are useful in diminishing corrosion. That the inlet pipe and the condenser plates should preferably be made of brass. That the condenser should be protected against stray currents. Protective coatings are not recommended.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

ST. ANDREWS.—Mr. W. O. Redman King has been appointed demonstrator in zoology and lecturer on embryology, in succession to Dr. J. R. Tosh, who has returned to Australia.

BIRMINGHAM.—A lectureship in civic design and town planning has been established in the University of Birmingham. The cost will be defrayed by the Bournville Village Trust, which was founded by Mr. George Cadbury as a practical attempt to solve the problem of the housing of the less wealthy classes. Mr. Raymond Unwin, who is well known for his work in connection with the Garden City at Letchworth and the Hampstead Garden Suburb, has accepted the lectureship for the first year, and will begin his course during the present session. The lectureship will be associated with the department of civil engineering, but it is hoped that students of other faculties will take advantage of the lectures, especially those who are working in the course on social study.

THE new science buildings at Shrewsbury School, which have been erected at a cost of 2500*l*., will be opened on October 20 by Dr. Francis Darwin, F.R.S.

ON Wednesday, October 4, at 4 p.m., a public inaugural lecture will be delivered at King's College (University of London) by Dr. William Brown on "Emotions and Morals." The chair will be taken by Prof. James Sully.

BY the will of the late Lord James of Hereford, the sum of 3500*l*. is bequeathed to the governing body of Cheltenham College for the purpose of founding "James of Hereford" scholarships at that school. Lord James of Hereford was president of the council of the school.

MR. M. GREENWOOD, jun., will begin a course of lectures and demonstrations on "Statistical Methods and their Applications in Preventive Medicine and Pathology" at the Lister Institute of Preventive Medicine on Monday, October 16, at 5 p.m. This course is open, without fee, to all medical men and to others interested in the subject.

FOUR lectures on "Flies as Carriers of Disease" will be delivered on Tuesday–Friday, October 10, 11, 12, and 13, by Dr. F. M. Sandwith, Gresham professor of physic. The lectures will be delivered at the City of London School, Victoria Embankment, E.C.; they are free to the public, and will begin each evening at six o'clock.

THE calendar for the sixty-third session, that of the present academic year, of the Bedford College for Women gives full particulars of the varied arrangements for the higher education of women made at this constituent college of the University of London. Bedford College was recognised in 1900 as a school of the University in the faculties of arts and sciences, and it is further recognised for preliminary medical studies and for advanced medical studies in chemistry and physiology. The college cooperates in a scheme of inter-collegiate teaching with other colleges of the University for honours and post-graduate work. We notice that the new buildings for the college at York Gate, Regent's Park, London, will, it is hoped, be ready for occupation next year.

THE eighty-ninth session of Birkbeck College commenced on Wednesday, September 27, with an opening address by Sir William Tilden, F.R.S. The classrooms, &c., were afterwards open for inspection, and there was an exhibition in the art school. The college is conducted in relation with the University of London; classes are held both in the day and evening; thirty members of the staff are recognised teachers of the University. There is a very complete curriculum for chemistry, physics, mathematics, botany, zoology, and geology. The laboratories are well equipped with modern apparatus and appliances, and research work is encouraged in all the science departments. According to the calendar, more than 140 students passed some examination of the University during the last session; forty-seven took degrees in arts or science, twenty-one with honours, two the LL.B. degree, one with honours, and several students gained distinction at other universities.

THE Bethnal Green Free Library was founded in 1876 to meet the requirements of a crowded working class and poor borough, and is supported entirely by voluntary contributions. The main library now contains more than 30,000 volumes; the lending section has 8000 more. Commercial, evening, and other classes are held, and free instruction in design, brushwork, needlework, &c., is given to young girls. To earnest students the library is scarcely less than a local British Museum, where skilled artisans may find technical books of service to them in their trades. Free lectures and concerts provide healthful recreation. A deficiency in the annual income of 200*l*. is causing the council some anxiety. In order that the work shall not suffer in any department, the council has opened a reserve fund of 10,000*l*., and to this the present King has subscribed. Both Queen Victoria, King Edward VII., and Queen Mary also extended their favour to this institute. Donations to the general fund may be sent to the librarian, or to Mr. F. A. Bevan, treasurer, 54 Lombard Street, and Mr. Stephen A. Gard, honorary secretary, will receive donations to the reserve fund.

THE announcements for the present session of the Northampton Polytechnic Institute, Clerkenwell, London, show that day and evening courses have been arranged in mechanical and electrical engineering, in electro-chemistry, technical optics, and horology. The engineering courses include automobile work, aëronautics, and radio-telegraphy. Several new developments have been arranged. In the electrical engineering department, the new generating station, which was opened last winter, is now available for the instruction of senior students. The equipment of this station is very complete in all details of the generation and distribution of continuous and alternating current. In the mechanical engineering department the equipment for experimental work in aëronautics has been increased, and it is hoped that work of a research character will be done during the coming winter. New departures have been made in the day work of the technical chemistry and of the horological departments by the institution of morning classes for apprentices in workshops. In these classes students, all of whom are engaged in commercial workshops, are in attendance from 9 a.m. to 1 p.m., and spend the afternoons in their employers' workshops. The experiment is interesting as an attempt to solve the problem of providing instruction for the artisan without the drawbacks involved in attendance at evening classes after a strenuous day's work. In the evening classes an important series of lectures on illuminating engineering is being given jointly by the electrical engineering, technical chemistry, and technical optics departments.

THE calendar of the University of Bristol for the session 1911–12, which is now available, reminds us that the University of Bristol Act was passed in 1909 only, and that excellent progress has been made since that date in establishing the various departments of the University which is to serve the west of England. Several institutions in the neighbourhood have been affiliated with the University. The work of the faculty of engineering in all its branches is carried on in the Merchant Venturers' Technical College, agreements between the University and the Society of Merchant Venturers having been signed in July, 1909, and May, 1911. In July, 1910, the Royal Agricultural College, Cirencester, became associated with the University for the purpose of instruction in agriculture, forestry, veterinary science, and kindred subjects. Two theological colleges in Bristol are similarly associated for instruction in theology and certain linguistic subjects. There are, in addition, day training colleges for teachers, and the University is fortunate in the number of institutions near it open to students of medicine for hospital practice and clinical instruction. A public health laboratory has been established to enable medical men in the area to obtain trustworthy information and reports upon pathological material, and of placing at the disposal of authorities dealing with drinking water, persons concerned with the supply or consumption of milk, and those engaged in manufacturing processes, the resources of a properly equipped bacteriological research laboratory. It is clear that the University authorities are fully alive to their opportunities of influencing the life and industries of the counties surrounding the University, and that it will not be long before the good effects of higher instruction in the various branches of knowledge will follow.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 18.—M. Armand Gautier in the chair.—Ch. **Lallemand**: The deformations resulting from the mode of construction of the international map of the world on the scale of one millionth. The author establishes simplified formula for the construction of the map, having regard to the accuracy possible with the scale chosen. It is shown that the linear and angular errors, due to the method employed, would be much less than those due to the hygrometric deformations of the paper on which the map is printed.—Edm. **van Aubel**: Hall's phenomenon and the transversal thermo-magnetic effect in graphite. Details of measurement of the thermo-electric power of a graphite-copper thermocouple. This was found to be +17·8 microvolts per degree between 21·0° C. and 57·6° C., and 18·1 microvolts per degree between 20·9° C. and 98·55° C.—Georges **Baume** and Albert F. O. **Germann**: Fusibility curves of gaseous mixtures: the oxonian systems formed by acetylene, ethylene, nitric oxide, and methyl oxide. Diagrams are given showing the fusibility curves of the systems (methyl oxide-acetylene), (methyl oxide-ethylene), and (methyl oxide-nitric oxide). Each of these curves shows a clearly marked angular point corresponding to the molecular proportions $((CH_3)_2O+C_2H_2)$, $((CH_3)_2O+C_2H_4)$, and $((CH_3)_2O+2NO)$.—J. **Bougault** and C. **Charaux**: Lactarinic acid, a keto-stearic acid extracted from some fungi of the genus Lactarius. This acid is present in the free state in *L. theiogalus*, *L. plumbeus*, *L. pyrogalus*, and *L. uvidus*, and can be extracted by boiling alcohol. The properties of the acid are described; it is shown to be a ketostearic acid of the composition $C_{18}H_{34}O_3$.—P. **Gaubert**: The indices of refraction of some crystalline liquids. Measurements of the refractive indices of propionate, benzoate, acetate, and caproate of cholesterol are given.—E. **Kayser** and H. **Delaval**: Contribution to the study of ropy bread.—Charles **Nicolle**, A. **Conor**, and E. **Conseil**: The nature and the seat of the pathogenic agent in exanthematic typhus. Experiments are adduced in support of the hypothesis that the virus is localised in the leucocytes. The blood was separated by centrifugation; the white corpuscles proved on inoculation to be the most virulent; the plasma is less active, and appears to owe its poisonous action to the leucocytic débris difficult of removal; the wasted red corpuscles are inactive. The blood serum was proved to be inoffensive to man, and the cephalorachidian fluid, devoid of cells, proved to be also inactive.

DIARY OF SOCIETIES.

TUESDAY, OCTOBER 3.

FARADAY SOCIETY, at 8.—The "Paragon" Electric Furnace and Recent Developments in Metallurgy: J. Hardén.—Progress in the Electro-metallurgy of Iron and Steel: Donald F. Campbell.—The Hering "Pinch Effect" Furnace: E. Kilburn Scott.

WEDNESDAY, OCTOBER 4.

ENTOMOLOGICAL SOCIETY, at 8.—Report on a Collection of Bombyliidæ (Diptera) from Central Africa, with Descriptions of New Species: Prof. Mario Bezzi.

CONTENTS. PAGE

THURSDAY, OCTOBER 5, 1911.

A ZOOLOGICAL TRIBUTE.

Festschrift zum Sechzigsten Geburtstag Richard Hertwigs (München) geboren den 23. September, 1850, zu Friedrich, i.H. Erster Band, "Arbeiten aus dem Gebiet der Zellenlehre and Protozoenkunde." Pp. v+674+49 plates. Price 110 marks. Zweiter Band, "Arbeiten Morphologischen, Biologischen und Deszendenztheoretischen Inhalts." Pp. iii+624+30 plates. Price 70 marks. Dritter Band, "Experimentelle Arbeiten." Pp. iii+308+20 plates. Price 50 marks. (Jena: Gustav Fischer, 1910.)

THE three volumes before us represent one of the most remarkable tributes ever paid to a professor of zoology. We refer not merely to their size and weight, which have unfortunately hindered us from reviewing them more promptly, but to their high standard of workmanship and to the cordiality with which the various authors recognise indebtedness to their master for inspiration and instruction, for precept and example. It is true, of course, that those who have joined in this "Festschrift" to their highly esteemed teacher are now strongly marked individualities, ploughing their own furrows; yet it would be less than fair not to see that the diversity of contributions is correlated with the diversity of gifts in Richard Hertwig himself. For he has worked along many lines of zoology, and always with signal success—with a carefulness, thoroughness, and thoughtfulness which we should not presume to praise were they not reflected so clearly in the volumes which it is our business to-day to review. He has dealt with Protozoa and Metazoa, with morphology and physiology, with the most minute intricacies of the cell, with the big questions of sex and reproduction, and with the general problems of evolution. The congratulations of NATURE to Richard Hertwig, as one of the big international educationists in zoology of recent years, may be, through the reviewer's fault, a little belated, but they are none the less sincere. We wish for him many years of pleasant work, judiciously mingled with as much holiday as he can enjoy.

But how are we to review three enormous volumes with 1600 pages and a hundred plates? Perhaps the most useful way is the objective one of giving a rapid inventory of the treasures of this great Festschrift.

W. T. Howard leads off with an account of a peculiar kind of nuclear budding which occurs in the "depressed" cells of some tumours. It represents a reversion on the part of these cells to a primitive type of division common among certain Protozoa (such as Podophrya, according to Hertwig), and the author also suggests that the degeneration and extrusion of nuclear buds followed by mitosis of the mother nucleus is, in principle, comparable to the maturation division of egg cells. M. Popoff describes in various cells of Muscidæ what Hertwig called the formation of chromidia—the extrusion of chromatin from the nucleus into the cytoplasm. This colonisation of the cytoplasm by nucleoplasm seems to bear a relation to the functioning of the cell; thus the chromidia may be distributed along lines of diffusion currents. The author points out that what have been described as mitochondria, chondriomites, chondriokonts, pseudochromosomes, ergastoplasm, and so on, are simply phases of chromidia. Prof. Vlad. Ružička has studied in *Bacterium nitri* the relations of chromatin and of plastin to the life of the cell, and finds that these two substances tend to be distributed respectively in areas of active and of reduced metabolism. In a paper with very striking illustrations, Th. Moroff describes what goes on inside the large Radiolarian Thalassicolla, the nucleus of which can be seen easily with the naked eye. The vegetative and reproductive phases are contrasted, and an account is given of the formation of isospores and anisospores. The author discusses such points as the significance of nucleoli, which are interpreted as forms of chromidia.

C. Clifford Dobell gives an account of his study of an interesting blood parasite, Hæmocystidium, discovered by Castellani and Willey in a Ceylon Gecko. He describes the schizogony and the formation of gametocytes, and contrasts the genus with the malarial organism, Plasmodium, to which it is closely akin. Hubert Erhard shows, in reference to the cells of the bile-duct in the snail, and of the epididymis in the white mouse, that the "trophospongia" of Holmgren is really a chromidial apparatus of nuclear origin. In regard to the epididymis he brings forward strong evidence that the secretion is due to the activity of the chromidia in the cytoplasm. In the next study Julius Schaxel describes the oogenesis of the well-known jellyfish Pelagia. He lays emphasis on the interesting give and take between nucleus and cytoplasm; from nutritive material supplied by the cytoplasm the nucleus forms chromatin, part of which is emitted from the nucleus into the cytoplasm to form physiologically important "kineto-chromidia." The history of the chromosomes in the larval salamander is the subject of a study by Karl Camillo Schneider—a kind of study which is difficult for those who have not a clue to the labyrinth of the nucleus. We may, however, point out that according to the author each chromosome of the nucleus in the prophase before division is bivalent, being composed of two "elementary structures" or "Mites," which are spirally coiled! In following the history of these spirals Schneider has found strong corroboration of Boveri's theory of the individuality of the chromosomes. In the next paper Paul Buchner gives a redescription—more penetrating than ever—of the spermatogenesis and oogenesis, the maturation and fertilisation in Sagitta.

E. A. Minchin describes *Malpighiella refringens*, a new amœboid parasite which he found in the malpighian tubes of the rat-flea (*Ceratophyllus fasciatus*), in which he was studying the transmission of *Trypanosoma lewisi*. It occurs principally in two forms—an amœboid form with a single nucleus, and an encysted form with four nuclei. In the next paper we are brought back again to chromidia, for Alexander Issakowitsch describes these on the marginal gland cells of Porpita, and shows that they play an essential part in the production of mucus. Then follows an interesting study by Rh. Erdmann, dealing with

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Amoeba diploidea, which he kept at a temperature far above the normal. Nuclear degenerations and disturbances ensued, the culture became quite asexual, and sooner or later died off. In short, a state of "facultative apogamy" was experimentally induced, and the result afforded indirect evidence that part of the utility of the sexual process is to counteract "depressions" and disturbances of the cellular functions. Max Hartmann describes from the gut of a Termite a new representative of the very remarkable Protozoa known as Trichonymphidæ. He is inclined to make the family into a class comparable to Ciliata, but one almost hopes that this is going too far. Very remarkable they certainly are, with their males and females and young stages, their fission and gametogeny, their unique "head-organ" (probably a complicated blepharoplast), and their compound or "polyenergid" nucleus. Another interesting Protozoon, *Trypanosoma rotatorium,* Grube, from the frog, is redescribed by W. Lebedeff. It is remarkable for its striking polymorphism, for four principal forms occur. Another interesting parasite, a species of Lankesteria which lives in the food-canal of Turbellarians in Lake Baikal, is described by B. Swarczewsky. An account is given of the formation of gametes, their conjugation, the development of sporocysts, and of the life-history in general.

Very prominent in more ways than one is the description which Max Jörgensen gives of the growth of the ovarian ovum in Proteus. It occupies nearly 200 pages, and it is illustrated by twenty-three beautiful plates of cytological details. The author tells us all sorts of wonderful things, *e.g.* how the chromatin in the second stage of growth becomes pulverised, how the chromidium helps in the reconstruction, how the remarkable "lamp-brush" chromosomes arise, how the nucleoli migrate and what they do (probably serving as reservoirs for certain products of metabolism, and furnishing ferments which are useful in plasm-growth and yolk-formation. A most interesting account is given of the conditions of ooplasm-growth and of yolk-forming, and, in general, of the marvellous interactions between the different members of the cell-firm.

The second volume begins with a paper by J. P. Schtschelkanowzew on the internal and external male organs of Chelifer and Chernes. Among other interesting points the absence of a tail in the ripe spermatozoa may be noted. A discussion of the affinities of the Chelonethi leads to the conclusion that they are most nearly related to the Urotricha or Holopeltidia. Bruno Wahl deals with the classification of two families of Turbellarians, Dalyellidæ and Umagillidæ, which include a number of interesting and, in part, parasitic forms, such as Graffilla, Anoplodium, and Syndesmis. There seems to be some puzzle about *Graffilla parasitica,* which is abundant inside Tethys, for Wahl could find no trace of male gonads. Great interest attaches to the fine account which Sergius Kuschakewitsch gives of the development of the gonads in the edible frogs. It is a fine study in the origin and differentation of gonads, but it is also welcome in connection with experiments on sex-determination. The author contrasts the ovary and the testis stage after stage. There seems to be a remarkable lability in the details of the development, and the differences seem to depend partly on the locality and partly on the degree of ripeness of the eggs when they are fertilised. Confirmation is given of Hertwig's conclusion that over-ripeness of the ova results in a great preponderance of males. Philipp Lehrs takes us to a different kind of zoological problem in his discussion of a new species of Lacerta from Lebanon. He compares it with other mountain lizards, and shows the interest of it in binding together the Neo-Lacerta and Archæo-Lacerta species. C. Sasaki relates how he has almost cleared up the life-history of a rather famous aphis—*Schlechtendalia chinensis*—which makes galls on *Rhus semi-alata* in Japan and China. The galls are used in dyeing and tanning—they are rich in tannin, and in former times they served the Japanese women as a tooth-powder for blackening the teeth. Sasaki has succeeded in finding the wingless mother-insect, the fundatrix, who sets the ball a-rolling. Wingless females, parthenogenetic and viviparous, come and go; at length winged females appear which lay eggs, containing well-advanced embryos that soon hatch out. But no males have been seen, and we have a glimpse of a possibly continuous Parthenopeia.

R. Goldschmidt devotes a hundred pages to a searching account of the minute structure of the glia, the nerve-fibres, and the ganglion cells in the common threadworms of horse and man. He devotes particular attention to the neurofibrils, only, however, to rob them of their supposed nervosity, for he strongly maintains, with Apathy and others, that neurofibrils simply represent cellular skeleton. Goldschmidt has made in previous memoirs such a thorough analysis of the nervous system of Ascaris that he has the cells all numbered, and, as it were, ticketed. It is extraordinary indeed to read that "cell 26 of the internal lateral cephalic ganglion is present only in the males"—a fine instance, on the one hand, of penetrating analysis, and, on the other, of the penetrating nature of sex. O. Steche takes us to the open sea with his interesting study of the Portuguese man-of-war. He has introduced order into what he calls the "perplexing Wirrwar" of zooids, by discovering the law of budding. What is even more important, he shows how the development of the huge pneumatophore that projects above the waves has reacted on the architecture, leading to a great shortening of the stem and a giving up of the usual budding-zone. Incidentally, he mentions that Physalia has great power of regenerating lost appendages—a capacity which other Siphonophora are not known to possess.

In the next paper Harry Marcus makes another contribution to the much studied problem of the architecture of the head. He deals with Hypogeophis, one of the Gymnophiona, and discusses the "neuromerie, mesomerie, dermatomerie, and branchiomeric" of the head, which has at least nine segments. Adjoining this important, but highly technical contribution, there is a practical study by Schwangart, an authority on vine diseases. He deals with the deadly "Traubenwickler," caterpillars of two species of Tortricidæ, the ravages of which are nothing short of calamitous. In 1906 the loss in the Pfalz alone was estimated at six millions of marks. After discussing the life-history and habits, and the natural enemies of the caterpillars, as well as a variety of chemical, mechanical, and physical methods of dealing with the pest, the author gives an interesting account of their infection with a pathogenic mould, a species of Cordyceps. Ernst Stromer takes us back to ancient days in his discussion of the phylogeny of the Dipnoan stock, a subject raised by his very interesting discovery of teeth of both Protopterus and Lepidosiren in the Lower Oligocene of Egypt.

Plate's contribution to the Festschrift is an expanded version of the inaugural lecture which he gave in entering upon his duties as professor of zoology in Jena. He deals with the laws of inheritance in their relation to general evolution-theory. He has been breeding mice and has found not a single fact against the Mendelian theory. But he does not think that the selection theory has lost any of its importance. Some of his analyses of current conceptions are very interesting; thus he distinguishes seven forms of germinal variation, five kinds of atavism, and several kinds of correlation.

The third volume begins with observations by Arnold Lang on the heart-beats of hibernating snails. As the temperature falls the beats become fewer and fewer, but even at -3° C. they were still observed. A heart that can beat fifty times a minute in summer may only beat 2·36 times a minute at a temperature of 2·65° C. in February. In the next study Karl von Frisch takes us out to brooks and streams, and inquires into the colour-change of the trout and the minnow. It is many years since Pouchet demonstrated the importance of the sympathetic system in this connection, but von Frisch has already in this "vorlaüfige Mitteilung" got further into the business. He has shown that there is in the anterior end of the medulla oblongata a special centre, the stimulation of which makes the fish lighter, *i.e.* makes the chromatophores contract. He has also found the place where the nerve-fibres that control the chromatophores pass out of the spinal cord into the sympathetic, in which they extend forwards and backwards.

By means of ingenious experiments, especially on bicephalous Planarians, Paul Steinmann has shown, for Triclads, that the nature of what is regenerated, *e.g.* whether a head or a tail, depends, not on the line of cutting, nor on the adjacent tissue, but on the regenerating organism as a whole. Even distant parts of the regenerant have their "organising" influence on the regenerate. Another paper dealing with regeneration is by Gustav Wolff, who reports on the continuation of his studies on newts. He has previously shown that the regeneration of the lens takes place apart from nervous stimulus, but now he shows that in the regeneration of the hind limb a nervous factor is indisputable. He makes much, for instance, of the remarkable fact that when an abnormal limb, say one with only two toes, is cut off, the regenerated limb has also only two toes. There is a very interesting historical reference to a forgotten paper by T. J. Todd, who directed attention, in 1823, to the influence of the nerve in the regeneration of the newt's leg.

An investigation of a very different type is that of W. F. Ewald on the contraction of the adductors in freshwater mussels. He has discovered a special "tonus-current," and gives a definition of the "tonic muscle-contraction." It is not oscillatory or discontinuous, but a persistent process, both in its mechanical and its electrical aspects. Albrecht Bethe deals with the equilibration of aquatic animals, discussing those with statocysts and those without, those the construction of which gives them an automatic stability, and those "labile" forms that keep themselves in a particular position by a coordination of movements. In some young fishes there is at first an automatic determination of the position, and the coordination is subsequently acquired. O. Maas has studied the peculiar involution-processes which occur in various sponges when they are starved or kept without sufficient lime salts. By passing into a resting stage, comparable to gemmules, the sponge may survive the disadvantageous conditions and exhibit subsequent revivification. One of the interesting general results is the corroboration of the view that sponges are essentially diploblastic. Th. Boveri has studied the developmental potencies of Ascaris-blastomeres in cases where the normal type of cleavage has been departed from, either as the result of double fertilisation or in consequence of centrifugal rotation. He gives the *coup de grâce* to the hypothesis of differential nuclear division.

F. Doflein takes us into the open-air again with his very interesting—though admittedly preliminary—study of the behaviour of two prawns, species of Leander, common on the Riviera coast. He discusses their fine coloration and its changes; the different kinds of chromatophores and pigments, red, blue, yellow, and white; their behaviour when feeding, when cleaning themselves, and so on; and the reactions to diverse stimuli.

This remarkable tribute, a credit alike to the genial professor and his school, ends with an interesting study of the awakening of the hibernating hedgehog. Whether automatically, or by "pulling itself together," the hedgehog warms itself up, and that rapidly. The chemistry of this, according to Tanzo Yoshida and Ernst Weinland, is that a rapid combustion of glycogen occurs, and that fat serves as an accessory fuel to the vital fire.

THE AGRICULTURAL DEVELOPMENT OF EGYPT.

Text-book of Egyptian Agriculture. Edited by G. P. Foaden and F. Fletcher. Vol. ii. Pp. viii+321–878. (Cairo: National Printing Department, 1910.) Price 9*s.*

IN the agricultural development of a country two lines of attack have always to be followed: investigations are made with the objects of discovering the best crops to grow and the best methods to follow; and the cultivator—who is generally constitutionally conservative—has to be persuaded that the new methods really are an improvement on the old. Egypt, old as she is, has to adapt herself to the changed economic conditions of the world, and the problem before her agricultural advisers is fundamentally the same as in new countries, though in its details more complex.

The book before us is the second volume of the complete work, the first having been reviewed in these columns about eighteen months ago. It deals with individual crops, with farm pests and farm animals, and its object is to present the student with a general summary of the work done, and the information collected and sorted out, by the experts attached to the various agricultural institutions in the country. The writing of each section of the book has been entrusted to one man, generally one who has done much work on the subject, so that the volume consists of a detached series of contributions. It is therefore extremely useful for the expert who can evaluate the various chapters, but it has not quite the organic unity desirable for a student's text-book. Indeed, it is, in any case, rather large for an elementary student, and the editors will probably find advantages in drawing up an abridgment of the whole work for general use, leaving these larger and more authoritative volumes for the advanced student.

Cotton is at present the crop to which the Egyptian looks for profit, and where it can be grown everything else is made subsidiary to it. If the land will grow cotton every two years so much the better; but Mr. Cartwright, who has charge of this section, enters a wise caution against overcropping:—

"Egypt depends on the quality of its staple for its position in the cotton world. This quality of staple is intimately bound up with the fertility of the land, and any loss of the second will almost certainly be accompanied by deterioration in the first."

A common rotation is cotton, berseem, wheat; berseem being the Egyptian clover (*Trifolium alexandrinum*), which keeps up the supply of humus in the soil, thus counteracting the effect of the extremely rapid decomposition going on.

The wheat is mainly of the durum type. Red, white, bearded, and beardless varieties can all be found, and the samples are usually very mixed in quality. Wheat forms an important crop in basin cultivation; indeed, the red wheats from the Upper Egypt basins are considered the best type. In Lower Egypt wheat is grown under irrigation as a winter crop.

In Upper Egypt sugar cane is often the basis of the rotation instead of cotton, the course being sugar cane, sugar cane, berseem, followed by doura, wheat with or without doura; sometimes, however, the cane is only grown one year, and the wheat is replaced by a bare fallow. The two great classes of cane in general cultivation are Beladi, for long the commonest grown, and Roumi, now replacing the older class because of higher producing capacity. Ordinarily the sugar obtained is 10 to 15 per cent. of the weight of the cane, about 2·5 per cent. being molasses. Doura or maize is an extremely useful crop for the fellah. Its thinnings supply a large quantity of green food for his cattle when "keep" is scarce; its grain supplies him and his family with food; moreover, it responds well to liberal treatment.

Fungoid diseases are ably dealt with by Mr. Balls, who has, on the whole, a very cheerful account to give of the cultivator's lot.

"The immunity of the important cultivated plants from disease induced by fungi is most remarkable; berseem and maize, although grown in enormous quantities, are practically free from disease; wheat only bears rust-pustules commonly after the flowering period; and although cotton is inhabited by four common fungi, it is yet attacked by them at such times as to be but little affected thereby."

But Mr. Balls will not leave the cultivator to be lulled into a false sense of security: this happy immunity, he insists, is not entirely due to climatic conditions, although it is in part; thus the high temperature is unfavourable to fungi, and the unvarying character of the climate enables the pathologist to know exactly what to expect.

On the other hand, insect pests are numerous and do a good deal of damage. Mr. Willcocks, who writes this section, inclines to the belief that they are more or less indigenous. Their life-histories are being steadily worked out and remedial measures designed. But it is not always easy to apply remedies in practice. The psychology of the cultivator counts for much, and Oriental fatalism is a bar to the taking of active precautionary measures. The cultivator always hopes that Providence, or at least Government, will do something, but does not himself do what the Western man would do at once.

Perhaps the cotton boll-worm is the most serious pest, but the cotton worm (*Prodenia littoralis*), the small green cotton worm (*Caradrina exigua*), and the cut worm (*Agrotis ypsilon*) also do harm, not only to cotton, but to other crops as well.

Farm animals are dealt with by Mr. McCall. The native cattle are described as races of *Bos indicus*, but have not undergone artificial selection and improvement, like the European races of *Bos taurus*. It is considered that some very fine strains could be produced by proper breeding.

The book concludes with tables of useful statistics and some good illustrations of live stock. Altogether it will be found very helpful to all who are interested in Egyptian agriculture. E. J. R.

THE PROPAGATION OF ELECTRIC CURRENTS.

The Propagation of Electric Currents in Telephone and Telegraph Conductors: a Course of Post-Graduate Lectures delivered before the University of London. By Prof. J. A. Fleming, F.R.S. Pp. xiv+316. (London: Constable and Co., Ltd., 1911.) Price 8s. 6d. net.

THIS book is an elaboration of lectures which the author has given in the Pender Laboratory to telegraph and telephone engineers. The immediate and practical object of the book is to show how by a scientific treatment of the problem of electric wave propagation higher speed in telegraphy and better articulation on long telephone lines may be obtained. The problems involved are, however, fundamental to all electrical engineering, and thus the usefulness of the book is by no means limited to the class of readers for which, to judge by the title, it has been written. The phenomena of electric wave propagation play an important part in long power-lines, and much of what the author has to tell us about the waves in telephone cables may, with some obvious modifications, be directly translated into the domain of heavy electrical work. Problems connected with propagation are most easily treated by the use of the symbolic method, and although Heaviside, Steimetz, Pupin, Kennelly, and others have for some years used this method in their publications, the majority of electrical engineering text-books still ignore it. Electrical engineers will therefore feel grateful to the author for having given them in his book a very clear and readable exposition of the treatment of electric problems by complex quantities. This is done in the first chapter. Then follows a chapter on wave propagation generally. The subject is introduced by the investigation of sound waves in air. In this way the main principles of such an investigation are established by reference to a problem with which all engineers are more or less familiar, and this is a material help to the more complicated problems of magnetic and electric waves, which are treated next.

In the third chapter we come to the general case of an infinitely long cable having at one end impressed on it an alternating e.m.f. It is this case which is of interest not only to the telephone engineer, but also to the designer of a power-line. By making use of the symbolic methods outlined in the first chapter, the author shows how the current gets weaker as we proceed from the home end, and how at the same time the phase angle between e.m.f. and current increases. He distinguishes thus between an "attenuation factor," which applies to the real part, and a "phase factor," which applies to the imaginary part of the complex quantity. In telephony the attenuation factor is not of paramount importance, since the ear is able to appreciate even very weak sounds, provided their general character as determined by the sequence of the waves of different frequency remains the same. But this is just the condition which in an ordinary telephone cable only exists if its length is moderate. The phase factor is different for each wave-length, and thus the longer the line the greater is the distortion in the arriving waves. A moderate amount of distortion the human ear is able to analyse, in the same way as we are able to recognise a person's face from a caricature if the distortion of the true features is moderate, but on very long lines the attenuation and phase factors have so altered the character of the waves that the ear is no longer able to analyse them, and telephony becomes impossible.

This refers to an ordinary cable in which there is little inductance, but much capacity. The author shows that the old rule according to which the product of capacity and resistance was considered, the important item on which clearness of speech depended, is wrong, and that, as was first pointed out by Heaviside, the condition for perfect transmission is equality between two products, namely, that of capacity and resistance per mile and that of inductance and leakage per mile. In a cable of this kind the velocity of propagation is the same for all frequencies, and consequently all parts of a composite wave travel at the same speed and arrive without distortion, although, of course, attenuated. Heaviside called a cable of this kind a "distortionless cable."

By reference to Pupin's theory it is next shown how an approach to the perfection of such a cable may be obtained by "loading," that is, putting inductances at intervals along the line in series with the conductor. This approach to perfection will obviously be the closer the more it approaches the condition of a uniformly loaded line. This means that the impedance coils must not be too far apart. Eight to nine coils per wave-length is the number theoretically found in an example given of a 90 ohms per mile line, where coils of 0·2 henry every two miles satisfy this condition. In the Anglo-French telephone cable laid by the British Post Office last year the impedance coils have each an inductance of 0·1 henry, and are spaced 1·53 miles apart. The construction of this cable is fully described. There is also a chapter devoted to submarine telegraphy, and another to the study of the propagation of waves of very high frequency along wires. Here, again, the power engineer will find much useful information.

GISBERT KAPP.

MARINE REFRIGERATION.

Cold Storage, Heating, and Ventilating on Board Ship. By Sydney F. Walker, R.N. Pp. vi+269. (London: Constable and Co., Ltd., 1911.) Price 8s. net.

THE increasing luxury of modern sea-travel makes the use of cold storage almost a necessity for any but the smallest passenger boats. In the large liners the most elaborate arrangements are used to preserve the food and to keep a continual flow of air at the proper degrees of temperature and dryness through the passenger regions. In this book the author has brought together the general principles which must be used to get such a result, and in the section on cold storage considers the principal methods used to convey the enormous quantity of food now brought to this country in cold storage.

An improvement would be an index, especially to designers and freezer engineers, for whom the book is primarily intended, as it is not easy to find if a reference is made to any particular fitting or arrangement. It is well known, for instance, that there are two distinct methods of treatment suitable for different kinds of food. In one, so soon as the natural heat has gone out, the food is frozen to some degrees below freezing-point, and maintained frozen—but at no particular temperature—until ultimately thawed for use; in the other, the food is never frozen, but is maintained at as constant a temperature as possible a few degrees above freezing-point, and in an atmosphere with a definite degree of humidity. There is no difficulty about the first method, which is used, for instance, for mutton; but in the latter, used for beef, fish, and fruit, the constancy both of the temperature and the humidity is most important. There are at the present time various devices for maintaining the constancy of these factors more or less automatically, so as to relieve the operating staff from the continual strain of watching gauges, but no reference seems to be made to them.

Again, the advantages of the various methods for producing cold are given, but no attempt at summarising the knowledge so that a marine engineer could easily determine which system would be the most suitable for his particular case.

Considerable attention is paid to the discovery and prevention of faults in the whole storage system, and the advice given would doubtless be of great use to the freezer engineer. In the sections on ventilating and heating, which are clearly to be taken together, the various methods in use are considered in some detail. The author obviously inclines to electrical methods, which certainly have the great advantage that the transference of air and the generation of heat can be far more easily controlled at a large number of points. An interesting calculation is made as to the expense of running electric heating on a large liner, and appears to show that the cost is quite disproportionate to the extra comfort obtained.

There are some curious instances of the inclusion of really extraneous matter, such as the question of ventilation in mines, where the problem is essentially different and the presence of poisonous or explosive gases makes the failure of the ventilation a cause of real danger and not merely of discomfort.

In the heating section also there are a large number of illustrations of electric heaters differing very little, and more suitable to a catalogue. The book is well illustrated, and should find a distinct place in the literature of the subject. F. H.

RADIOGRAPHY.

Disease in Bone and its Detection by the X-Rays. By E. W. H. Shenton. Pp. xii+72+46 figures. (London: Macmillan and Co., Ltd, 1911.) Price 4s. 6d. net.

MR. E. W. H. SHENTON was one of the first medical men to take up the use of the Röntgen-rays for the purposes of medical diagnosis. His experience extends to more than fourteen years, and thus dates back almost to the time of the publication of Prof. Röntgen's discovery. Mr. Shenton points out in his preface the necessity for skill in carrying out the examinations and in interpreting the results. Many laymen are able to take "clear" X-ray photographs, but only an expert can be sure of taking photographs in the best way for obtaining the maximum diagnostic information. The final words of Mr. Shenton's preface are—

"To the staff of Guy's Hospital I owe more than I can acknowledge here, but for nothing am I more grateful than their attitude towards the whole subject of X-ray work. In my opinion, it has raised radiography from a branch of photography to a branch of practical medicine. As a pioneer I might have had the rough time pioneers look for, but my way has been considerably smoothed by their generous encouragement."

In the diagnosis of diseases and injuries of bones, changes of form or of density are those chiefly concerned, for opacity to X-rays is a function of density. Mr. Shenton makes the helpful general statement that acute bone disease is made evident by increase of transparency, and chronic disease by increase of opacity. He warns us against the common error of mistaking apparent variations in density of bone, due to the condition of the X-ray tube, for actual variations in density. The exposure should be such as to give the greatest possible amount of detail of texture of the bones, and a "very clear" skiagram, where the contrast between the bones and the soft parts is extremely sharp, is usually lacking in detail of bone texture.

Mr. Shenton goes fully into the subject of fracture, and directs especial attention to the subject of "callus," the new material formed around fractures, uniting the fragments. When first formed this callus is entirely transparent to the X-rays. This is a very fortunate fact, as otherwise we should not be able to judge the nature and extent of a bony lesion except just after its occurrence; not for many weeks as we are able to do. The author directs special attention also to the absence of unnecessary callus in fractures treated by Mr. W. Arbuthnot Lane's method of bringing the fragments into accurate apposition by metal plates and screws.

Various diseases of bone—abscesses, tumours, and inflammatory diseases—are described and illustrated, as are also the rheumatic and gouty conditions which affect bones in the proximity of joints. The appearance of the teeth in normal and abnormal conditions is illustrated and described.

The book is full of information, the result of the author's almost unequalled experience. It is beautifully printed in large clear type on art paper, so that the illustrations show to the best possible advantage. A. C. J.

OUR BOOK SHELF.

A Text-book of Elementary Foundry Practice for the Use of Students in Colleges and Secondary Schools. By W. A. Richards. Pp. xii+121. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1910.) Price 5s. 6d. net.

THAT a text-book of elementary foundry practice should be required for the use of students in secondary schools reads strangely in this country, but indicates how far trade practice is being brought into school curricula in the United States; and this work is by the instructor in forge and foundry practice in the University High School and the University, Chicago. A careful perusal of the book shows that it is the practice of the foundry—and that mainly of moulding—that is treated of, and not the science underlying foundry work. Only hand tools and such moulding as can be done with them are described, and the making of moulds for the production of steel castings is not included.

The author claims that though his book is written for boys in secondary schools, he hopes it may suit the college student, and that it is so plain and practical that it may be used without an instructor. A series of exercises in moulding is explained in great detail, but wherever the author ventures into the field of the science underlying any portion of foundry practice, his theory is wild and not helpful. He quotes McWilliam and Longmuir with approval (McWilliams and Longair he calls them), but is not in agreement with them when he recommends that the vent wire should be pushed down to the pattern. It is a pity that the author did not leave the science of the subject alone, for it is disheartening to find the student being told that fireclay is almost pure oxide of alumina, that copper and manganese form manganese bronze, copper and phosphorus phosphorus bronze, and like statements.

The main body of the book is, however, devoted to a simply worded and painstaking explanation of a series of exercises in moulding, so selected and arranged as to illustrate as many as practicable of the principles used in the more elementary parts of the moulder's art.

Moxly's Theory of the Tides. With a Chapter of Extracts from Moxly's Original Work. By J. F. Ruthven. Revised and enlarged edition. Pp. 103. (London: J. D. Potter, 1911.)

THIS monograph is an attempt to uphold the claims of the equilibrium theory of the tides as opposed to those of the dynamical theory now generally maintained. It is seldom possible to return to older scientific hypotheses which are of so general a nature and have been superseded, and it is impossible here.

The gist of the matter is contained in a statement by Sir George Airy, which the author quotes on page 72—"Suppose now that the water assumed the form which we have found, and that the earth revolves within its coating of water. This supposition, absurd as it is, is the only one upon which it is possible to apply the equilibrium theory." The author, following Moxly, denies the truth of this statement, and states that the equilibrium theory assumes that it is only the *form* and not the *mass* of the water which is fixed relatively to the moon. But if the form only be fixed (as *must* be assumed), then the particles of water are in relative oscillatory motion, and the tidal wave is a species of oscillation (an idea to which Moxly greatly objected, page 83)—a forced oscillation, the characteristics of which therefore depend partly on the nature of the free oscillations, and the problem is essentially dynamical.

The author seems to labour under some misconceptions of the dynamical theory in thinking, for instance, that it implies impossible ocean currents, and that the tidal crest must be 90° behind the moon (pages 8 and 9).

However, the book is a very clear exposition of the principles of the equilibrium theory, and claims to explain in general terms a number of anomalous tides; but sometimes one fails to see why the same explanation cannot hold good on the dynamical theory. The note on the tides in the Bay of Fundy (pages 88 and 89) is interesting.

W. J. HARRISON.

An Introduction to Vegetable Physiology. By Prof. J. Reynolds Green, F.R.S. Third edition. Pp. xxii+470. (London: J. and A. Churchill, 1911.) Price 10s. 6d. net.

IN the preface to the present edition Prof. Reynolds Green states that he has carried out a careful revision in order to introduce alterations suggested by practical use, and to incorporate such new ideas as have met with approval. Additional paragraphs have been inserted in the second chapter to emphasise the general relations of the individual with its environment, and further explanations are given with regard to perception of stimuli; the recasting of the sections dealing with energy and respiration was prepared for the second edition.

The book has been found particularly useful for the instruction of students up to an intermediate stage. Generally speaking, the author treats his subject so far as facts are established or theories have received acceptance. Therefore the student proceeds along a course that is, for the most part, non-contentious, and his progress is made easy by the careful arrangement and clear presentation of the subject-matter. The value of the book to the advanced student would be increased if references to literature dealing with debatable or more recent arguments were provided; for instance, it would be useful to find a reference to the description of the original experiments concerned with the detection of formaldehyde in leaves.

A History of England for Schools, with Documents, Problems, and Exercises. By M. W. Keatinge and N. L. Frazer. Part i., pp. x+388. Part ii., pp. x+324. (London: A. and C. Black, 1911.) Price 2s. 6d. each part.

IN addition to its immediate good effect on the pupils themselves, the introduction of laboratory methods of teaching science has had an indirect, beneficial influence on the other work of schools. Practical exercises are becoming a necessary part of courses of study in geometry, geography, and other subjects in which originally boys and girls had little else to do than listen to the exposition of their teachers. The most recent experiment in this direction is the introduction of the "research" method in the study of history, which is, in some schools, done in specially equipped rooms.

This work is a welcome indication of the improvement in teaching history which has taken place in recent years, and it may be recommended to the careful consideration of teachers who believe in securing the active cooperation of their pupils by setting them problems to study by themselves with the view of arriving at conclusions. An excellent collection of documents is provided, and they are intended to supply the apparatus for work which to some extent at least is analogous to that provided in the laboratory in the teaching of science.

Calendar of Papers in Washington Archives relating to the Territories of the United States (to 1873). By David W. Parker. Pp. 476. (Washington, D.C.: The Carnegie Institution of Washington, 1911.)

THIS volume is the first calendar of archive materials in Washington issued by the Department of Historical Research in the Carnegie Institution. It follows upon Messrs. Van Tyne and Leland's "Guide to the Archives of the Government of the United States in Washington." Mr. J. Franklin Jameson, the editor of the series to which this book belongs, says that the interest of historical writers at the present time is greatest in respect of papers which have to do with territories as a whole, especially with their government and their constitutional and political history. Accordingly attention has, in the present volume, been concentrated upon papers of this class.

Lehrbuch der Zoologie für Studierende. By Prof. J. E. V. Boas. Sechste vermehrte und verbesserte Auflage. Pp. x+690. (Jena: Gustav Fischer, 1911.) Price 12.50 marks.

PROF. BOAS's text-book is so well known—both the original text and the translation—that no description is necessary of the sixth revised edition now before us. The fifth edition was reviewed in NATURE of April 22, 1909 (vol. lxxx., p. 214), and the present issue differs from it only by the addition of a few pages and fifteen new illustrations.

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.*]

Non-Euclidean Geometry.

MR. FRANKLAND (NATURE, September 7) has raised the old problem of Bertrand's proof of the parallel-axiom by a consideration of infinite areas. This is perhaps the most subtle and the most specious of all the attempted proofs, and this character it owes to the fact that a process of reasoning which is sound for finite magnitudes is extended to a field which is beyond our powers of comprehension—the field of infinity. The fallacy which underlies Bertrand's proof becomes more apparent in Legendre's simpler device ("Éléments de Géométrie," 12 éd., Note ii.). A straight line divides a plane in which it lies into two congruent parts—this, of course, has no real meaning, since we are dealing with infinite areas, but such is the argument—and two rays from a point enclose an (infinite) area which is less than half the whole plane. Hence, if two intersecting lines are both parallel to the same straight line, the area of half the plane can be enclosed within an area which is less than half the plane.

This is the same sort of paradox as the well-known one by which the part is made to appear equal to, or even greater than, the whole. The even numbers 2, 4, 6, . . . form a part of the aggregate of integral numbers 1, 2, 3, . . ., but a (1, 1) correspondence can be established between them, viz. to $2n$ in the part corresponds n in the whole aggregate, and to n in the whole corresponds $2n$ in the part. Hence the part is equal to the whole. And, again, a (2, 1) correspondence can be established between the part and the whole, viz. to $4n$ in the part corresponds n in the whole, while the numbers of the form $4n+2$ have no correspondent. Thus the part is greater than the whole.

Mr. Frankland's comparison of the areas of a circle and a regular inscribed polygon is not quite fair to the polygon. The area of a regular N-gon, as its radius tends to infinity, tends to a finite limit, $\pi k^2(N-2)$, which, of course, tends to infinity as N is increased. The area of a circle is $4\pi k^2 \sinh^2 r/2k$, which also tends to infinity as r is increased. The first he calls a linear infinity, and the second an exponential infinity, and certainly e^x/x^n tends to infinity with x, if n is any finite number. But what is the relation between r and N? If we take the expression for the area of a regular N-gon inscribed in a circle of radius r, and then let N increase, we get a limit $4\pi k^2 \sinh^2 r/2k$, which is the expression for the area of the circle. Again, if in the regular N-gon with infinite radius we inscribe a circle, its area is $2\pi k^2(\operatorname{cosec}\frac{\pi}{N}-1)$ and this always bears a finite ratio to the area of the N-gon; it is thus an infinity of the same order, if N is increased indefinitely, and the N-gon, the inscribed circle, and the circumscribed circle all tend to the same geometrical limit—the absolute.

The fact that the cuspidal edge of the surface of rotation of the tractrix forms a line of discontinuity in this representation, and that none of the types of surfaces of constant negative curvature exactly images the hyperbolic plane in the properties belonging to analysis situs, appears to be no objection to hyperbolic geometry. An exactly similar difficulty occurs in the representation of elliptic geometry, since there is no continuous surface of constant positive curvature on which two geodesics have but one point of intersection. Geometry has become entirely a matter of postulation; but, at the same time, it is of interest to observe that the non-Euclidean geometries are capable of being truly represented, even within a restricted field, in Euclidean space.

D. M. Y. SOMMERVILLE.

The University, St. Andrews, September 30.

Elements of Comet 1911*f*.

FROM M. Quénisset's observation of September 23, and my own of September 26 and 30, I obtain the following approximate elements:—

$$T = 1911 \text{ November } 12{\cdot}67$$
$$\omega = 123^\circ\ 13{\cdot}4'$$
$$\Omega = 35^\circ\ 36{\cdot}6'$$
$$i = 102^\circ\ 19{\cdot}8'$$
$$\log q = \bar{1}{\cdot}89116.$$

The comet is now receding from the earth and approaching the sun, and there is no reason to expect much increase in brilliancy. The only point of interest is that when at the descending node on December 16 it will be about half a million miles outside the earth's orbit. The difference of the heliocentric longitudes of the earth and comet will, however, be 132°, so that no near approach is possible.

J. B. DALE.

Craigness, New Malden, Surrey, October 3.

Rainfall in the Summer of 1911 and of 1912.

HAS Mr. MacDowall the courage to apply his own experience, to which he refers in NATURE of September 28, to "supply long-range forecasts of months, seasons, &c."? Will he publish in advance a forecast for the winter 1911–12 or for the spring and summer of 1912, such as he considers could have been done for the summer of 1911? Or is it only after the event that he can discover what points in the past have to be considered and in what grouping they have to be compared in order to yield an *a posteriori* "forecast"?

HUGH ROBERT MILL.

62 Camden Square, London, N.W., October 2.

Miniature Rainbows.

WHEN returning one day in August of last year from the Farne Islands to Berwick in a pleasure steamer, I was standing in the bow of the boat, and was much struck by the display of a permanent rainbow in the spray that was thrown up. The rainbow was inverted, the result, presumably, of my position above it. The sea was very rough, and thus the spray was constant.

EDWARD A. MARTIN.

285 Holmesdale Road, South Norwood, S.E.

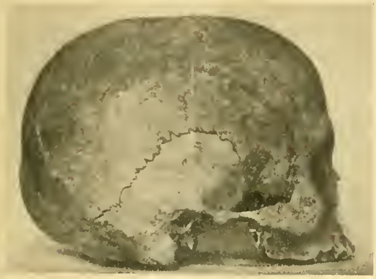
THE STONE AGES OF SOUTH AFRICA.[1]

THE papers in this volume are a very full and important addition to the work already published by Mr. J. P. Johnson; but it is doubtful whether they bring us any nearer to a solution of one of the most interesting questions connected with archæological or palæontological discoveries in South or Central Africa —namely, the approximate age to which the existence of man can be traced back in South Africa, East Africa, the Congo basin, West Africa, and the Sudan. Though Dr. Péringuey would seem, from one or two phrases, to lean to the theory of a very ancient date for the human colonisation of tropical Africa, he has to admit repeatedly that so far no cogent evidence has been produced in the shape of geological features associated with the finds of human remains or implements to indicate, as positively as is the case in Europe and Asia, the period in the earth's history with which such remains are to be associated.

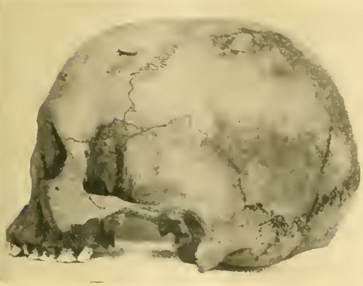
As our knowledge advances towards perfection, as we become better and better able to read that new Bible, the book of the Earth itself, we may have to revise our estimate of the ages of the hitherto discovered prehistoric, palæolithic, and eolithic human remains in Europe and Asia. Still, there can be little

[1] Annals of the South African Museum: vol. viii., part 1, containing the Stone Ages of South Africa, &c. By Dr. L. Péringuey, with further contributions by Mr. A. L. Du Toit and Dr. F. C. Shrubsall. (London: Printed for the Trustees of the South African Museum by West, Newman and Co.) Price 40*s*.

question within a few thousand years, more or less, of the relative ancientness of the calvarium, the molar teeth, and thigh-bones of *Pithecanthropus erectus* in Java; of the *Homo primigenius* type of lower jaw found near Heidelberg; and of the Grimaldi skeletons, &c. Of course, the mere finding of stone implements



(i) Strandlooper.



(ii) Bushman.

(iii) Hottentot.
Crania from South Africa.

in any part of Europe or temperate Asia argues some degree of antiquity in the specimens, because we know more or less historically the period at which they were abandoned for implements or weapons of metal. But in tropical Africa no such argument can apply, for a few small portions of the continent are still in the Palæolithic, or even Eolithic, Stone age. The south-western extremity of Africa was certainly in the palæolithic age 400 years ago, when Europeans first arrived there; though the Bantu tribes bordering on the Hottentot and Bushman domain had for many centuries before been mining, smelting, and using copper and iron.

So far as the reviewer is concerned, he continues to adhere obstinately to the belief, not as yet shaken by any registered fact, that man is a relatively recent immigrant into Southern Africa, and that Africa in general south of the Sahara Desert and of Somaliland has been much more newly populated by man (almost entirely of the negro subspecies) than has been the case with Asia—the original birthplace of the human species and genus—and with Europe.

Much interesting palæontological and geological evidence is collected and laid before the reader in chapter vii. (p. 74 and onwards). In this, Dr. Péringuey mentions that a portion of a molar tooth of a mastodon has been found in close proximity to a deposit of palæoliths and fragments of stone, evidently used as human implements, at Barkly West, in Cape Colony. Human implements have also been found in association with the lower jaw of an extinct horse of large size and of the gigantic long-horned buffalo—*Bos* or *Bubalus baini* (a close ally of the *Bos antiquus* of Algeria). But from the rock drawings in Algeria we know that this gigantic North African buffalo not only was contemporaneous with man, but even with neolithic man, and only seems to have become extinct a few thousand years ago. Similarly, in the extremity of South Africa a mastodon, a large horse, and the South African type of gigantic buffalo may have lingered down to quite a late period, since this same portion of the continent contains in a living state at the present day creatures which became extinct in Europe a hundred thousand years ago. (In this portion of his narrative Dr. Péringuey persists in confusing *Hyena brunnea* of South Africa with *Hyena striata* of East, West, and North Africa and Western Asia. I write under correction, but had always believed that *Hyena brunnea* was a very distinct species which hitherto had not been found north of the Zambezi and South Angola, and, though allied to the various types of *striata* far more than to *crocuta*, was nevertheless a very distinct species.)

Some of Dr. Péringuey's deductions are very interesting, especially as combined with the observations of Dr. Shrubsall. One of these would seem to be that the earliest human invaders of South Africa were of somewhat higher culture, of different head-form, and better brain development than the modern Bushman. These people are the now celebrated Strandloopers. At one time it was assumed, on the strength of some very prognathous skulls found in the coast regions of South Africa, that the Strandlooper was more "simian" (if that word may be applied to a very slight approximation towards the basal human type) than the Bushman. This deduction would seem to be wrong. The sub-nasal prognathism in the skulls of the earliest cave-men of Strandlooper types is less than in the Kalahari Bushmen and the Nama Hottentots of to-day, or in the general mass of negroes. One of the Strandlooper skulls, according to Dr. Shrubsall, has a more prominent nose and face than the typical negro, and in some respects recalls the river-bed type of early Europeans. The cranial capacity of these primitive Strandloopers was distinctly greater than either Bushmen or Hottentots, and this feature is present in the oldest skulls. One of these has a cranial capacity of 1600 c.c., while in a female skull of the Bush race from the Kalahari Desert there is a capacity of only 950 c.c.

Moreover, it would seem to be as though there had been a marked degeneration not only in the physical conformation of the pre-Bantu inhabitants of South Africa from the earliest Strandlooper type downwards, but also in the character and size of the stone implements manufactured by these primitive South African peoples.

Dr. Péringuey in some of his remarks (p. 168) would seem to regard the Bushman as not being a primitive race, but an example of retrogression in some directions and a singular advance in others. He puts forward the interesting hypothesis that the ancestors of the Bushman having discovered the potency of vegetable and animal poisons, gave all their attention to the manufacture and shooting of poisoned arrows, and therefore no longer cared to fabricate large stone weapons.

Dr. Péringuey writes as a South African, and South Africans are apt to hold heretical notions regarding the Bantu. One is that there is a Bantu physical type of negro, which is not the case; and the other is that the Bantu languages in their present form are of immense antiquity, and came to Africa from India. The Bantu-speaking peoples of South Africa vary in physical type, just as they do in the rest of Bantu Africa, and do not present any collective difference from millions of other negroes not speaking a Bantu language. As to this language family, I have given at different times reasons which appear to me conclusive for supposing that it cannot have originated in North Central Africa more than some 3,000 years ago. It was brought into existence in the heart of Africa, just like its neighbour Hausa, by the intrusion of some half-white race similar to the Hamite or the Fula.

This book gives interesting illustrations of the steatopygia and peculiarities of the external genitalia of the Bushman race. H. H. JOHNSTON.

CALIFORNIAN TREES.[1]

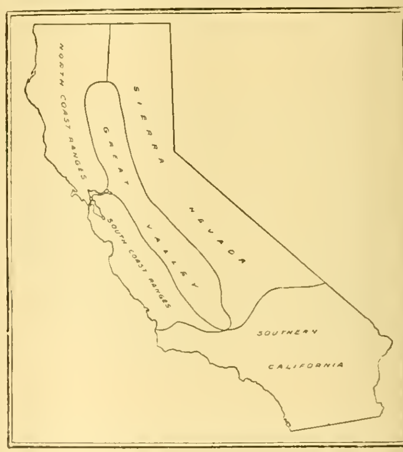
PERHAPS the noblest and most fascinating of all subjects for the writer and student of trees is the sylva of California. The arboreal vegetation of no other area of similar dimensions rivals it in interest or in the size of its individual types. Three trees alone—the two Sequoias ("Big Tree" and "Redwood") and the Douglas Fir—give to it a unique distinction, and they are supplemented by a group of scarcely less wonderful pines, firs, and spruces. Whilst it is the immense coniferous trees that give to the Californian sylva its remarkable fascination, many of the "broad-leaved," or non-coniferous, species are scarcely inferior in interest and distinction. There are, for instance, the magnificent Madroña—*Arbutus Menziesii*—a close ally of the Killarney arbutus, but reaching 125 feet in height, with a trunk 5 feet in diameter; the golden chestnut (*Castanopsis chrysophylla*), its leaves a tawny gold beneath, also over 100 feet high; the Mountain dogwood (*Cornus Nuttallii*), an ally of our Cornelian cherry, but often 50 to 60, sometimes 100, feet high, with its beautiful white involucres 6 inches across. Mr. Jepson, therefore, may well be congratulated on his subject.

To us in the British Isles it possesses an exceptional interest, because most of the Californian trees can be cultivated in the open air in many parts of our country. Nowhere else, indeed, out of California itself, can its coniferous trees be seen to such perfection as in the Perthshire valleys and in various places in the south and west of England and Ireland.

[1] Memoirs of the University of California. Vol. ii., "The Silva of California." By W. L. Jepson. Pp. 480+85 plates+3 maps. (London: T. Fisher Unwin; Berkeley: University Press, 1910.) Price 2l. 2s. net.

The history of the Californian sylva as known to Europeans strikes one as curiously recent. Botanical knowledge began with the visits of the Malaspina and the Vancouver expeditions. The latter, a voyage of survey organised by the British Government, touched California about 1793. Most of the botanical work accomplished on this journey was done by Archibald Menzies, but he only penetrated a few miles from the coast. David Douglas visited and explored California in the interests of the Horticultural Society of London about 1827, and with him may be said to have commenced the real revelation of its sylva. It was carried on by Nuttall, Fremont, Kellogg, Brewer, Bolander, and others. But even the existence of the "big trees" (*Sequoia gigantea*) was not definitely and authoritatively made known till nearly the middle of the nineteenth century, although hunters and wandering pioneers had previously brought home accounts of marvellous trees—mostly received, however, with the scepticism the stories of such folk obtain.

Among the later investigators of the Californian sylva a foremost place is held by the author of this



The Five Forest Provinces of California.

volume. Only two years ago he published an admirable little book, "The Trees of California," of which the present elaborate work is an amplification. The new volume opens with an interesting essay on the remarkable topography of California, its climate, rainfall, and tree distribution. The two great mountain systems (the Coast Ranges and the Sierra Nevada) enclose a great oval plain known as the "Great Valley," drained by the San Joaquin and Sacramento rivers, which meet about midway, and empty into the Pacific. This region, 400 miles long and averaging about 50 miles in width, is sparsely wooded and weak in number of species. One peculiar characteristic of its scenery is the park-like grouping and disposition of a few species of oak, chiefly the Valley oak (*Quercus lobata*) and the Live oak (*Q. Wislizenii*). They never form forests as the coniferous trees of the foot hills and mountain slopes do, and scarcely anywhere on this central plain does an aggregation of individuals amount to more than what may be termed a grove.

Besides the great valley of the Sacramento and San Joaquin, the author discusses his subject from the point of view of four other great geographical areas:

(1) the Sierra Nevada, the chief sylvan interest of which belongs to the long western slope, where occur the Big Tree groves, the eastern slope being remarkably abrupt; (2) the North Coast Ranges, a region rich in individuals and species, including the Redwood and many others which extend northwards into Oregon and Washington; (3) the South Coast Ranges, which form an interesting area richest forestally on the seaward slopes, where, among others, flourish the Redwood, Douglas Fir, and *Pinus ponderosa*. This region includes the remarkable peninsula of Monterey, where the well-known Monterey cypress of our gardens (*Cupressus macrocarpa*) is endemic; (4) Southern California, where the rainfall is deficient and the arboreal growth confined to mountain valleys and cañons, and where, in many places, the vegetation is of a purely desert character.

Spread over these five forest provinces are the ninety-four species of trees which come under the author's purview. The whole essay, which is one of remarkable interest, is the result, as Mr. Jepson tells us, of nineteen years' travel and study in the field. The only criticism we would make is that the exclusive use of vernacular names renders it impossible to follow the author without a continual and rather irritating reference to the body of the work in order to ascertain what species it is to which he is alluding. Such names as "Interior Live oak," "Santa Lucia fir," convey no meaning to the majority of readers, and their general adoption (which the author is anxious to bring about), as well as the reader's convenience, would have been furthered by a citation of the botanical name as well.

The treatment of the individual species is admirable. A very full synonymy is given, and a copious list of references. After an adequate and not very technical description of the tree, the author discusses its geographical distribution, its history, economic value, and any other matter of interest concerning it. To the Redwood and Big Tree, ten and eight pages respectively are devoted, and the distribution of the latter is shown by two large maps. The book is illustrated by eighty-five full-page plates, many of them reproductions of photographs showing the trees in their native habitats, and, incidentally, characteristic bits of Californian scenery.

Mr. Jepson has the orthodox conception of a species, which is decidedly refreshing after the orgy of species-making his compatriots of recent times have indulged in As presenting an original and authoritative account of a group of trees of particular interest to arboriculturists in the British Isles, his book may be strongly recommended. W. J. BEAN.

IMPERIAL SURVEYING.[1]

IN response to an invitation sent by the Colonial Office in March, 1909, to the Dominion, Commonwealth, State, and Provincial Governments in the Empire, delegates for the Commonwealth of Australia and the Dominion of Canada met in London in June last to discuss the proposal for establishing some system of reciprocal admission for surveyors between the different portions of the Empire. The question had been raised originally as a resolution submitted by the Government of New Zealand to the Colonial Conference of 1907, at which a memorandum drawn up by the council of the Surveyors' Institution was discussed, and a resolution was adopted affirming the desirability of reciprocity with regard to the examination and authorisation of land surveyors. The outcome of this was that particulars of examinations and other requirements with regard to the authorisation of surveyors were obtained from several Dominions, and were coordinated and compared in a second memorandum by the council of the Surveyors' Institution, in which the desirability of a conference between those concerned was pointed out.

This conference recommends as a first essential the formation of a central board, which would use its influence to keep up a uniform standard of examination, and on which the different Governments of the Empire would be represented. All examination papers set in any part of the Empire under any scheme of reciprocity would be sent to the board, which would direct attention to any questions falling below the standard agreed upon, and would consider any proposals for improving the working arrangements for reciprocity. Further, a syllabus was drawn up for a preliminary examination in English, arithmetic, algebra, plane and solid geometry, plane trigonometry, and mensuration; and for another of more advanced type to be passed after two years' field service, and including practical and theoretical surveying up to secondary triangulation.

Though this may appear a slight basis on which to construct a scheme of imperial reciprocity in this direction, the complexity of the whole subject must be remembered. In the United Kingdom the Ordnance Survey has provided an accurate topographical survey of every portion, though a true cadastral survey indicating all property boundaries does not yet exist, and, according to the recent report of the Royal Commission on the Land Transfer Acts, is not recommended, since therein verbal description of boundaries is preferred, maps being used in all cases, but only for assisting identity. Consequently there is no profession of highly trained surveyors having an intimate knowledge and full experience of the most precise methods of land and earth measurement, nor is geodesy studied at the higher educational institutions as is the case on the Continent. A moderate knowledge of land measurement enables the necessary interpolations and additions to be made to an ordnance map, and a land surveyor's duties are very largely concerned with valuation. The Surveyors' Institution has arranged a special advanced examination in land surveying, but being of no great value at home, and not recognised in a colony, use is not made of it.

In the various colonies the conditions are wholly different, for large areas remain unsurveyed, the demand for the location of property boundaries is urgent, and in many cases the surveyor has no official control points to connect with, but must make his own survey self-contained. It is therefore necessary for the Governments of these colonies to insist upon a high standard of technical efficiency in land measurement, including an acquaintance with geodetic work in all its branches. With such very different conditions existing any arrangement for the free interchange of surveyors must be difficult, and the proposals now put forward may be a first step as providing a guarantee of a certain standard of efficiency which may in some Dominions, Provinces, or States require to be supplemented to qualify for their special certificates.

In the United Kingdom at the present time there is no place where higher surveying and geodesy are regularly taught to those who are already acquainted with the ordinary and more approximate methods, and an improvement in this respect would do much to enable a surveyor in this country, wishing to practise in the colonies, to acquire the additional technical equipment which is required by some of their regulations. But besides the self-governing colonies there are vast tracts administered by the Crown colonies, and in these administration and development are de-

[1] Report of a Conference on the Question of Reciprocity throughout the Empire in the Examination and Authorisation of Surveyors. [Cd. 5776.] (London: Stationery Office, 1911.) Price 2½*d*.

manding both topographical and cadastral surveys as rapidly as they can be prepared. If these are to be both efficient and economical, and if as little as possible of the work done in early stages is to need complete revision at a later date, then those engaged in directing them should have a thorough knowledge of the methods, principles, and requirements of surveying of the highest grade, and not merely a certain proficiency in the simpler classes of topography that is now demanded; but for the acquirement of such knowledge there are not as yet in this country facilities such as exist on the Continent, where numerous chairs of geodesy and precise surveying are to be found.

H. G. L.

FRANCE AND CLASSICAL EDUCATION.

AT the Dijon meeting of the French Association for the Advancement of Science last August the president, M. Ch. Lallemand, delivered an informing and luminous address on the question of modern *versus* classical education. The address should be particularly instructive to English educationists, for the home of the traditional curriculum of our public schools is France, the direct heir of Roman literary culture.

Recently there has been something of a crusade against "modernism" in education, the chief argument being that the French language and French culture are being endangered by the abandonment of what the French call "Latin education," which, like our classical education, is chiefly based on Latin and Greek. But, as will be seen, there is no abandonment, and the crusade is probably no more significant than its predecessor of forty years ago, or the longer-continued counter-crusade against "Latin education." We shall refer to it more fully below.

Science and modern languages were introduced as parallel lines of education, but not as superseding the classical system, under the Second Empire. The growing needs of industry and commerce and the enormous development of science forced this on the nation. This "bifurcation" was continuously successful, though it was at once attacked. A counter-attack on the classical course followed, increasing in vigour towards the end of the century. M. Jules Lemaître put the weight of his great authority into the scale against classics. A similar attack was meanwhile being made in Germany, the Emperor William pronouncing strongly against classical education. From 1882 to 1900 the proportion of German students not learning Latin increased from 9 per cent. to 43. Then in 1902, as the result of a parliamentary commission, came further concessions to the claims of modernism. The resulting system, known as the "quadrifurcation," comprises, besides the general classical course, Latin and modern languages, Latin and science, and the specially "modern" course of modern languages and science.

The system is attacked both by literary and, significantly, by commercial authorities. M. Marcel Prévost says: "The new crop of graduates does not know more algebra, or physics, or modern languages than the old, and of their own language they know less." The chambers of commerce and great financial administrations have complained of the decay of correct writing and spelling, and demand the restoration of Greek and Latin as being indispensable for proficiency in commercial composition. Societies have recently been formed for the protection of French culture and the French tongue.

M. Lallemand disproves the notion that there is *une crise du français*. Recently in China the mandarins complained that young students were neglecting the study of the "characters" under the baneful influence of occidental ideas. When the classical system in France was "uncontaminated" by modernism, the complaint was made that the engineers of the public departments could not write or spell, and a special course was instituted to make this defect good.

Further, statistics show conclusively that if this ignorance of the principles of composition and orthography exists, it is not due to the abandonment of Latin and Greek. As a matter of fact, the number of students taking Latin has steadily increased since 1902. In 1910, of 1875 first-year students in Paris, only 362 had not learnt Latin. Of 646 students leaving L'Ecole Polytechnique between 1906 and 1910, there are 203 "moderns" as against 443 "Latins." Finally, as to the writing question, the Polytechnique examinations in French composition during the last ten years show a considerable superiority on the part of the "moderns"!

As to the alleged decadence of correct writing and calligraphy, M. Lallemand suggests that the increasing congestion of curricula, necessary in view of increasing knowledge, may be a factor. Perhaps in France, as in England, no serious attempt has ever been made to teach the native language. The present writer holds that this defect, together with the retention of Latin and Greek, constitutes the crying evil of present-day education.

M. Lallemand has some good remarks and quotations on the alleged educative virtue of dead languages and on the inconsistent arguments of those who advance it. They might form the basis of a logical inquiry, which is much needed, into the "educative" processes. He also has some penetrating observations on caste-feeling, which has a good deal to do with the recent crusade. The smallest shopkeeper is in favour of Latin, because his son can learn it as well as the son of the noble. If science were the cornerstone of education, the smallest shopkeeper would, on the same principle, vote for science.

A. E. CRAWLEY.

SIR HERBERT RISLEY, K.C.I.E.

BY the untimely death of Sir Herbert Hope Risley on September 30, at the age of sixty, science has lost an eminent anthropologist and India an official of no ordinary ability. Born in 1851, educated at Winchester and New College, Oxford, he joined the Indian Civil Service in 1873, and was posted to Bengal. He was soon transferred to the secretariat, a class of work for which his qualifications were better suited than that of an executive officer. But already he had acquired a taste for ethnological research during a short period of service in Chota Nagpur, where, on the basis of Colonel E. T. Dalton's "Descriptive Ethnology of Bengal," he compiled an account of the interesting hill races, which appeared in vol. xvi. of Sir W. Hunter's "Statistical Survey" of the province, issued in 1875–7. This, with the period spent on special duty as ethnographical superintendent in Bengal, was the only opportunity he enjoyed of obtaining that intimate familiarity with the rural classes which can be gained only by lifelong service in their midst.

The results of his researches in Bengal were embodied in his work on the tribes and castes of that province which appeared in 1891. Aided by a band of skilled co-workers, and utilising the materials privately published by Dr. J. Wise in 1883 under the title of "Notes on the Races, Castes, and Trades of

Eastern Bengal," he produced a work of considerable interest and authority, which at once attracted the attention of European scholars. He admitted that this work was only provisional and that it was merely "circulated for criticism"; but he had no opportunity for the preparation of a revised edition. Under the guidance of the late Sir W. Flower he mastered the principles of craniometry, and his receptive mind familiarised him with the general problems of ethnography and their bearing on the special conditions of the Indian races. Appointed director of the Ethnographical Survey in 1901, he suggested a scheme for research which, for reasons of finance, was rejected. On a limited scale it was sanctioned by the Government of Lord Curzon, and is now in progress in certain provinces.

Risley's reputation as an anthropologist must depend upon his account of the Bengal tribes and castes, and the chapters on caste and race contributed to the report on the census of India of 1901, conducted under his supervision. The latter was a remarkable *tour de force,* considering that it was written amidst the pressure of other arduous duties. In this class of work his lucid style and grasp of principles enabled him to present in an attractive form the results of the researches into Indian anthropology and sociology made by his assistants and himself. Had he lived longer he would probably have revised some of the theories advanced in his census report, which, with some modifications, was re-issued under the title of "The People of India." In particular he must have realised that craniometry alone is a slippery foundation for an analysis of the complex of Indian races; that he was mistaken in denying the influence of the Scythian and Hun invasions, particularly in relation to the origin of some of the Rajput tribes; and that his scheme of classification to some extent ignored the influence of environment, and the confusion of groups resulting from long ages of internal war and social disorganisation. But in his skilful account of the caste system and its working his powers of systematisation, aided by considerable literary ability, are fully displayed.

It may be feared that he was unable to complete a work on the people of eastern Bengal, which was announced for publication soon after his retirement from India. But he has left enough to show that, with more opportunity for personal study of the people and more leisure for examination of the material which he had collected, he might have attained a scientific reputation even higher than that to which he attained. Besides his published work, the initiation of the Ethnographical Survey of India is the best memorial of his services to the cause of science.

NOTES.

A meeting of the International Commission on Mathematical Teaching was held at Milan on September 18–21, Prof. F. Klein presiding. The main subjects discussed were:—(1) The question of rigour in teaching mathematics, especially geometry. It appears that of European countries Italy is the most wedded to rigorous methods, while Germany and Austria stand at the other end of the scale, and admit intuitive methods freely. France and England adopt a middle course, France inclining toward the Italian practice and England toward the German. It was agreed that Euclid does not satisfy modern standards of mathematical rigour. (2) The question of "fusion," *e.g.* of geometry with algebra, of plane with solid geometry, of geometry with trigonometry, of solid geometry with descriptive geometry, of analytical with geometrical conics, of differential with integral calculus. (3) The provision of mathematical instruction for students of such subjects as chemistry, biology, and economics. Such courses were at one time provided in French universities, but are now entrusted to the schools. In other countries there does not appear to be any systematic provision of this kind. The reports issued by the various national subcommissions were presented; of these, the French reports are now complete; eight of the thirty-four English reports have been issued by the Board of Education (Wyman and Co.), and a large amount of literature has been issued by the German subcommittee, whose labours, however, will not be completed for two years more. Arrangements were made for the educational subsection at the International Mathematical Congress to be held at Cambridge (England) on August 22–28, 1913. A full report of the Milan meeting will be published in due course in *L'Enseignement Mathématique.*

The summary of the weather for the first nine months of the present year, which has just been issued by the Meteorological Office, shows that the temperature for the period was in excess of the average over the entire area of the British Islands, the excess being greatest over England. The rainfall was everywhere deficient, the deficiency amounting to 7·20 inches in the north of Ireland, to 6·71 inches in the Midland counties, and to 6·20 inches in the south-west of England. In the south-east of England, which district embraces London, the deficiency of rain for the nine months amounts to 5·57 inches. Over the north of England the deficiency is little more than 2 inches, and in the north of Scotland it is only 0·05 inch. The largest aggregate rainfall for the nine months is 35·58 inches, in the north of Scotland, the least 11·94 inches, in the Midland counties. Rain fell on 163 days in the north of Scotland, but only on 97 days in the south-east of England. There was an excess of sunshine in the nine months over the entire kingdom, the greatest excess being 334 hours, in the south-east of England. The greatest aggregate duration of sunshine for the nine months is 1799 hours, in the Channel Islands, but it was very little less in the south-east of England, where the aggregate duration was 1720 hours. In the north of Scotland it was only 1116 hours. The summary for September shows that it was only in the English districts that the temperature was in excess of the average. The rainfall for the month was deficient over the entire kingdom, except in the north-east and north-west of England and in the south of Ireland. The sunshine was again in excess of the average over the entire country. At Greenwich the mean temperature for the month was 61°, which is 3° in excess of the average; the temperatures in the early part of the month beat all previous records, both for the absolute readings and for the mean of the period. The total rainfall for the month was 1·34 inches, which is 0·85 inch less than the average, and rain only fell on eight days. The sun was shining for 222 hours, which is nearly 70 hours more than the normal.

Sir Thomas Crosby, who has been elected Lord Mayor of London for the ensuing year, is the first medical man to occupy that office (though his term will be the 723rd Mayoralty of the City), and is probably the oldest citizen upon whom the honour has been conferred, his age being eighty-one. He took the degree of M.D. at St. Andrews University in 1862, after being in practice for ten years, and filled the office of president of the Hunterian Society in 1871. He is a member of the Senate of the University of London.

New regulations for the sale of mineral acids have now come into force. They have been made by the Privy

Council with the object of preventing the misuse of sulphuric, nitric, and hydrochloric acids. These acids, and also salt of lemon, must now only be sold by retail in bottles, distinguishable by touch from ordinary bottles, and bearing on a label the name and address of the seller, together with the words "Poisonous" and "Not to be taken." Ammonia will also be subject to the same regulations in four months' time.

THE popular science lectures which are given at the Royal Victoria Hall, Waterloo Road, S.E., every Tuesday evening from October to May, will commence on Tuesday, October 10, when Prof. W. Flinders Petrie, F.R.S., will lecture on "Life in Egypt 2000 Years Ago." Other lectures during this month are:—October 17, "The Modern Gun and Armour Plate," J. S. S. Brame; October 24, "Seeing Canada," Miss A. D. Cameron; and October 31, "Mountaineering," Mr. H. V. Reade.

WE notice with regret the announcement of the death, on September 26, of Mr. G. C. Donington, senior chemistry master at the City of London School. Mr. Donington was for a time demonstrator in chemistry at the Central Technical College, South Kensington, and was afterwards successively science master at Highgate School, Christ's Hospital, and Leeds Grammar School before his appointment to the City of London School. He was the author of a laboratory manual entitled "Practical Exercises in Chemistry," issued in 1906, and of a helpful "Class-book of Chemistry," published a few months ago. His death at the early age of thirty-seven will be deeply regretted by many friends and pupils.

AN investigation of the disease known as "sprue" is to be undertaken by the London School of Tropical Medicine. It is hoped that funds to the amount of 1000*l.* will be available for this purpose, of which the Government of Ceylon has provided 750*l.*, and the remainder will probably be subscribed by the Ceylon Tea Planters' Association. It has not yet been decided what representative of the school will undertake the investigation. The disease occurs in Ceylon, Malaya, Indo-China, China, and other districts, and is of considerable importance, causing a large amount of sickness and disability, and in some instances a fatal issue. At present little is known of the causation of the malady.

IT is proposed to erect a memorial to Mungo Park and Richard Lander. A committee has been formed consisting of Lord Curzon, Sir George T. Goldie, Lord Scarbrough, Major Leonard Darwin, Sir Walter Egerton, and Sir Hesketh Ball to take the necessary steps to secure funds for this purpose. Both explorers have been honoured in their native towns of Selkirk and Truro, but no record of any kind exists in the land to which their lives were consecrated and sacrificed. In appealing for support, the committee remarks:—"As the main object of their travels was to discover where the Niger joined the ocean, the most suitable site would seem to be its principal ocean port. It is therefore proposed to erect an obelisk of similar design and dimensions to Cleopatra's Needle on a projecting point of land at Forcados, where it would both attract general attention and serve as a landmark to vessels approaching the port. The total cost is estimated at 2000*l.*, exclusive of the foundations, which it is understood will be undertaken by the Government of Southern Nigeria." Donations may be sent to the honorary treasurer of the fund, Dr. J. Scott Keltie, 1 Savile Row, London.

THE new session of the Royal Geographical Society will be opened on November 6, when Dr. Nansen will read a paper on the Norsemen in America. On November 20 Dr. Tempest Anderson will give a paper on volcanic craters and explosions. On December 4 Sir Alfred Sharpe, until recently Governor of Nyasaland, will deal with the geography and economic development of British Central Africa. On December 18 Dr. T. McDougal, of the Carnegie Institution of Washington, will contribute a paper on American deserts. In the new year Sir William Willcocks will deal with his further researches on the Garden of Eden and its restoration. Dr. Mackintosh Bell, late director of the Geological Survey of New Zealand, will describe an unknown corner of South Island. Mr. Douglas Carruthers will describe, probably in March, his travels in Central Asia. Mr. A. J. Sargent will deal with the commercial geography of the Tyne Basin, and Mr. P. A. Talbot with the journeys in the Central Sudan. In January or February a course of three lectures will be given in the afternoon on the desert of North Africa, by Captain H. G. Lyons, F.R.S. The Christmas lectures this session will be:—on January 5, by Mr. Julian Grande, on "Amongst the Alps"; on January 8, by Mr. W. Herbert Garrison, on "Our World-wide Empire"; and on January 11, "A Lady's Journeys in the Central Sudan," by Miss Olive MacLeod.

A COPY of the first monthly number of the eighth volume of *The South African Journal of Science*, being the issue for August last, has been received. The periodical is the organ of the South African Association for the Advancement of Science, and the present issue is concerned with the Bulawayo meeting of the association held in July last. The presidential address of Prof. P. D. Hahn is printed, and in it he dealt, we find, with the advance in the teaching of science during the last forty years. "There was," he said, "no professorship or lectureship for any branch of science in existence in any of the schools or colleges of South Africa forty years ago, whilst at the present time we have over sixty professors and lecturers appointed to teach certain branches of science in our colleges and technical and agricultural schools." In Section A of the association, concerned with astronomy, mathematics, physics, meteorology, geodesy, surveying, engineering, architecture, and geography, the Rev. E. Goetz was president, and took "weather forecasting" for the subject of his address, which is printed in part in this issue. The South Africa Medal and Fund, which was raised by members of the British Association in commemoration of their visit to South Africa in 1905, were presented to Dr. L. Péringuey, director of the South African Museum, in recognition of his entomological research in South Africa. The fund amounted to 50*l.* The 1912 meeting of the association is to be held at Port Elizabeth.

MR. A. HAMILTON, director of the Dominions Museum at Wellington, New Zealand, has issued a useful hand-list of pamphlets and papers containing information relating more or less directly to the Maori race, supplementing the earlier catalogue published by him in vol. **xxxiii.** of the Transactions of the New Zealand Institute for 1900. He has excluded from his collection anything which might be called a "book," as these are to be found in various library catalogues and bibliographies. The present list is therefore confined to detached articles, many found only in obscure sources, which supply information on this interesting people. The publication is thus of much value to students of sociology, ethnography, folk-lore, and comparative religion and mythology.

IN his paper issued by the University of London Press on the pronunciation and orthography of the Chindau dialect, one of the Bantu group, spoken in that part of south-east Africa lying to the west of Sofala, Mr. D. Jones, lecturer in phonetics at University College, has provided a useful addition to our knowledge of African linguistics and phonology. He pleads for the general adoption of the national phonetic alphabet, because, in the first place, it is scientifically constructed on the "one sound one symbol" principle; secondly, because it is not the pet system of any single individual, but was prepared by representatives of a number of European languages; and, thirdly, because it is in more general use than any other existing system and is international. Missionaries engaged in the study of the languages of savage or barbaric tribes, and natives desirous of acquiring the correct pronunciation of English, French, or German, would be well advised to adopt it.

The second part of vol. xi. of the Annals of the South African Museum is devoted to a continuation of Messrs. Gilchrist and Wardlaw Thompson's descriptions of Natal marine fishes. Five species, including a mullet, are described as new.

As the result of a study of the luminous organs of certain fishes, Mr. H. Ohshima, writing in the Journal of the Tokyo College of Science (vol. xxviii., art. 15, finds that whereas in sharks these structures lack definite numerical arrangement, and are merely diffuse, minute epidermal swellings partially sunk in the cutis, in the Sternoptychidæ they are arranged in a definite order and limited in number, with a complicated structure. Still greater specialisation attends these organs in the Myctophidæ, in which there may be a sexual difference in arrangement. The luminosity in sharks is faint and diffuse.

In a continuation of his notes on zoological gardens, museums, &c., in the September *Zoologist*, Captain Stanley Flower expresses his admiration of the large size of the paddocks accorded to ungulates in the municipal menagerie at Lyons, which is further notable on account of the large amount of water running through the grounds. This establishment is open free to the public. Admiration is likewise expressed for the site of the new zoological gardens at Munich, which occupy a picturesque position on the Isar, are well timbered and watered, and contain scarped cliffs, bushy coverts, wooded ponds, and open meadows admirably suited for animals of many kinds. At the Naples Aquarium Captain Flower was interested in some living file-fishes (Balistes), which, although healthy at the time of his visit, were not likely to live long, as in confinement these fishes generally die at the approach of winter. They feed on molluscs and crustaceans, the shells of which are cracked so smartly by the powerful teeth that the sound is audible through the glass of the tank.

Biologisches Centralblatt for September 15 (vol. xxxi., No. 18) contains a preliminary account of investigations undertaken by Mr. S. Kowalewsky in regard to sex-determination in animals, the second title of the paper being the capricious determination of the sex in the germ of mammals and birds. Previous theories on the subject are reviewed, notably the opinion that poor nutrition in the female parent is conducive to the production of male offspring, and *vice versa*. Considerable importance appears to attach to this from the circumstance that, according to the author, female fœtuses are found in that portion of the ovary of guinea-pigs and rabbits which receives the greatest supply of blood, males being developed in the less richly nourished area, while where the blood-supply is still poorer the germs are infertile. It is also shown that subcutaneous injection of alcohol leads to a great preponderance of males in guinea-pigs, as does also a poverty of acid. The latter phenomenon seems connected with the fact that in races (such as Tatars and Australians) in which the females arrive early at puberty there is a marked preponderance of males over females.

We have received two parts (Nos. 27 and 29) of Dr. F. E. Schulze's *Das Tierreich*, now in course of publication by Messrs. Friedländer. In the former Dr. F. Werner deals with the chamæleons (Chamæleontidæ), while in the latter Mr. R. von Ritter-Záhony treats of that remarkable pelagic organism known as Sagitta, and its relatives, which collectively form the group Chætognathi. The chamæleons comprise a much larger number of species than are recognised in the third volume of Mr. Boulenger's British Museum Catalogue of Lizards (1887). In the latter work forty-four species of the typical genus Chamæleon are catalogued, whereas the number is now raised to seventy-four. In 1887 the Malagasy genus Brookia was represented by three species; it now includes seven. A still greater increase occurs in the tropical African Rhampholeon, of which Mr. Boulenger recognised but two species in 1887, whereas the present author enumerates seven. The Chætognathi are classified under six generic headings, one of the genera having been named by the author during the present year; twenty species are included in the type genus, while the other genera contain from one to three. Excellent figures of the structure of these organisms are given, and the diagnosis of the group is clear and succinct, but nothing is said with regard to certain views which have been recently expressed as to the taxonomic position of the Chætognathi.

An interesting paper on plant-inhabiting mites of a useful nature, contributed by Prof. G. F. Scott-Elliot, appears in the Transactions and Proceedings of the Botanical Society of Edinburgh (vol. xxiv., part iii.). The red spider and other inimical mites are well known, but the beneficial mites, although exceedingly common, have received less attention. Their homes, in the shape of small hollows behind hairs on the undersides of leaves on trees, are termed acarodomatia; they are not confined to dicotyledonous trees and shrubs, as was supposed, but are common on tall herbaceous plants, and the author has found them on the leaves of Solomon's Seal. With respect to their sphere of usefulness, it is asserted that they feed on scale insects, fungus spores, and other pests. The author suggests that with bacteria they help to prepare organic dust particles for the benefit of plants.

The Quarterly Journal of the Geological Society of London for August is concerned with British zones and fossils. E. S. Cobbold and C. A. Matley respectively describe trilobites and brachiopods from the Lower Cambrian beds of Comley. D. Woolacott directs attention to the brecciation of the Permian rocks of Durham, which may be due to thrusts of Miocene age. H. Bolton brings his intimate knowledge of our Coal-measures to bear on the stratigraphy of the Bristol Coalfield. He finds that the fossils of the marine bands are of no service in marking zones. S. H. Reynolds and A. Vaughan have investigated the Avonian series of Burrington Combe in Somerset in the light of modern research, and now publish work that has extended over several years. The paper concludes with some interesting evolutionary generalisations (p. 389). The Carboniferous system receives further study from F. G. Collins, E. N. Arber, and G. C. Crick in a paper on the Culm of the Exeter district. The Lower Culm-measures are regarded as equivalent to the Midland Pendleside series. The name Culm thus becomes misleading, especially from a Continental point of view (see p. 399).

Finally, A. Wade describes Silurian rocks from near Welshpool, including some of igneous origin.

A MAP by the Edinburgh Geographical Institute, showing the density of population in Scotland as given by the census of 1911, appears in *The Scottish Geographical Magazine* for September. The method of Bosse is employed in calculating the density values, in which all uninhabited country and all urban districts and towns of 10,000 inhabitants and upwards are left out of account. Comparing it with the map setting forth the results of the 1901 census, the areas of densest population show a marked increase in spite of the reduced rate of increase of the population as a whole. The south shore of Moray Firth and the neighbourhood of Wick are also areas where population density has increased. These last two areas are connected with the fishing industry, which has improved of late, while the mining and manufacturing industries of the lowland region has drawn people to it.

THE valuable rainfall reports for the German protectorates of (1) Togoland (West Africa) for 1910, and (2) South-West Africa, for two years ended June, 1910, published by Baron v. Danckelman in *Mitteilungen aus den Deutschen Schutzgebieten* (vol. xxiv., part ii., 1911), show that in the first case the amount of rainfall was very favourable; in the coastal and central districts it was a record year, and at most of the stations the wettest since the commencement of regular observations in 1901. In the second case the rainfall for the fiscal year ended June, 1909, everywhere exceeded the average of the last ten years. The excessive amount caused an undue development of injurious insects, malaria, and sickness among cattle. In 1909–10 the amount was generally satisfactory, but not nearly so abundant as in the previous year. Rain is mostly accompanied by thunderstorms; in places thunderstorms frequently occur without rain.

A DETAILED summary of the meteorological observations made at the municipal observatory of the city of Bremen has just been published under the title "Beiträge zur Klimabeurteilung Bremens." The work is in two parts. In the first section the diurnal variations of the various meteorological elements are set out, both for the seasons and for the whole year, but the harmonic coefficients have not been determined. The second section concerns itself with monthly means and extremes, and for purposes of comparison corresponding values are given for Berlin and Frankfurt. The moderating influence of the ocean on the climate of the seaport is very strikingly brought out by this juxtaposition of figures, and the full meteorological statistics which are given for all three towns form a very useful book of reference. The work has been compiled by Prof. W. Grosse, the director of the observatory.

WE have received copies of the valuable meteorological charts of the great oceans issued by the U.S. Weather Bureau for October. The reverse sides of those for the North Atlantic and North Pacific Oceans contain interesting papers by Prof. W. J. Humphreys (1) on the origin of the permanent ocean "highs," and (2) the Aleutian and Icelandic "lows," illustrated by maps. There is a close connection between the positions and intensities of these areas and the weather of adjacent continents; they are the maxima and minima, with closed isobars, in the belts of high and low pressure, or so-called centres of atmospheric action. The subject of the importance of observations in these belts was brought before the International Meteorological Committee at the St. Petersburg meeting in 1899, and at the conference at Innsbruck, in 1905, a resolution of the Solar Commission advocating the establishment of permanent stations in the regions in question was unanimously adopted. Few attempts have been made to explain the origin of the maxima and minima; the author refers to the hypotheses put forward by Ferrel and Angot, and has supplemented them by one of his own. He concludes, *inter alia*, that a maximum ocean "high" must be at that place where the mechanical and thermal causes combine to produce the greatest result, *i.e.* a little to the west of the intersection of the coldest portion of an ocean current with a high-pressure belt.

FROM the observations of Eve at Montreal, Ashman at Chicago, and Satterly at Cambridge, it has been concluded that in each cubic metre of air near the ground there is an amount of radium emanation which would be in equilibrium with 80×10^{-12} grams of radium. This conclusion has been confirmed by observations made at Tokyo by Messrs. Kinoshita, Nishikawa, and Ono, which are described in the June number of the Proceedings of the Tokyo Mathematico-Physical Society. The amount of emanation decreases with distance from the ground, but if a homogeneous layer only 5 kilometres thick be taken as the equivalent of the whole atmosphere, over each square metre, there is an amount of emanation which would be in equilibrium with 4×10^{-7} grams of radium. Half of this breaks up in 3·7 days, and the question arises, how is the supply to be kept up? If it is derived, as it has been thought to be, from the strongly active air which exists in the pores of the soil, it must be possible to show by measurement that a large amount of emanation is exhaled from a square metre of soil. This has just been done by Prof. Joly and Mr. Smyth, who describe their observations in the August number of the Proceedings of the Royal Dublin Society. They find that near Dublin the amount exhaled often exceeds the $2·9 \times 10^{-9}$ grams per square metre per hour necessary to maintain the atmospheric emanation.

WITH the year 1910 the *Ergebnisse der magnetischen Beobachtungen* of the Royal Observatory of Wilhelmshaven commences a new series, edited by Prof. Bidlingmaier, the assistant director. The volume extends to forty-five pages, and possesses two charts. It contains an account of the absolute and self-recording instruments. At present the latter consist of declination (D) and horizontal force (H) magnetographs of the Kew pattern by Adie, but a vertical force instrument seems under construction. The methods of observation and reduction, and the base values of the curves, are treated in great detail. One reason for this doubtless is that, following the example of Potsdam, mean values are assigned to every day of the year, which go to 1 γ in H and to 0·1′ in D. Again, following Potsdam, the hourly values represent mean ordinates from sixty minutes centring, not at exact hours of the day, but at half hours. Mean diurnal inequalities are given for individual months, going to 0·01′ in D and to 0·1 γ in H and in the north and east components. Corresponding values are also given in the case of the components for the Fourier 24, 12, 8, and 6-hour terms. The last two pages give vector diagrams for the diurnal inequality for individual months. In the diagrams and diurnal inequalities use is made of all days, whether quiet or disturbed, which probably explains the rather striking irregularities in the diagrams. While the influence of Potsdam example is manifest in the more normal parts of the volume, the treatment of disturbances affords scope for the ventilation of Dr. Bidlingmaier's own methods of treatment.

THE experimental study of vortex rings has in the past been qualitative rather than quantitative; but, according to the Journal of the Franklin Institute for September, Dr. E. F. Northrup, of Princeton University, has so materially improved the apparatus used in their production that accurate observations of them may now be made. A coloured ring of liquid is projected from the opening in the front of a metal box by a blow struck by an electromagnet on the back, and travels through a transparent liquid, which gradually decolourises the projected liquid. If the box is pointed slightly upwards, the issuing vortex ring is reflected on reaching the surface of the liquid, the angle of reflection being apparently equal to that of incidence. By the use of two liquids of different densities in the observing tank, refraction may also be shown. While, however, the actual matter of the vortex ring is carried forward into the second liquid if the density of the latter is greater than that of the ring, this is not the case if the ring is denser than the liquid into which refraction is about to take place. By projecting molten paraffin wax into cold water, solid rings can be obtained. A subsequent number of the Journal will contain photographs of rings in a variety of conditions.

We have received from the authors, Messrs. H. R. Hamley and A. L. Rossiter, a copy of a paper on the magnetic properties of stalloy, reprinted from the Proceedings of the Royal Society of Victoria. The remarkable magnetic properties of stalloy—essentially an iron-silicon alloy containing 3·4 per cent. of silicon—have already been investigated very fully in this country, principally by methods involving the use of a wattmeter; the present research emanates from two Government research scholars working in the University of Melbourne, and the methods used are entirely different, since they depend upon Prof. T. R. Lyle's method of tracing out the wave-forms. This application of Lyle's method is interesting, and it is satisfactory to find that the results substantially confirm those obtained by the wattmeter methods.

Three interesting equilibria are discussed in the Memoirs of the College of Science and Engineering of the Kyoto Imperial University, the third volume of which is now being issued. In the case of sodium acetate dissolving in acetic acid solutions of different strength, the complete equilibrium diagram for 20° C. plotted by R. Abe shows the existence of three salts having the formulæ

$$NaC_2H_3O_2,3H_2O;\ NaC_2H_3O_2,C_2H_4O_2,\ \text{and}\ NaC_2H_3O_2,2C_2H_4O_2.$$

In the case of sodium and potassium carbonates dissolving in water at 25° C., Y. Osaka finds that the only double salt which can exist in contact with its solution at that temperature is the salt $Na_2CO_3,K_2CO_3,12H_2O$. In the case of the system water, ethyl alcohol, ethyl ether, studied by S. Horiba, physical methods of analysis were adopted, the composition of the phases being determined from measurements of density, refractive power, and viscosity. The critical composition at which the two phases become identical was found to be: water 40 per cent., alcohol 28·4 per cent., ether 31·6 per cent., for a temperature of 25° C.

Some months ago attention was directed in these columns to a paper by Flint in *The American Journal of Science*, in which he claimed to have separated, by fractional precipitation of tellurium tetrachloride, a portion of the tellurium with an atomic weight so low as 124·32. This method of resolution had already been tried some years previously by Baker and Bennett, but without success. In view of the results recorded by Flint, Prof. Baker repeated his experiments in collaboration with Prof. Vernon Harcourt, and found once more that no resolution could be effected by this method. In describing their experiments in the Journal of the Chemical Society, these authors explain the probable origin of the anomalous results of the American observer. In recovering the tellurium which they had used, they noticed that an orange-coloured precipitate was formed from material that had previously been quite white. This yellow precipitate was found to be tellurium trioxide, which had been produced by the oxidising action of hydrochloric acid previously exposed to bright sunlight, and thereby contaminated with chlorine. A basic nitrate prepared from the trioxide and analysed by Flint's method gave (on the assumption that the tellurium was present as dioxide in the form $2TeO_2,HNO_3$) an atomic weight so low as 118·31, instead of the normal value 127·54. There can be little doubt, therefore, that the low figures given by Flint were due to oxidation of the material, and not to any resolution of the element.

The City of Paris depends upon its supply of fuel, food, and other commodities to a large extent on the traffic carried by water, the quantity brought into the city by this means of transport being greater than by the railways. Ever since the formation of the Manchester Ship Canal, the question of rendering the Seine between Rouen and Paris navigable for sea-borne vessels has been in agitation. The serious inundations that occurred in the lower parts of Paris about a year ago again directed attention to the condition of the river, and a commission was appointed by the Minister of Public Works to report on the matter. Recently this commission has presented its report. The question of making the river navigable for sea-borne vessels, and making Paris a seaport, is not, however, dealt with, the commission being of opinion that the present conditions of traffic can be considerably improved by the works proposed for dealing with the prevention of overflow and inundations. The widening and deepening of the channel in some parts where required, and the construction of a new channel across the bend between the Rivers Marne and Seine below Paris, proposed by the flood commission, would be of great service to the traffic. A large sum of money has already been expended in enlarging and improving the locks and the channel between Rouen and Paris, and boats carrying more than 200 tons can navigate the waterway.

Commenting on the wreck of the naval airship at Barrow on September 24, *The Engineer* for September 29 believes that had this vessel survived a few months longer even the Admiralty officials responsible for her inception would have become convinced that the airship in general is a hopelessly impracticable affair. The vessel will in all likelihood be repaired; indeed, even already there is news to this effect. Sufficient has not yet been done, our contemporary supposes, to justify the official abandonment of the whole idea. *Engineering* of the same date is more sympathetic, and considers that it would be a mistake to attach too much importance to the accident. The airship is still, like the aëroplane, in an experimental stage; and the Admiralty airship must be regarded as a great practical experiment, in which the results of trial and error, when carefully analysed, must yield important lessons. The material used for the outer envelope proved of high resisting quality, only yielding when there was abnormal tension. The duralumin girder-work proved very ductile and of great tensile strength against the racking stresses set up. The material of which the ballonets are made, as supplied through the War Department, has all along been a source of uncertainty and of little accidents, and the facts point to the cause of the collapse being due to the rupture of a gas-bag when the vessel was being drawn out of the shed.

OUR ASTRONOMICAL COLUMN.

DISCOVERY OF A THIRD-MAGNITUDE COMET (1911*g*).—Yet another object is added to the list of recently discovered comets. On September 28 M. Beljawsky, at the Simeis Observatory, saw a third-magnitude comet, of which the position at 17h. 8m. (Simeis M.T.) was

R.A. 10h. 43m., dec. 8° 15′ N.

This position lies in Leo, about half-way between χ and ρ Leonis, and rises just before dawn.

A further observation, secured by Dr. Strömgren at Copenhagen on September 29, 17h. 12·7m. (Copenhagen M.T.), gave the position of the new comet as

R.A. = 10h. 52m., 59·8s., dec. = 8° 57′ 49″ N.

According to telegrams published in *The Daily Mail*, this object was observed at the Greenwich Observatory at 16h. 30m. on Monday morning; it has a very bright tail, which shows up well on the photographs. At the same hour on Sunday morning it was seen at the Royal Observatory, Edinburgh, and its magnitude, soon after rising, was estimated as 3·0. The observers there describe the tail as curved and fan-shaped, and state that it could be traced for a distance of 2°.

Beljawsky's comet is the seventh comet to be discovered this year, and so will take the designation 1911*g*.

BROOKS'S COMET, 1911*c*.—Brooks's comet is now an object of general interest, and in a clear atmosphere shows a tail even to the naked eye; on Sunday last, at Gunnersbury, with a pair of ordinary opera-glasses, there was no difficulty in seeing a filmy appendage, which stretched for some 2° or 3° in a north-easterly direction.

Writing from Malta on September 20, Mr. C. Leach said the comet had been visible to the naked eye for some time, but no tail was seen until September 16; on the two succeeding nights he saw, without optical aid, some 3° or 4° of tail quite easily, and concluded that its brightness was increasing.

A number of observations are recorded in No. 4526 of the *Astronomische Nachrichten*. Prof. Nijland publishes some measures of magnitudes which suggest an oscillation in the brightness of the comet, and M. Esclangon records the phenomena observed during the occultation of a 10·5-magnitude star by the comet on August 17. From 10h. 1m. 0s. to 10h. 1m. 12s. (Bordeaux M.T.) he was unable to separate the star from the well-defined but slightly fainter stellar nucleus of the comet. Although he could detect no change of brightness while the star was passing through the nebulosity forming the coma, he noticed a distinct diminution of the star's light as it passed behind the nucleus.

QUÉNISSET'S COMET, 1911*f*.—Several observations of comet 1911*f* appear in No. 4526 of the *Astronomische Nachrichten*, where the discoverer and M. Baldet describe the object as being of magnitude 7·5, round in form, having a nucleus, and showing the hydrocarbon-cyanogen spectrum.

In the *Comptes rendus* for September 25 they give further details of the discovery, and briefly describe their photographs. Short exposures (34 mins.) on September 23 showed a round head and traces of a tail, while the spectrograms showed the blue band of the "Swan" spectrum and the cyanogen band at λ 388. On September 24 exposures of 2h. 9m. were possible, and a tail 1° long, in position angle 322°, was clearly visible on the direct photographs; the comet was sensibly brighter, and was suspected to be visible to the naked eye, its estimated magnitude then being 6·5. The spectrum was much denser, and in addition to the bands showed a fairly strong continuous radiation.

A set of elements and an ephemeris, based on observations made on September 24, 25, and 26, are published by Dr. Ebell in a supplement to No. 4527 of the *Astronomische Nachrichten*. The elements give November 12 as the time of perihelion passage, and the following is taken from the ephemeris:—

Ephemeris 12h. (M.T. Berlin).

1911		α (true) h. m.	δ (true) ° ′	log *r*	log Δ	mag.
Oct.	4	15 20·7	+52 30·5	0·0304	9·9839	6·7
,,	5	15 22·8	+50 35·6			
,,	6	15 24·7	+48 42·9			
,,	7	15 26·4	+46 52·6			
,,	8	15 28·0	+45 4·8	0·0103	0·0026	6·7
,,	9	15 29·4	+43 19·6			
,,	10	15 30·7	+41 36·9			
,,	11	15 32·0	+39 56·8			
,,	12	15 33·1	+38 19·3	9·9903	0·0252	6·7
,,	13	15 34·2	+36 44·4			

CALCIUM VAPOUR IN THE SOLAR ATMOSPHERE.—Continuing his discussion of Mount Wilson observations of the movements and condition of calcium vapour over sun-spots and other special regions of the solar surface, Mr. C. E. St. John arrives at some valuable conclusions regarding the conditions obtaining in the solar atmosphere, in No. 2, vol. xxxiv., of *The Astrophysical Journal*; only a very brief summary of the principal results can be given here. In most sun-spots the calcium vapour is descending at from 0·68 to 2·2 km. per second, but over the penumbræ that vapour which produces the bright K_2 line appears to be in vertical equilibrium. Over flocculi a very doubtful upward motion of this emitting vapour is suggested, but in both cases the absorbing vapour descends as it does over the general disc. Both absorbing and emitting vapours appear to participate in the occasionally occurring rotary motion around spot umbræ, but the former have the greater velocity; this is also true for the inward radial motion of vapour across the penumbræ, and the combinations of the two produce the vortical motions converging on the umbra. Large masses of relatively cool calcium vapour high above the chromosphere, that is to say, projected prominences, are held responsible for the abnormal absorption line sometimes splitting or bordering the K_2 bright lines. In addition to the general circulation, there appear to be local systems in which emitting vapour rises around the flocculi, and, flowing across the penumbra, descends into the umbra of the spot. The apparent changes of intensity in the bright K_2 line, at the sun's centre and limb, is shown to be probably no more than a contrast effect. The differences and changes in the intensities of the K_1, K_2, and K_3 lines, and hence the different results obtained for various levels in the sun's atmosphere, find a possible explanation in the modifications of the radiation coefficients by several agencies.

ELEMENTS AND DESIGNATIONS FOR RECENTLY DISCOVERED MINOR PLANETS.—The usual list of elements and numbers for minor planets recently discovered is published by Dr. Cohn, of the Berlin Astronomisches Rechen-Institut, in No. 4521 of the *Astronomische Nachrichten*. It includes twenty-three asteroids discovered in 1909, 1910, and 1911 at the Königstuhl, Taunton, Vienna, and Teramo Observatories, and the final number given is 714.

THE MASSES OF SPECTROSCOPIC BINARIES.—An interesting paper in which Dr. Ludendorff discusses generally the masses of different classes of spectroscopic binary stars appears in No. 4520 of the *Astronomische Nachrichten*. *Inter alia*, he shows, from the study of twenty-five binaries of the spectral classes O*e*5 to B8, that they have combined masses two or three times as great as have the twenty-six systems of classes A to K stars which he considered.

PUBLICATIONS OF THE U.S. NAVAL OBSERVATORY.—A number of works recently received from the U.S. Naval Observatory includes the following:—Vol. vi. of the Publications describes the equatorial observations of the satellites of the major planets, made during the period 1893–1907. It also contains a number of miscellaneous observations, an account of the transit of Mercury observations in 1894, and a list of the Naval Observatory publications. In the introduction to the part dealing with the equatorial observations there are some excellent plate illustrations of the various instruments employed. Vol. vii. is a catalogue of 23,521 stars in the Washington zones for which the observations were made in 1846–52, and are reduced to epoch 1850.

FORTHCOMING BOOKS OF SCIENCE.

AGRICULTURE.

Crosby Lockwood and Son.—The Rubber Planter's Note-book, F. Braham, illustrated. *Longmans and Co.*—The Profitable Culture of Vegetables; for Market Gardeners, Small Holders and Others, T. Smith, illustrated. *Williams and Norgate.*—The Soil Solution: the Nutrient Medium for Plant Growth, F. K. Cameron.

ANTHROPOLOGY.

George Allen and Co., Ltd.—Bushman Folk-lore, W. I. Bleek and L. G. Lloyd, illustrated with numerous specimens of Bushman drawings, with preface by Dr. McCall Theal. *Macmillan and Co., Ltd.*—The Golden Bough: a Study in Magic and Religion, Dr. J. G. Frazer, new edition, in six parts, part iii., The Dying God.

BIOLOGY.

George Allen and Co., Ltd.—Birds and Beasts, C. Lemonnier, translated by A. R. Allinson, translated; The Life of the Bee, M. Maeterlinck, illustrated. *D. Appleton and Co.*—A Text-book of Heredity, Prof. W. E. Castle. *Edward Arnold.*—The Horse: its Origin and Development, combined with Stable Practice, Col. R. F. Meysey-Thompson, illustrated; The Life of a Tiger, S. Eardley-Wilmot, illustrated; and new editions of Scottish Gardens, the Right Hon. Sir H. Maxwell, Bart., illustrated; and A Book about Roses, the late Very Rev. S. Reynolds Hole, illustrated. *Baillière, Tindall and Cox.*—Fungoid Diseases of Plants, Prof. J. Erickson. *A. and C. Black.*—Sea-fishing, C. O. Minchin, illustrated; The Grammar of Science, Prof. Karl Pearson, F.R.S., third edition, part ii., Biological, illustrated; Talks about Birds, F. Finn, illustrated; Peeps at Nature, edited by the Rev. C. A. Hall, illustrated:—(1) Wild Flowers and their Wonderful Ways, Rev. C. A. Hall; (2) Bird Life of the Seasons; (3) British Land Mammals, A. N. Simpson. *Cassell and Co., Ltd.*—Wild Flowers as they Grow, photographed in colour direct from nature by H. E. Corke, with descriptive text by G. Clarke Nuttall, second series; Breeding and the Mendelian Discovery, A. D. Darbishire, illustrated; Marvels of Fish Life, Dr. F. W. Ward, illustrated; The Regeneration of the Race, Dr. H. Havelock Ellis; The Methods of Race Regeneration, Dr. C. W. Saleeby; The Family and Race Regeneration, W. C. D. Whetham, F.R.S.; Canaries, Hybrids and British Birds, in Cage and Aviary, J. Robson, Dr. A. R. Galloway and others, illustrated. *Chatto and Windus.*—Vine-growing in England, H. M. Tod, illustrated. *Constable and Co., Ltd.*—The Origin and Distribution of American Fauna, Dr. R. F. Scharff, illustrated; Outlines of Evolutionary Biology, Prof. A. Dendy, F.R.S., illustrated. *Gustav Fischer (Jena).*—Wissenschaftliche Ergebnisse der deutschen Tiefsee-Expedition auf dem Dampfer *Valdivia* 1898–1899, edited by Prof. C. Chun, Dreizehnter Band, Zweites Heft, W. Kükenthal and H. Broch, Pennatulacea, illustrated; Flora der Umgebung der Stadt Sao Paulo in Brasilien, Prof. A. Usteri, illustrated; Sammlung anatomischer und physiologischer Vorträge und Aufsätze, edited by Profs. E. Gaupp and W. Trendelenburg, Heft 16 (Heft 3 des II. Bandes), E. Laquer, Bedeutung der Entwicklungsmechanik für die Physiologie; Vergleichende Physiologie, Prof. A. Pütter; Lehrbuch der Botanik für Hochschulen, Profs. E. Strasburger, L. Jost, H. Schenck, and G. Karsten, new edition, illustrated; Die Palaeobotanische Literatur, Zweiter Band, Die Erscheinungen des Jahres 1909 und Nachträge für 1908, W. J. Jongmans; Geologische und paläontologische Abhandlungen, edited by E. Koken, Neue Folge Band x. (der ganzen Reihe Bd. xiv.), Heft 3, Beiträge zur Kenntnis der Cephalopoden der norddeutschen unteren Kreide. I. Die Belemnitiden der norddeutschen unteren Kreide. 1. Die Belemniten des norddeutschen Gaults (Aptiens und Albiens), E. Stolley, illustrated; Lehrbuch der Protozoenkunde, Prof. F. Doflein, new edition. *Henry Holt and Co. (New York).*—General Zoology, Prof. E. C. Conklin; Living Plants, Prof. W. F. Ganong; Biology of the Seasons, Prof. J. A. Thomson, American edition; Eugenics, C. B. Davenport; Plant Life and Evolution, Prof. D. H. Campbell; Hertwig's Manual of Zoology, translated by Prof. J. S. Kingsley, new edition; Evolution of Animal Intelligence, Prof. S. J. Holmes; American Woods, Prof. E. C. Jeffrey and L. W. Bailey. *C. H. Kelly.*—Tree Lore, F. G. Heath. *John Lane.*—Some Nature Biographies (Plant, Insect, Marine, and Mineral), J. J. Ward, illustrated, cheap edition. *Longmans and Co.*—Butterfly Hunting in Many Lands, Dr. G. B. Longstaff, illustrated. *Macmillan and Co., Ltd.*—The Natural History and Antiquities of Selborne in the County of Southampton, Gilbert White, illustrated in colour; The Depths of the Ocean based on the Scientific Researches of the Norwegian Steamer *Michael Sars* in the North Atlantic, Sir J. Murray, K.C.B., F.R.S., and Dr. J. Hjort, assisted by Prof. Gran and Dr. H. Hansen, illustrated. *Methuen and Co., Ltd.*—Reptiles, Amphibia, and Fishes, R. Lydekker, F.R.S., and others, illustrated; Outlines of Biology, Dr. P. C. Mitchell, F.R.S., revised by G. P. Mudge, illustrated; Elementary Lessons on Plant Life, D. G. Scott, illustrated. *John Murray.*—The Bulb Book, or, Bulbous and Tuberous Plants for the Open Air, Stove, and Greenhouse, containing particulars as to descriptions, culture, propagation, &c., of plants from all parts of the world having bulbs, corms, tubers, or rhizomes (orchids excluded), J. Weathers, illustrated; The Cell and Cellular Reproduction of Living Beings, Dr. M. Hartog (Progressive Science Series). *Oxford University Press.*—Forestry for Woodmen, C. O. Hanson; Nature Children: a Flower Book for Little Folks, G. M. Faulding and E. S. March. *Lovell Reeve and Co., Ltd.*—Supplement to the Coleoptera of the British Islands, Rev. Canon Fowler and K. Donisthorpe; Lepidoptera Indica, Col. C. Swinhoe, vol. ix., Flora of Tropical Africa, vol. vi., part iii., Flora Capensis, vol. v., part iii., edited by Sir W. T. Thiselton-Dyer, F.R.S. *Smith, Elder and Co., Ltd.*—Marshall and Hurst's Junior Course of Practical Zoology, new edition, revised by Prof. F. W. Gamble, F.R.S. *S.P.C.K.*—The Process of the Year, H. H. Brown, illustrated. *University Tutorial Press, Ltd.*—Practical Botany, Dr. F. Cavers; Aims and Methods of Nature Study (South African edition); School Lessons in Plant and Animal Life, Dr. J. Rennie. *Ward, Lock and Co., Ltd.*—More Kindred of the Wild, C. G. D. Roberts, illustrated. *John Wiley and Sons (New York).*—Forest Physiography: Physiography of the United States and Principles of Soils in Relation to Forestry, Dr. I. Bowman; Insect Pests of Farm, Garden, and Orchard, E. D. Sanderson. *Williams and Norgate.*—Studies in Seeds and Fruits, H. B. Guppy. *Witherby and Co.*—The Home Life of the Osprey, C. G. Abbott, illustrated; The Birds of Colorado, W. L. Sclater.

CHEMISTRY.

F. Alcan (Paris).—L'Electrochémie, Prof. W. Ostwald. *George Allen and Co., Ltd.*—Famous Chemists, E. Roberts. *Allman and Son, Ltd.*—Elementary Domestic Chemistry, Dr. J. Newton Friend. *G. Bell and Sons, Ltd.*—An Experimental Course in Physical Chemistry, Dr. J. F. Spencer, vol. i., Statical Experiments, vol. ii., Dynamical Experiments. *Ch. Béranger (Paris).*—Manuels pratiques d'Analyses Chimiques:—Alcool méthylique, vinaigres, Calvet; Huiles et Graisses végétales comestibles, Halphen; Eaux naturelles et artificielles, Diénert; Chaux, Ciments, Pierres artificielles, Leduc and Chenu; Eaux-de-Vie, Rocques; Vins, Gayon and Laborde; Boissons fermentées, Stœcklin; Laiterie, Bordas and Touplain; Confiserie, E. Roux and Muttelet; Patisserie, Boulangerie, Arpin; Beurre et Graisses animales, Bruno; Matériaux de Construction, Leduc and Chenu; Savonnerie, Parfumerie, J. Dupont; Conserves, Blanc; Textiles et Tissus, Beuké; Engrais, Demoussy; Tourteaux, Bussard; Métaux précieux, Garantie, Guénez; Chocolats, Cacaos, Bordas. *A. and C. Black.*—Chemical Analysis, Qualitative and Quantitative, a Text-book for Technical Schools and Colleges, G. G. Gardiner, vol. i. *Cassell and Co., Ltd.*—The Story of the Five Elements, E. W. Edmunds and J. B. Hoblyn. *W. and R. Chambers, Ltd.*—Organic Chemistry, Profs. W. H. Perkin, F.R.S., and F. S. Kipping, F.R.S., new edition. *J. and A. Churchill.*—Allen's Commercial Organic Analysis, vol. v., Tannins, Dyes, and Colouring Matters, new edition, edited by W. A. Davis and S. S. Sadtler. *Constable and Co., Ltd.*—An Introduction to the Study of Fuel, Dr. F. J.

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TWO MINOR AUSTRALIAN GOLDFIELDS AND THE ANTIQUITY OF MAN IN AUSTRALIA.[1]

THE goldfield of Forbes and Parkes is situated about 200 miles to the west of Sydney, where the old rocks of the East Australian Highlands disappear beneath the Black Soil Plains. Low spurs from the Palæozoic rocks project westward into the plains, and wide valleys of alluvium run eastward into the foothills. Gold was found during 1861 in the river gravels at Forbes, near the bank of the Lachlan River, and a gold-quartz lode was discovered in the following year at Parkes, on Gooban Creek, a tributary of the Lachlan. Further leads and lodes were discovered at both localities. Mining on the field has, however, been very irregular in its results. The alluvial deposits at Forbes yielded 212,547 oz. in 1862 and 71,493 oz. in 1863; but since then the output from both fields has varied from 57,851 oz. in 1875 down to as low as 1583 oz. Mining at Forbes has at times ceased entirely, and the field is now almost derelict. In the hope of reviving mining there, Mr. Pittman, the Government geologist of New South Wales, arranged for a geological survey of the field to collect trustworthy evidence as to its past history and determine the most likely directions for future mining. The problem of the field is mainly physiographic; and the work was entrusted to Mr. E. C. Andrews, who has already made his mark as an able physiographer. His interesting report is a valuable contribution to the geology of central New South Wales.

The main gold supply of the field has come from its leads, which are buried river channels containing auriferous gravels. These old river beds lie beneath the alluvium, and their working has been hampered by the excessive water with which they are saturated. Alluvial mining has ceased owing to the difficulty of following the deposits into the deeper ground. The methods of deep-lead mining were developed in Victoria, where, as a rule, the gold is found most abundantly in the deep, central river channels. In the Forbes area, however, for reasons which Mr. Andrews clearly explains, some of the richest patches of gold are on the sides of the buried valleys, and he advances weighty arguments that the deep drifts of the old Lachlan Valley would, if discovered, prove too poor in gold for profitable working.

The lode mines of the field are of two types. The foundation of the area consists of Ordovician and Silurian rocks associated with intrusive andesites and andesitic lavas, and covered in places by some Devonian rocks. To the east are some large areas of granite of post-Silurian, but pre-Devonian or Devonian, age. The gold-quartz lodes are associated with the intrusive andesites or occur along crush-zones. Mr. Andrews concludes that the gold has been introduced into the lodes in solution, and did not come from the igneous rocks, and that where gold has been found in igneous rocks in New South Wales it is of secondary origin.

The report includes one item of anthropological evidence that may prove of unusual importance. Hitherto Australia has remained the one continent on which there is no direct evidence of the antiquity of man. It has often been pointed out that, in spite of the thorough search of Australian drifts during mining operations, no early trace of man has yet been found in them. Mr. Andrews records (pp. 19 and 27) the occurrence of some blackfellows' ovens 18 feet below the surface, and associated with remains of Diprotodon. It is to be hoped that a more detailed account of this discovery will be published. On the theory that the Australian aborigines entered Australia in the north-west, and were specialised for desert existence, as they worked their way across Central Australia, it is in such localities as Forbes, where mining operations expose the drifts on the borders of the central plains, that early remains of the aborigines would be expected. Though under special conditions 18 feet of alluvium might accumulate in a short time, the association of the ovens with bones of Diprotodon appears to indicate that Forbes has yielded the earliest trace of man yet found in Australia. Mr. Andrews holds that the whole series of drifts, of which that containing the ovens is one of the later members, is of post-Tertiary age.

Mr. Andrews's memoir is of great interest and unusual merit. The history of the field, too often neglected in such reports, has been carefully compiled, and the features of the country are graphically described and suggestively interpreted. Considering that the closing of the mines prevented the author from inspecting the old workings, he has collected instructive evidence as to the structure of the lodes. His sections, however, give no strong support to his suggestion that the Silurian rocks have been overthrust on to the Ordovicians. As such memoirs are for the benefit of the mining industry, the less familiar terms, such as miarolitic, might be explained in footnotes. The most serious omission is the absence of heights from the map. The scarcity of altitudes on Australian maps is at

[1] The Forbes-Parkes Goldfield, New South Wales, Department of Mines. Mineral Resources, No. 13. Sydney, 1910 (issued 1911). By E. C. Andrews. Pp. iii+109+map+7 plates of plans and sections.

General Report on Tanami Goldfield and District (North-western Central Australia). By L. C. E. Gee. Pp. 2.+map+19 illustrations. (Adelaide, 1911.)

present their greatest defect, which is especially marked in this case, as they are indispensable in the study of deep leads.

The map accompanying Mr. Gee's report on Tanami is also heightless. That report tells a very different story. The field was only discovered in 1900, and the great difficulties in its development are in access and scarcity of water. The locality is 50 miles from the frontier of West Australia, 800 miles from the end of the South Australian railways at Oodnatta, and 696 miles from Port Darwin, on the northern coast. The goldfield was visited by Mr. H. Y. L. Brown, the Government geologist, in 1909, and in consequence of his favourable report and the increased number of prospectors, the Government sent Mr. L. C. E. Gee there as warden and magistrate. Mr. Gee has now furnished a very interesting report on the district, the prospecting mining work, the rainfall, climate, and aborigines, with lists of plants collected and birds observed. In spite of its tropical position, Mr. Gee describes the climate as very healthy. The rainfall observed in ten months was 15½ inches, and a good supply of water is often obtained from wells at about the depth of 150 feet. The surrounding country is called desert, but Mr. Gee describes it as containing much fair and some good pastoral country. The mining results hitherto have done little to fulfil the original expectation that at length a great goldfield had been discovered in South Australia.

J. W. GREGORY.

ENTOMOLOGICAL NOTES.

THE U.S. Department of Agriculture is anxious lest the mango-weevil (*Cryptorhynchus mangiferae*), which does so much harm to mango-plantations in other parts of the world, should be introduced into those recently established in Florida. The larva burrows into the seed while soft, where it remains for a considerable period, and is thus carried all over the tropics. In a circular issued by the Bureau of Entomology it is recommended that all mango seeds introduced into America should be opened and examined, and those selected for planting made to germinate under a wire-gauze screen.

The advent between 1900 and 1902 of the sugar-cane leaf-hopper (*Perkinsiella saccharicida*) into the sugar-cane plantations of Hawaii was the beginning of a great calamity which has befallen sugar-growers in four of those islands; for by February, 1903, the insect had spread over the whole area devoted to sugar-culture, and had become so numerous as to constitute a serious pest. Its spread was greatly facilitated by the fact that in those islands only half the crop is harvested at a time, so that there is a continuous supply of nutriment. Moreover, there was an absence of indigenous enemies, although some native species have since taken to preying on the leaf-hopper. The species was introduced from Queensland; and the loss to planters in Hawaii during 1903 and 1904 from this and other insects is estimated at three million dollars. Bulletin No. 93 of the U.S. Bureau of Entomology is devoted to an account of the life-history of the leaf-hopper and the best means of checking its ravages.

In part ii. of the sixth volume of Records of the Indian Museum Dr. J. J. Kieffer continues his description (in French) of the gnats and midges of the family Chironomidæ in the collection of the Indian Museum, naming eighty-seven species as new, the majority of which come from the Oriental region, although others are from the Suez Canal.

Parasitic Hymenoptera from the Transvaal form the subject of a paper by Mr. P. Cameron in vol. ii., No. 4, of Annals of the Transvaal Museum. In a previous paper the author was able to record, from material in the museum, only thirteen local representatives, but, thanks to a collection made by Mr. A. J. T. Janse, he now describes a very large number, some of which represent peculiar generic types, as new. The larval hosts of many of the species are likewise recorded. In this connection it may be noted that the serial quoted suffers from the absence of a table of contents or index to the various numbers.

Mr. J. W. Shoebotham has favoured us with a copy of a paper by himself from the July number of *The Annals and Magazine of Natural History* on spring-tails (Collembola) new to the British fauna, with the description of a new species of Oncopodura, typically from Berkhampstead, Herts. The collection on which the paper is based was mainly made in the counties of Hertford, Buckingham, and Stafford.

Another addition to the British fauna is a coccid taken in ants' nests in Somersetshire by Mr. H. St. J. Donisthorpe, and identified by Mr. E. E. Green, in *The Entomologist's Monthly Magazine* for August, with *Ortheziola rejdovskyi*, a species hitherto apparently known only from Bohemia. At the conclusion of his paper Mr. Green discusses the serial homology of the segments of the antennæ in various members of the Coccidæ.

THE CULTIVATION OF LUCIDITY IN SCIENTIFIC WRITING.[1]

ACCORDING to the reports of examiners for medical degrees, many students seem unable to write an essay or thesis exhibiting any literary quality and style. The fault is not entirely that of the candidates. Whatever subjects they may have learnt at school, the writing of their own language has, in general, not been one of them. Even during their university career the use of the written English language, except as a machine for taking notes or answering examination questions, has not formed any regular part of their course.

The teaching of English is often understood to mean the attempt to teach a literary style by the imitation of good models; but what is really wanted is the power of expressing clearly one's own ideas in one's own language, and this ought now to be within reach of every English-speaking man and woman. The usual methods of teaching English still leave the average boy and girl singularly deficient in the art of saying what they mean on paper, however ready they may be in expressing themselves by the spoken word. This is largely due to the want of systematic practice in writing; moreover, essays are generally criticised by the teacher from the point of view of style rather than in respect of intelligibility. Students should learn to express their own meaning in absolutely clear and intelligible language before they think about the manner in which that language is to be manipulated. A split infinitive is a less important fault than a failure to make the meaning clear. Teachers and examiners of scientific subjects often say of a pupil or an examinee that he evidently understands what he is trying to say, but is merely unable to express his meaning, and then give him full credit for the knowledge and pardon him the failure to express it.

In these circumstances it is not surprising that much scientific writing of the present time is loose and unintelligible in its expression. The remedy is to cultivate the quality of lucidity; this will lay the foundation for a good style.

There cannot be clear writing without clear thinking, and he who learns to write clearly will in the process learn to think clearly. Except in the drafting of resolutions and telegrams, most people have little practice in making their meaning absolutely clear. Letters in the daily papers and many books and memoirs on scientific subjects fail singularly in the quality of lucidity. It would be a good thing if schools and universities had societies which gave their students the same valuable training in the use of the pen which their debating clubs give in the practice of fluent speaking.

In the scientific revival of the nineteenth century the great expositors who wrote with such admirable lucidity led the public to see that the study of science, like that of philosophy, is an education in clear thinking; but now that so much scientific writing is badly expressed, the impression is conveyed that the studies which lead to such loose writing cannot really be conducive to accurate and clear thought. The remedy is in the hands of students themselves, who can, by constant practice in everything that they write and by determination to make their meaning clear, cultivate the essential quality of lucidity before they try to acquire the graces of a good style.

[1] From the introductory address delivered at St. George's Hospital on October 2 by Dr. H. A. Miers, F.R.S., principal of the University o London.

SOME QUANTITATIVE STUDIES IN EPIDEMIOLOGY.

AN account of some quantitative studies in epidemiology has recently been published in the second edition of my book on the "Prevention of Malaria" (Murray), and the Editor of NATURE has asked me to give a general description of them here. The attempts originated in the following manner. Shortly after Anophelines were shown to carry malaria, it was often observed that little apparent correlation could be found between their numbers and the numbers of infected persons in a locality. The observations were always far too scanty to establish any real absence of correlation; but they were used, nevertheless, to support the thesis that the *amount* of malaria does not depend upon the *number* of the Anophelines, and that therefore the proposed anti-malarial measure of mosquito reduction (then very unpopular) was useless. For many reasons a trustworthy experimental investigation would have been very difficult and costly, and it was therefore all the more necessary to examine the subject by a carefully reasoned analysis of the relations which must hold between the amount of the disease and the various factors which influence it. My first attempt in this direction was made in an official report on the "Prevention of Malaria in Mauritius" (Waterlow and Sons, 1908), and fell into the form of a simple difference equation. This was further developed in the first edition of my book already mentioned, and the subject was at the same time ably attacked by Mr. H. Waite, at the instance of Prof. Karl Pearson, in *Biometrika*, October, 1910.

The attempt now referred to aims at extending the reasoning to infectious diseases in general. The object is as follows. Suppose that a given proportion of a population in a given locality at a given moment are infected with some disease. Then we know from experience that the number will not remain fixed, but will vary from time to time and from place to place. The problem is to calculate these variations on the supposition that all the coefficients are known, which, of course, is by no means always the case. The use of the calculation will be (1) to obtain more light regarding the coefficients by comparing calculated with observed results; (2) to obtain quantitative estimates as to how far each coefficient should affect the result; and (3) to improve preventive measures by showing which factors they should be directed against. My studies have been hitherto concerned only with time-to-time variations, and the reader will understand that they require verification and completion by better mathematicians than myself. So far as I can ascertain, the subject has been little dealt with hitherto.

We must first obtain clear ideas on some points. Infectedness is not the same thing as sickness. *Infectedness* begins when the infecting organisms first enter the body of the host (man, animal, or plant), and ceases only when the last of them die out of him or leave him, or when he himself dies. *Sickness* may be quite absent during the whole of this period, or may begin after an "incubation period"; may cease long before or long after infectedness ceases, or may be intermittent. It is therefore merely an episode of infectedness, and one which does not concern us greatly just now. Another episode, and a more important one at the moment, is *infectiveness*, that is, the state of the infected person during which the infecting organisms are able to pass from him to others. The period or periods of infectiveness are always contained within the period of infectedness, but do not necessarily coincide with the periods of sickness. Thus typhoid or diphtheria carriers may be ill for only a week or so, or not at all, but may remain infective for months. In yellow fever, according to good researches, sickness and infectiveness begin together a few days after the commencement of infectedness at inoculation; but infectiveness ceases three days later, often long before the sickness is over. In malaria, sickness and infectiveness are intermittent and not coincident episodes, and may recur for years. Infectedness itself is only the preliminary stage of *affectedness*, which begins at inoculation and does not end until the last trace of the resulting sickness or acquired immunity has vanished. Reinfection often occurs during existing affectedness, and may increase its duration and that of the episodes. Medical treatment may have the opposite effect, and natural immunity and prevention may reduce susceptibility to infection. Lastly, the natural fluctuations of population, due to births, deaths, immigration, and emigration, must be considered, and these may vary in consequence of the epidemic.

Hence many coefficients have to be taken into account; and the principal difficulty lies, I fancy, in arranging for all of them in the equations. The course which I have adopted as being perhaps the best for a beginning is to conceive the matter in the most general terms possible by taking the act of infection as being one of any kind of event, such as accident, death, marriage, bankruptcy, receipt of bequests, insect-bite, &c., which may occur to a population, the various coefficients being at present taken as constant during the period considered. If such an event occurs to a given constant proportion of the population in unit of time, how many affected people will there be in the locality on a given date, on a most probable estimate, and how many of these have been affected once, twice, thrice, &c.? This simple form may be called the problem of *happenings*, and its solution will often be useful in epidemiology, as, for instance, in estimating the most probable frequency of reinfections or of insect-bites. But for some kinds of events, such as marriage, wealth, and infectedness, we must contemplate a continuance of the event in the individual, with a possible reversion to the unaffected class after the cessation of affectedness. Such events may be called *becomings*; and we have now to find the proportion of the population in this condition on a given date.

I will treat the equations as briefly as possible. Consider the following:—

$$\begin{aligned} a_{t+1} &= (1-h)va_t + \mathrm{HV}z_t \\ z_{t+1} &= h\,va_t + (1-\mathrm{H})\mathrm{V}z_t \\ p_{t+1} &= va_t + \mathrm{V}z_t \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1) \end{aligned}$$

Here a_t and z_t are respectively the numbers of unaffected and affected individuals, and p_t is the total population at the end of t units of time; v and V are respectively the variations in number of the unaffected and the affected due to births, deaths, immigrations, and emigration in unit of time; h is the proportion of the unaffected which become affected, and H the proportion of the affected which become unaffected (to be better defined presently) in unit of time. Thus $1-h$ and $1-\mathrm{H}$ are respectively the proportions which remain unaffected and which remain affected, and a_{t+1} and z_{t+1} are the numbers of the groups after the lapse of one unit of time. The gain of one group is the loss of the other group, and the total population is the sum of the two groups, the factors h and H disappearing in the summation.

If n, m, i, e denote the (constant) nativity, mortality, immigration, and emigration rates among the unaffected, and N, M, I, E the similar rates among the affected, it is correct, I believe, to write $v=(1+n)(1-m)(1+i)(1-e)$, and a similar equation for V. Different symbols are necessary for the two groups, because all the quantities, even the immigration, may differ. We now take the equations in more exact detail, but omitting v and V for the moment. Thus

$$\begin{aligned} a_{t+1} &= (1-h)a_t + (1-h)na_t + (1-h)\mathrm{N}z_t + (1-h)rz_t \\ z_{t+1} &= h\,a_t + h\,na_t + h\,\mathrm{N}z_t + h\,rz_t + (1-r)z_t \\ p_{t+1} &= a_t + na_t + \mathrm{N}z_t + z_t \quad . \quad . \quad . \quad (2 \end{aligned}$$

Here n and N are the birth-rates of the two groups. The second and third columns give the happenings among the births; rz_t is the proportion of the affected which *revert* to the unaffected group in unit of time, and hrz_t the (very small) proportion of these which immediately become reaffected; $(1-r)z_t$ is the proportion of the affected which do not revert, and $(1-h)rz_t$ the proportion of the reverted which are not immediately reaffected. Obviously p_{t+1} is merely the sum of the two groups a_t and z_t *plus* the births that have occurred to both in the unit of time, and the symbols h and r disappear in the summation. The equations are not symmetrical, because, though the progeny of the unaffected are born in this group and belong to it, the progeny of the affected are not born affected, and therefore do not belong to the latter group. I think that this is the better arrangement; but it would be possible to add a term for affected births, as in syphilis. The first two of the above equations may be written

$$a_{t+1}=(1-h)(1+n)a_t+(1-h)\frac{N+r}{1+N}(1+N)z_t$$

$$z_{t+1}=\quad h(1+n)a_t+\left\{1-(1-h)\frac{N+r}{1+N}\right\}(1+N)z_t \qquad (3)$$

If, now, we restore the mortality, immigration, and emigration rates, that is, affix to a_t in both equations the coefficient $(1-m)(1+i)(1-e)$ and to z_t the coefficient $(1-N)(1+I)(1-E)$, we have

$$a_{t+1}=(1-h)va_t+(1-h)\frac{N+r}{1+N}Vz_t$$

$$z_{t+1}=\quad h\,va_t+\left\{1-(1-h)\frac{N+r}{1+N}\right\}Vz_t \quad . \quad . \quad . \quad (4)$$

which are obviously the same as equations (1) if H is now defined as the value of $(1-h)(N+r)/(1+N)$.

The complete solution of these difference equations is

$$(X-Y)a_t=(a_1-a_0Y)X^t-(a_1-a_0X)Y^t$$
$$(X-Y)z_t=(z_1-z_0Y)X^t-(z_1-z_0X)Y^t$$
$$(X-Y)p_t=(p_1-p_0Y)X^t-(p_1-p_0X)Y^t \quad . \quad . \quad . \quad (5)$$

where

$$a_1=(1-h)va_0+HVz_0 \qquad z_1=hva_t+(1-H)Vz_0$$
$$p_1=va_0+Vz_0 \qquad p_0=a_0+z_0$$

and X and Y are the roots of the auxiliary algebraic quadratic equation

$$x^2-\{(1-h)v+(1-H)V\}x+(1-h-H)vV=0.$$

These roots are rational for several particular values of the constants. The most important instance is when $v=V$, that is, when the happening does not affect the normal fluctuations of the population. Here $X=v$ and $Y=(1-h)(1-r)/(1+N)$, and

$$z_t-Y^tz_0=\frac{h(1+N)}{N+r+h-hr}(p_t-Y^tp_0). \quad . \quad . \quad . \quad (6)$$

As Y is in this case less than unity, Y^t diminishes without limit as t increases, and therefore z_t, the number of affected individuals, asymptotes to a fixed proportion of the total population, provided that all the elements remain constant. I call this proportion the *static value.* In disease it gives what is called the *endemic index*, or *ratio.*

In epidemiological applications the symbol z refers, not to sickness or even infectedness, but to affectedness as defined above; and the symbol r does not mean recovery from sickness or infectedness, but reversion to a susceptibility to a fresh happening (inoculation), that is, to loss of acquired immunity. Thus in drawing curves of epidemics we must remember that this last factor may not come into play until long after the commencement of the epidemic, or not at all.

In my book the above equations are treated also in the infinitesimal form, when the integrals become exponential. Thus the second of equations (2) becomes

$$\frac{dz}{dt}=h(p-z)+qz,$$

where $q=V-1-r-N$. If the total population p remains constant, this is easily integrable if h is also constant, or (what more probably happens in epidemics) is a linear function of z, say cz.

Numerous applications are possible; but I have space to refer only to the important case of "metaxenous diseases," that is, to infections common to two species of animals or plants. The same equations apply to both species, but the happening-factor h in one equation must be a function of z in the other equation. We thus have two simultaneous equations to solve, namely,

$$\frac{dz}{dt}=k'z'(p-z)+qz$$

$$\frac{dz'}{dt}=kz(p'-z')+q'z'$$

where the marked symbols apply to one species of animals (say, mosquitoes) and the unmarked ones to the other species (say, man), and k and k' are constants composed of the most probable frequencies of communication between the two species, of infectivity and of natural immunity. Prof. F. S. Carey has referred these equations to Prof. A. R. Forsyth, who thinks that they are not likely to be easily integrable in finite terms; but the most important case is where both z and z' have reached static values, when the differential coefficients vanish. We then obtain at once

$$z=\frac{kpk'p'-qq'}{kk'p'-kq}$$

with the similar equation for z'. In the case of some insect-borne diseases this becomes (reduced)

$$z\{(1-r)fb'f'b'A+rfb'\}=p\{fb'f'b'A-rN'\},$$

where z is the ratio of affectedness among men (say), f and f' the proportion of infective men and insects, b' the frequency of bites, r the reversion rate among the human patients, N′ the birth-rate of the insects, and A the ratio of the number of the insects to head of human population. Numerical estimates of the constants in malaria are attempted in the book, and a table of calculated values of A for various values of z and b' are given (as already partly done by Mr. Waite).

The following important laws seem to be established:—(1) the disease (z) will not maintain itself unless the proportion of Anophelines (A) is sufficiently large; (2) a small increase of A above this figure will cause a large increase of z; and (3) z will tend to reach a fixed value, depending on A and the other constants. I doubt whether these laws could have been reached except by such mathematical attempts. The second one is especially important. If A is just at the critical value, z will be zero, or only just above it; but if A is only about double this critical value, a serious epidemic, amounting to about half the whole population, may follow. Yet such a small increase in the number of Anophelines will scarcely be detectable except after very careful study, a fact which easily explains why marked correlation has not always been observed. The same equation shows that, if certain experiments are to be trusted, yellow fever can scarcely be considered an endemic disease of men at all; and it also explains the absence of certain diseases in the presence of capable carriers, and the general phenomena of smouldering epidemics.

The most probable numbers of individuals to which a happening has occurred never, once, twice, &c., can easily be obtained, and are equal to the successive terms in the expansion of $\{(1-h)+h\}^tV^tp_0$ in ascending powers of h. This enables us to estimate the number of persons who have been bitten, or the number of insects which have succeeded in biting never, once, twice, &c., in a given period, and to calculate the average number of bites received or inflicted by each individual. It also enables us to calculate (what I think has not been done before) the frequency of *reinfections.* At present such reinfections are not much considered during the course of an already existing infection, but I estimate that in a locality where half the people are statically affected with malaria no fewer than about 63 per cent. will be infected or re-infected every four months (under constant conditions). In 1898 I showed that birds reinoculated with malaria could exhibit renewed and severe infections.

Lastly, to complete the study, it is necessary to estimate the most probable proportion of affected individuals who are also infected, or infective, or sick at a given moment. This will be the same as the proportion of the average number of days lived during these "episodes" to the average number lived during the whole period of "affectedness," which can be calculated from the special pathological data.

These studies require to be developed much further; but they will already be useful if they help to suggest a more precise and quantitative consideration of the numerous factors concerned in epidemics. At present medical ideas regarding these factors are generally so nebulous that almost any statements about them pass muster, and often retard or misdirect important preventive measures for years.

RONALD ROSS.

RESEARCH IN MEDICINE.[1]

THE object of research is to discover something which was not previously known, or to correct or to confirm some previous observations. There are two methods of research—one by *observation*, the other by *experiment*. In medical research the method by observation is much out of fashion; it is slow, and may be often interrupted for want of material. The imperfection of the material is often very disappointing. The method by experiment (not by any means limited to experiments on animals), on the other hand, is the fashion of the day; it is quicker, less liable to be interrupted, and may yield brilliant results in a very short space of time. But it is a two-edged weapon, and needs to be used, and its results to be accepted, with great caution. Mr. Hunter, who was a confirmed and most ingenious experimenter, said in the course of his evidence at the trial of Captain Donellan:—"I apprehend a great deal depends upon the mode of experiment; no man is fit to make one but those who have made many and paid attention to all the circumstances that relate to experiments."

Let me give you my experience of the two methods in the investigation of cancer. Many years ago there was great confusion in the minds of pathologists and surgeons regarding the differences and resemblances between sarcoma and carcinoma. I made a diligent study of them by observation of the cases at my hospital, the cases at other hospitals, and the cases recorded in the literature of many countries. The research was very long, very tedious, and very disappointing by reason of the small number of cases which were sufficiently recorded to be available for use. The results formed the subject of the Erasmus Wilson lectures thirty years ago, and proved that the life-history of the varieties of malignant disease does not depend merely on their structure, but upon their seat of origin, and that the varieties of malignant disease of every part of the body must be separately studied if they are to be treated with success. Observations of a similar kind have been made by other clinical pathologists, with the result that the most successful operations for cancer at the present time are based on the results of clinical pathology. For no part of the body has this been done with greater success than for the breast. Charles Moore and Mitchell Banks urged the importance of very large operations many years ago; but surgeons fought shy of them, because they lacked that which was supplied many years later by Heidenhain and Styles—a scientific basis. Recently Handley has again added valuable information on the same subject, founded on clinical and microscopical observation.

I have never engaged personally in experimental investigation on account of the difficulty of doing so thirty years ago. But I have been associated with the Imperial Cancer Research, and in touch with its staff from the foundation of the research, and have been a member of the publication committee of all its scientific reports. It has done nothing on the lines in which observation has been so useful. It has not unfolded the life-history of a single variety of cancer so that we can base our operations on the information. It has not even discovered whether spontaneous cancer of a particular part of the body in the rat or mouse runs a similar course to spontaneous cancer of the same part of the body in the human subject. These problems are not suited for experimental investigation; they are determined by observation. On the other hand, within the space of eight or ten years it has definitely settled a matter of dispute which was discussed and fought long before I became a student, perhaps for centuries. It has proved, beyond the possibility of doubt, that cancer in its early stages is a local, not a constitutional or blood, disease. It is impossible to overrate the value of this knowledge to the surgeon. So long as he believed that cancer is in the blood, and that an operation only removes the local manifestation of it, he was hopeless of the results of his operations, and removed the tumour solely to afford the patient temporary relief. Now he goes to his operation filled with hope that, if the disease is limited and in an early stage, and his operation is well designed and skilfully carried out, it may be quite successful. Thus it will be seen that the two methods, *observation* and *experiment*, have their special values in relation to cancer, that each is supplementary to the other, and that neither is fitted to take the place of the other.

It will be noticed that I have dwelt on the use to which these researches have been put in the treatment of cancer and of the value of them to human beings. You may fairly think these ought to be the immediate objects of all research in medicine, and that researches which are not likely to be immediately useful should be discouraged. But while I freely admit that my sympathy is in favour of this view, I am bound also to admit that it is wholly erroneous. The investigator should be solely interested in discovering the truth, and his attention should not be diverted and his judgment warped by the desire that his research should terminate in a particular manner because that might seem likely to be more useful to medicine and surgery. It is notorious that some of the researches which have seemed to fulfil no useful purpose have yielded the most valuable practical results, while other researches, pursued with a useful end in view, have furnished nothing good. If a utilitarian value were considered essential to research, many young investigators who have later produced the most brilliant work would have been discouraged, so that they might never have persevered in original research. I need only give two illustrious examples, Pasteur and Lister.[1] Their first researches had no utilitarian object. What a lamentable thing it would have been if they had been discouraged from research on that account. The great thing is that young people who are fitted to do so should be encouraged to search. What they search for is of comparatively small consequence. On the other hand, I would not have it supposed that a utilitarian research is derogatory to the dignity of the worker or necessarily damages his *moral*. Sir Humphry Davy deliberately worked out the problem of coal gas and explosions, and invented a safety-lamp at the urgent request of the coal-owners. Pasteur investigated the nature of the Pébrine disease of silkworms at the request of Dumas, and moved by pity at the wretched condition into which the silkworm industry had fallen. He discovered that it depended on a parasitic protozoon, and devised a successful method of stamping it out.

Just a few words on the cost of research. Dr. Leonard Hill[2] pointed out some years ago what great results could be achieved by an able worker with the simplest materials and at the smallest cost, and that fine laboratories and costly apparatus are not essential to research in medicine. All this is very true, just as it is true that David killed Goliath with a stone cunningly hurled from a sling. I do not think David at the present day would sally forth with a sling to oppose a foreign host; and our profession is continually urging on the wealthy public the financial claims of research.

In order to determine whether women are likely to be useful and successful in research, it is necessary to consider the qualities which should be looked for in an investigator—I mean in an investigator who has the sole charge of a research, even though it be carried out in a laboratory where other persons are at work. I am not speaking of an expert assistant or even of a joint investigator.

For (1) experimental research (including experiments on animals) I should set down: dexterity and neatness in manipulation; a knowledge not only of the principles, but of the practice, of aseptic and antiseptic surgery; and certainly humanity, so that the experiments which are necessary should be performed with as little suffering to the animals as possible.

For (2) every kind of research I should look for personal cleanliness; cleanliness of habit; industry, which must be extended to mean continued industry; patience, and a large stock of it; perseverance, and a determination to pursue

[1] From the introductory address delivered at the opening of the winter session, October 2, at the London School of Medicine for Women, by Sir Henry T. Butlin, Bart.

[1] The first researches of Pasteur were on the crystallisation of tartaric acid and its salts. The first researches of Lister were on the contractile tissue of the iris and on the muscular tissue of the skin.

[2] *Brit. Med. Jour.*, 1907, vol. i., p. 660. "Men of science are not made by institutes, money, or apparatus. Helmholtz did his best work on 120*l.* a year, and modelled his inventions out of spectacle lenses and his wife's sewing gear. Faraday did his epoch-making work with bits of wood, glass, and wire. Claude Bernard filled his pupils with enthusiasm in a laboratory little better than a cellar."

the research to the end; extreme care in observation and strict attention to detail; careful recording of observations, which should be done at the earliest possible moment; thorough belief in the importance of the particular research, amounting even to enthusiasm; conscientiousness.

Many of these desirable qualities will at once commend themselves to you; they need no more than enumeration. But you may wonder why I have set down others of them. For instance, what has conscientiousness to do with research any more than it has to do with any other of the affairs of life? Do I mean that an investigator should be honest and not appropriate or use unfairly the work of other investigators? Oh, no! I assume such honesty as this in every investigator. The conscientiousness of which I speak is of the worker to himself and his own work. In this way. A worker has been engaged in a research during many months. He has made many experiments and observations, and they have all gone to prove the correctness of the result at which he has arrived. But there is still one experiment which it would be well to try. He tries it, and curiously it does not turn out quite right. He puts two and two together and they do not make four. And everyone agrees with "The Professor in the Case" that two and two do make four, "not *some* times, but *all* the time." Now is the moment when his conscientiousness should come into play. The temptation is overwhelming to explain the failure by some fault in technique, and to set the result of that experiment on one side rather than to repeat it again and again as he ought certainly to have done. Had he done so it would again have failed, and he would have learned in the end, not that two and two do not make four, but that one of his twos was not a two, and he would have avoided publishing that result of his research which was afterwards discovered to be incorrect by a more careful and conscientious worker. It must always be borne in mind that the mischief of a faulty result does not end with that research, but may be the starting point of a long series of equally faulty results.

GEOGRAPHY AT THE BRITISH ASSOCIATION.

IN his presidential address Colonel Close, the recently appointed Director-General of the Ordnance Survey, raised again the oft-debated question, "What is geography?" His contention that geography, apart from cartography, cannot be treated as a science in itself, but must serve as a common meeting-place and popularising medium for various other sciences, will certainly not be accepted by modern geographers without considerable modification and amplification.

Prof. Herbertson exhibited and explained a new series of thermal maps which he has constructed to show the actual mean temperatures prevailing over the globe instead of the temperatures reduced to sea-level, as indicated on the ordinary meteorological maps. Among other papers on cartography were two by Mr. A. R. Hinks, one dealing with the use of colour on contour maps, and the other with the most suitable projections for atlas maps. Captain Henrici discussed the present state of our knowledge—not altogether satisfactory—of the mean sea-level round our coasts, and arrived at the conclusion that there is no evidence, from the observations made, to justify the belief that mean sea-level is not constant around the British Isles. Captain Henrici also contributed a note on the height of Ruwenzori as determined by him from observations made by Captain Jack. His result is $16,801 \cdot 3 \pm 5 \cdot 3$ feet.

Among the papers on physical geography, two of the most interesting were contributed by Prof. J. W. Gregory and Prof. O. Pettersson. The former showed that while waterfalls have generally been regarded as destructive, they may in certain circumstances be constructive and act as agents of deposition instead of denudation. In support of this he instanced certain waterfalls in Dalmatia, Bosnia, and Herzegovina. In the former country, for example, the Kerka Falls are due to a barrier of calcareous tufa which the Kerka River has built across its valley. Prof. Pettersson discussed the deep-water movements in the Skagerrak, and showed that they occurred when the earth is in perihelion. His theory is that these waves are influenced by the phases of the moon, but still more by its declination and distance from the earth. He also showed that since 1753 the herring fishery on the coasts of Sweden has been most prolific in years of maximum declination and least prolific in years of minimum declination, a result which he attributes to the influence of the movements in the deep water. Captain Rawling gave an account of the British expedition to Dutch New Guinea, and showed some excellent views of the Nassau Range with its precipitous front more than eighty miles in length and from 8000 to 10,500 feet in sheer height.

The work of the section was concluded by an interesting discussion on aëronautical maps. M. Lallemand described the resolutions recently adopted at his suggestion by the Permanent Committee for Aërial Navigation of the Public Works Department of the French Government on the production of an international air-map, and the establishment of marks required by aviators and aëronauts. Captain Lyons followed with certain general suggestions for the construction of aëronautical maps, and in the subsequent discussion several officers of the air battalion and others took part. A full report of this discussion is to be published in *The Geographical Journal*.

MECHANICAL SCIENCE AT THE BRITISH ASSOCIATION.

THE meeting of the Mechanical Science Section of the British Association at Portsmouth, under the presidency of so distinguished a naval architect as Prof. Harvard Biles, was naturally the occasion for a very interesting programme of papers relating to many branches of marine engineering work ranging over a wide field of applied science, and dealing with some of the most important developments which are now engaging the attention of engineers and men of science in this branch of engineering activity.

The programme contained important papers on the rolling of ships, by the president, the gyro-compass, electrical steering and propulsion of ships, and the developments of wireless telegraphy, especially in its relation to naval problems; while in the purely mechanical section the advances in methods of generating motive power were dealt with in a series of related papers on internal-combustion engines and the superheated steam engine. Not only had the members who attended this section an opportunity of hearing these papers and the very interesting discussions to which they gave rise, but all the sections took the opportunity so kindly afforded them by Admiral Sir A. W. Moore of witnessing, from a battleship which carried them into the Solent, a combined attack by numerous torpedo-boats and submarine vessels with as near an approach to the conditions of naval warfare as practicable.

The interest which all members of the association take in the practical applications of scientific discovery to naval matters was manifested by the close attention to the wonderful evolutions and diving performances of the attacking vessels, while the swift and silent attack of the torpedoes, invariably marked by the final dull thud of impact as each one found its mark, gave a thrill of the possibilities of actual warfare not easily forgotten.

Although the proceedings of the section were so largely devoted to naval matters, other subjects of importance also claimed the attention of the members, like the non-stop train, the peculiar corrugations produced on rails by the long-continued passage of trains; while subjects of more general interest were afforded by papers on smoke abatement, and the possibilities of the manufacture of nitrogen products in this country by electric power, a question of great importance in connection with agriculture and the manufacture of explosives.

The discussion between Sections A and G on aërial flight at the Monday's meeting attracted a very large gathering, and has been dealt with in a separate article (September 28, p. 439).

We now turn to a more detailed examination of the papers in their order, and the discussions to which they gave rise. The president's address, on the rolling of ships, dealt very largely with the question of the effects of the combinations of the natural oscillations of a vessel with the forced oscillations produced by wave systems, which in general produce their most dangerous effects before a permanent *régime* is established. In spite of the labours of previous investigators, the magnitudes of the oscillations produced in this transition period under various conditions are still to a large extent unknown; and Prof. Biles was able to indicate the methods of the investigation he is making for solving these problems experimentally, but owing to an unfortunate illness these were not completed in time for the meeting.

The important paper on the corrugation of tramway rails, which was brought before the section by Mr. Worby Beaumont immediately after the president's address, gave an interesting account of the phenomena observed on rails in service, and also particulars of an experimental investigation by the author on the contact areas between loaded wheels and rails, which enable conclusions to be drawn as to the intensities of the compressions and tensions produced by wheels rolling on rails of differing degrees of hardness. In the discussion which followed, Mr. Alexander Siemens suggested the use of hard metal for the sides of the rail with a softer metal composing the head; he considered that a reduction of speed and weight, and the use of larger wheels, such as the author suggested, were impossible under modern conditions. Sir William White gave particulars of the wear of rollers due to gun fire in turrets, and could not agree with Mr. Siemens's suggestion of a composite rail, while in reply the author defended his proposals. The proceedings on Thursday concluded with a paper on the Anschutz gyro-compass by Mr. Elphinstone, accompanied by a demonstration on a machine which was on view during the remainder of the meeting.

This instrument depends for its action on the precession effect of a rapidly rotating wheel due to the influence of gravity and its movement over the surface of the earth, and this effect is utilised for the purpose of a compass by employing a gyroscope running at 20,000 revolutions per minute, and floating in a mercury bath. The precession effect tends to cause the axis of the rotating mass to lie in the plane of the meridian, and hence true north is obtained. Unfortunately, time did not permit of a discussion on this paper.

The first paper at Friday's meeting of the association dealt with the question of electric drives for screw propellers, and Mr. Mavor advocated the use of steam turbines or internal-combustion engines running at a high speed and coupled to a generator. The current so obtained is used to drive a motor on a slow-speed propeller shaft, and the author claimed for this arrangement a high efficiency of power-generating plant and propeller, with an increased flexibility in the system, which offered great advantages and increased economies beyond those given by existing systems in many kinds of vessels. The president, Sir William White, Prof. Dalby, and others took part in a detailed technical discussion, in which the progress in the design of electric generators and propellers for ships and the uses of the author's system were clearly indicated.

A second paper on electrical steering, by Mr. Haigh, described an arrangement of a constantly running motor operating the steering gear by magnetic face clutches, an arrangement which allows of an extremely sensitive regulation of the rudder with great economy of power, since the motor may, if required, be run from the lighting circuit of the ship. Sir William White in opening the discussion said that he viewed electrically operated steering gears with much favour. The sensitiveness of the control was remarkable, almost too much so for the ordinary quartermaster, who would never let the helm alone, although this incessant movement had no real value in keeping the vessel to her course; as a consequence, it had been found necessary to provide hunting gear to diminish the sensitiveness of electric steering gears. Mr. Hawksley pointed out how very necessary it was still to provide auxiliary hand gear for emergencies.

The next paper, by Mr. T. F. Wall, on the repulsion motor, was essentially mathematical, and after a short discussion upon it by Mr. Haigh, Captain Sankey and Mr. Pollard Digby read a paper on a study of human susceptibility to vibration by aid of an instrument consisting essentially of a small mirror centred on a fine spindle and floating in a mercury bath. When the mercury is set in vibration by any disturbance, it causes the mirror to oscillate and throw a spot of light on a screen. The authors pointed out that the effects of vibration on individuals depend to a large extent on the frequency as well as on the amplitude, and that the perceptive faculty is very variable and often untrustworthy, points also emphasised by Sir William White and Prof. Petavel, the latter pointing out that the association of sound and mechanical vibration had in general a very disturbing effect on individuals.

A paper on some new aluminium alloys, by Prof. Wilson, concluded Friday's proceedings, and in the absence of the author was taken as read.

The section, which met again on Monday, devoted a couple of hours to a joint discussion on aëronautics with Section A, of which an account has been given already, and on its conclusion Prof. Howe gave a very striking demonstration of the recent developments in wireless telegraphy by aid of an aërial running from the top of the Town Hall into the lecture-room. With the aid of a Brown telephonic relay the audience was able to follow the time signals sent out from Wilhelmshaven, and to distinguish these from signals from other stations like that on the Eiffel Tower. In his paper the author dealt very fully with the improvements which have been made to prevent interference, and in a succeeding paper Captain Sankey described a portable wireless plant of the Marconi Company adapted for carriage on horseback, and capable of erection in a few minutes for use up to 100 miles. A short discussion by Profs. Dalby and Howe and Mr. Kilburn Scott concluded the day's proceedings.

On Tuesday three papers dealing with some modern methods of generating power were grouped together for discussion. Mr. Marshall described the special features and merits of the superheated over-type steam engine, Mr. Tookey gave a careful analysis of the costs of power production with suction gas engines, and Mr. Day gave a similar analysis for Diesel engines. The long and detailed discussion which followed was of the greatest interest, and was prolonged much beyond the time originally fixed for its termination. Mr. Rosenthal, who followed with a paper on marine oil engines, dealt with the most recent developments in this important subject; and the discussion, in which the president, Sir William White, Mr. Day, and Mr. Rosenthal joined, was chiefly remarkable in showing how confident these authorities are in the continuance of the supremacy of the steam turbine in naval work for many years to come

An overflow meeting on Wednesday was devoted to three papers of a more general nature and of great interest.

Mr. Kilburn Scott described the manufacture of nitrogen products by electric power, and particularly emphasised the importance he attached to this country's possessing the means for manufacturing all the nitrogen compounds required for explosives, and the danger of depending on foreign supplies in times of war. Sir William Ramsay agreed with the author that it was most desirable to locate factories in the neighbourhood of coal mines, and Sir William White expressed his general agreement with the author's views, although he did not consider that the present impossibility of manufacturing all the essential constituents of explosives in this country was a national danger. Prof. Petavel discussed the efficiency of the electric process, and Mr. Wimperis suggested the utilisation of the waste gases from blast furnaces for the process, and estimated the power available. In the following paper, on smoke abatement, by Dr. J. S. Owens, the fixing of a new standard of smoke emission from factory chimneys was suggested, and an instrument for measuring smoke density was exhibited. After a spirited discussion the final paper of the section was read by Mr. Yorath Lewis, on a new system of continuous transportation for passenger and other train services

The distinctive feature of the system is an endless screw of variable pitch, which enables the speed of passenger carriages to be varied at will, while the energy now lost in stopping trains by brakes is given back to the screw during the retardation, thereby avoiding a large waste of power when stations are frequent. The author enumerated many other advantages of his system, among which were included the abolition of signalling arrangements, increased mean speed of travelling, and increased comfort due to more gradual acceleration and retardation of the train.

Owing to the late hour only a brief discussion was possible; and a very successful meeting terminated with votes of thanks to the president and vice-presidents.

E. G. COKER.

ANTHROPOLOGY AT THE BRITISH ASSOCIATION.

NOTWITHSTANDING the comparatively small numbers attending the meeting of the association at Portsmouth, the audiences in Section H, which met under the presidency of Dr. W. H. R. Rivers, F.R.S., were well up to the average, at any rate in the morning sessions. In the afternoons the attendances were sometimes small, owing, no doubt, to the attractive nature of the local arrangements for the entertainment of members. In the circumstances it was thought advisable to abandon the sectional meeting on the afternoon of the naval display, and to adopt the unusual course of holding an evening session. The wisdom of the change was made apparent by the large audience which listened to the postponed papers by Mr. R. R. Marett and Prof. A. Keith.

The papers communicated to the section attained a uniformly high level: some may be counted as of first importance; and it is perhaps not unsafe to say that the discussions on totemism and on the institution of an Imperial Bureau of Anthropology will be of far-reaching effect.

The discussion on totemism, to which the whole of a morning session was devoted, was opened by Dr. A. C. Haddon, who explained that totemism was usually regarded as the association of definite human groups with non-human groups. After citing typical instances, he pointed out that even in Australia there was much variation, and other customs and beliefs might be present. Similar variability also obtained in other parts of the world, so that it had become extremely difficult to frame a definition of totemism that would hold good everywhere. Although it was primarily a social and not a definitely religious institution, in most cases it could not be distinguished from a religious sentiment. Dr. A. A. Goldenweiser remarked that all attempts to characterise totemism by a more or less definite set of features must needs be artificial. Consequently, its distinctive characteristics were not the individual features, but the relation into which they entered. Dr. Graebner, whose paper, in the unavoidable absence of the author, was read by the president, said that every attempt to account for the origin of totemism must first deal with the question whether this institution was a cultural entity, for if it were once conceded that the form of totemism found in different parts of the earth had arisen independently, there could be no justification for the assumption that it had had everywhere the same origin. An examination of the evidence from the South Seas, from Africa, from South and North America, and from Asia would appear to show that this was the case; there were no older forms from which group totemism could be derived. In the older form, in which totems were animals, there was an indefinite and unstable relation of sympathy between man and beast which could be explained simply by certain groups of men and animals having co-existed locally in a region of diversified physical character. Prof. Hutton Webster in his paper on the relations between totem clans and secret societies pointed out that secret societies, although acting as a native police in West Africa and Melanesia, were not consciously devised for this purpose. Investigation revealed the importance of the part played by them in funeral rites, and especially in initiation ceremonies at puberty. These and other features appeared to be closely connected with the structure and function of totemic clans, and he suggested that they had been transferred to the secret society in the course of the disintegration of ancient totemic groupings. In discussing methods of investigation, Prof. E. Waxweiler said that light could only be thrown on the question of totemism by the application of a scrupulously accurate method of analysis, which should be mainly sociological, *i.e.* it should consider the so-called totemic facts as being imposed by the conditions of organised social life amongst men. Further, its starting point should be "functional"; it must search for the social function from which totemism had sprung. Analysing the phenomena of totemism on these lines, it would appear that functionally it was a social device for sanctioning permanent situations, which were considered essential or peculiar in the organisation of the group, wherein individuals, or more frequently groups of individuals, appeared to remain.

The discussion on an Imperial Bureau of Anthropology was opened by a paper by Mr. J. Gray, who dealt specifically with the anthropometric work which might be carried out under the supervision of such a bureau, and laid stress upon its importance not only to the man of science but to the statesman and social reformer. Mr. T. C. Hodson, in a paper dealing with the ethnographic side of the work, gave an account in outline of the ethnographic and linguistic investigations instituted by the Government in India, the Sudan, and southern Nigeria, and dwelt on the importance of the extension and organisation of such work through a central body as a means of securing sympathetic administration of the affairs of dependent races and of ensuring that they should be trained on right lines to take their place as constituent parts of the Empire. In the discussion which followed the reading of the papers, Prof. J. L. Myres made a detailed survey of the efforts of the British Association at various times to obtain the cooperation of the Government, and expressed a hope that urgent pressure might bring Government departments and public opinion to a sense of the responsibility of this country for a proper record of our own population and of the ways of life of our large masses of native dependents abroad. Prof. Ridgeway recalled the memorials which had been presented to the Government by the Royal Anthropological Institute, and emphasised, by an apt citation of Mr. Crooke's paper on the cow in India, the importance to administrators and commercial men of the information concerning customs and beliefs which such a bureau would make accessible. The Rev. Dr. Bryce explained the organisation of the Canadian Ethnographical Survey, which had been set up as a department of the Geological Survey as a result of the representations made to the Canadian Government by the association at its Winnipeg meeting, and Prof. Hutton Webster gave a brief description of the work of the United States Bureau of Ethnology.

Among the remaining contributions to the proceedings, archæology held first place in point of numbers, although papers of an ethnographical character were more numerous than they had been for the last few years. With one exception, however, these dealt with particular points of research, and were not generally descriptive of a geographical or cultural area. The exception was Captain Rawling's account of the tribes of the Mimika district, of the tribes of the sea coast, and of the Tapiro pygmies encountered by the recent expedition to Dutch New Guinea, which is likely to provide ethnologists with material for discussion for some time to come. Mr. Crooke's paper on the reverence for the cow in India attributed the recent extension of the recognition of the sanctity of the cow, which had existed in a more restricted degree since Indo-Iranian times, to the rise of Neo-Brahmanism. Prof. Hutton Webster's paper on the origin of rest-days proffered an elucidation of Hebrew and Babylonian Sabbatical observances by bringing them into relation with the periods of communal cessation from work and of fasting, as a protective or conciliatory measure, among lower races on critical, usually seasonal, occasions. Mr. Hobley's account of the religious beliefs of the Akikuyu and Akamba of British East Africa dealt, among other matters of belief and ritual, with the *Thahu*, an analogue of the mediæval curse, and its effect on social custom and culture. Major A. J. N. Tremearne described the customs and beliefs of the Hausas in so far as these may be deduced from, or illustrated by, an analysis of their legends and folklore. Dr. C. G. Seligmann raised many points of interest in his important paper on the divine kings of the Shilluk. It is noteworthy that these kings, who trace their descent from Nyakan, a semi-divine founder, are sacrificed ceremonially when they become senile or ill to avert disaster to men, crops, and animals. Mr. Malinowski's paper on the economic influence of the Intichiuma ceremonies opened up an interesting field of research by suggesting that in the totemic ceremonies of the Australian tribes we may find the educative influence which led man first to overcome the primitive reluctance to systematic, continuous, or periodic organised effort which is the essential feature of economic labour.

In physical anthropology, Prof. C. J. Patten communicated further results of investigations of division of the parietal bone in the crania of certain Primates. A group of papers was offered by Prof. Arthur Keith describing a cranium of Cro-Magnon type from Dartford, a second skeleton from Galley Hill, and fossil bones of man discovered by Colonel Willoughby Verner in a cave near Ronda, in Spain. These papers, in conjunction with a paper by Mr. R. R. Marett on the excavation of caves in Jersey, in which Mousterian implements were found associated with remains of Pleistocene mammals, and human teeth which Prof. Keith regards, on morphological grounds, as belonging to the most primitive human type yet known, gave rise to an interesting discussion on the antiquity of man.

In addition to the paper by Mr. Marett, the archæological papers included three papers on American archæology. These were a short account by Mr. Warren K. Moorehead of the classification of American types of artefacts made by a committee of the American Association and of the Anthropological Society, a description of the paintings in the Temple of the Tiger at Chichen Itza by Miss A. C. Breton, and a comprehensive account of the present position of archæological study in Peru by the same author.

The study of British archæology was represented by papers by the Rev. Dr. Irving on further finds of horse and other prehistoric mammalian remains at Bishop's Stortford; by Mr. T. Davies Pryce on excavations on a Roman fortified post on the Nottinghamshire Fosseway, covering the excavations of 1910 and 1911; an exhaustive summary of our knowledge of prehistoric man in Hampshire, by Mr. W. Dale; and a suggestive paper by Mr. O. G. S. Crawfurd on the early Bronze age in Britain, in which he endeavoured to trace the main lines of communication and indicate the chief centres of population from a study of geographical conditions and the distribution of Bronze age finds. A paper by Mr. A. L. Lewis entitled "Dolmens or Cromlechs," in which the author, as the result of comparative study of a large number of stone monuments, arrived at the conclusion that these were not the work of one race, but rather a phase of culture through which many races have passed, was especially interesting on account of its variance from the conclusion of Prof. Elliot Smith in his paper on the relations and influence of the Egyptians under the ancient Empire. The latter attempted to explain the distribution of megalithic monuments by the hypothesis that they were introduced into European culture by the Armenoid population in Egypt, of which he had found traces. The Armenoid or Celtic peoples who invaded Europe through the Balkan Peninsula, although they had acquired the use of metal from contact with the Egyptians in Asia, did not build megalithic monuments, because they were not acquainted with Egyptian methods of architecture. Egyptian archæology was further represented by papers from Prof. W. M. Flinders Petrie on his recent discoveries of Roman portraits at Hawara, and Mr. G. A. Wainwright's paper on his important discovery of iron beads of pre-dynastic date in unplundered graves at El-Gerzeh.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Glasgow.—The appointments made to the new chairs in the medical faculty in connection with the clinical school at the Royal Infirmary are as follows:—St. Mungo chair of pathology, Dr. John A. Teacher; Muirhead chair of obstetrics and gynæcology, Dr. John M. Munro Kerr; Muirhead chair of medicine, Dr. Walter K. Hunter; St. Mungo chair of surgery, Dr. Robert Kennedy.

Mr. A. J. Grove, 1851 Exhibition scholar, has been appointed supernumerary entomologist to the Indian Agricultural Service at Pusa, under the Indian Government.

The foundation-stone of a new wing for the applied science department of Sheffield University was laid on September 28 by Judge Denman Benson. The buildings of the applied science department have become crowded, and the Drapers' Company has given 15,000*l.* for extensions. The total cost will be nearly 40,000*l.*, and towards this the sum of more than 8000*l.* is still required.

It has been reported to the executive committee of Ruskin College, Oxford, that the late Mr. C. S. Buxton, formerly vice-principal of the college, son of Mr. Sydney C. Buxton, President of the Board of Trade, has bequeathed to the college the sum of 5000*l.* unconditionally. It is proposed to name the lecture-room in the new college buildings "The Buxton Hall," and a suitable memorial tablet will be erected.

The programme of lectures and discussions arranged by the Child Study Society, London, for October–December includes the following:—October 19, "Co-education during Adolescence," Dr. A. Beresford Kingsford; November 2, "Psychology and Grammar," H. Holman; November 9, "Psychology of Speech," Prof. W. Rippmann; November 23, "Psychology of Reading," T. G. Tibbey; December 7, "Psychology of Mathematics," Dr. W. Brown.

At the Sir John Cass Technical Institute, E.C., to-morrow, October 6, the inaugural lecture of a course on colloids will be given by Mr. E. Hatschek, his subject being "The Properties of Colloids and their Relation to Industrial Processes." On Tuesday, October 10, Mr. Hugh Abbot will give an inaugural lecture on the fermentation industries, entitled "A Review of Modern Practice in the Bottled Beer Trade"; and on Monday, October 16, Mr. J. S. S. Brame will lecture on "Coal for Steam Raising: its Purchase on a Scientific Basis and its Economic Use," being the inaugural lecture of the courses on fuel.

Attention has been directed already (August 10 and September 21) to the new arrangements for the session 1911–12 at University College, London, in the faculties of engineering and medical sciences. The recent issue of the complete calendar of the college makes it possible to add to the information in the note referred to. The organisation of the department of applied statistics is being completed, and it now includes the Galton laboratory for national eugenics and the Drapers' Company biometric laboratory, under the direction of Prof. Karl Pearson, F.R.S. In the faculty of engineering a new lectureship in heating and ventilating engineering has been instituted.

The Home Universities Committee held a meeting at the University of London on September 29 to arrange the subjects for discussion at the Congress of the Universities of the Empire to be held next summer. Each of the universities of the United Kingdom was represented by its Vice-Chancellor or his deputy, and various representatives from Government offices were also present. The suggestions received from overseas universities in response to the communications sent after the last meeting of the Home Universities Committee, and the report of a preliminary Conference of Canadian Universities, were considered. Some of the more important topics for discussion were decided upon, and the committee appointed a subcommittee to draw up a programme for the consideration of the full committee, which will meet again on November 4. A draft paper of subjects which the committee sent out in November last includes the following topics:—(1) university organisation; (2) universities in their relations to teachers and undergraduate students; (3) universities in their relation to post-graduate and research work; (4) universities in their relation to schools and to other agencies for higher education.

The regulations for the establishment of a post-graduate scholarship in naval architecture, offered by the Royal Commissioners for the Exhibition of 1851, have just been issued by the Institution of Naval Architects. Candidates for the scholarship must be British subjects under the age of thirty who have passed with marked distinction through a course of study in naval architecture at one of the following institutions:—the Royal Naval College, Greenwich; University of Glasgow; Armstrong College, Newcastle-upon-Tyne (Durham University); or University of Liverpool. The value of the scholarship is to be 200*l*. per annum, and it may be tenable in ordinary circumstances for two years. The holder will be required to engage in research work at some approved institution at home or abroad where special facilities are available for advanced study in naval architecture, and/or to investigate the development of the shipbuilding industry by attaching himself to some recognised firm or establishment at home or abroad. The results of research carried on by the scholar will be published in the Transactions of the Institution of Naval Architects if the council of the institution deem advisable.

It is announced in *The Pioneer Mail* that the Secretary of State for India has recently sanctioned the modified scheme proposed by the local government authorities for the establishment of a technological institute at Cawnpore. The original scheme, which was put forward in 1907, on the recommendations of the Naini Tal Industrial Conference, proposed the formation of an institute with a staff of four technological chemists, and four assistant professors, with large laboratories. Financial considerations rendered its immediate introduction impossible, and it became evident that a more modest beginning must be made. The proposals, however, have been framed so as to admit of future expansion, and the new institute will be such that it can be adapted to form part of any more extensive organisation that may be required subsequently. For the present it is proposed to employ a chemist with four assistants to carry on research and to train students. Close to the institute will be a scientific library, which will be shared with the Agricultural Department. One of the main causes which operate against the success of scientific and technical research in India will thus be removed, and the staff of the new institute will be provided with facilities which in India are too rare. The sanction is conditional on funds being available from provincial revenues, but it is to be hoped that no difficulty will be experienced in finding such funds.

The Department of Agriculture and Technical Instruction for Ireland has issued in the form of a pamphlet an article which appeared in its Journal (vol. xi., No. 4) on "Technical Education in Clonmel," by Mr. Cecil Webb, principal of the Technical and Day Trades Preparatory Schools, Clonmel. Mr. Webb points out that in the towns of the south of Ireland technical education often finds a difficult task, namely, to arrest decay and rekindle hope in a declining and disheartened population. Clonmel presents this problem. After reviewing the history of the attempts in Clonmel to develop a system of technical education, Mr. Webb directs attention to a special feature of the present scheme of instruction in the town. This has been the endeavour to make the work of the school a means of reviving the road carriage-building industry which, when the technical school was started, still existed in Clonmel in a precarious way. A class in coach-building was formed under a well-qualified local carriage-builder. The effect upon the local industry has been very gratifying. The design and construction of cars have greatly improved. At show after show through the country Clonmel cars have carried off the prizes. Their repute has spread, and summer and winter the coachbuilders in Clonmel are now kept busy. Such an effect could only be attained by the technological training which the school provided, being backed by enterprise and perseverance on the part of those engaged in the trade.

In the recently published "Statistics of Public Education in England and Wales, Part i.," some interesting numbers are given referring to the further education or occupation of pupils above twelve years of age who left secondary schools on the grant list of the Board of Education during the year ending July 31, 1909. The table in which the information is contained is based on data collected by the schools and recorded for each pupil in the admission registers. The total number of such boys and girls was 38,200, and of these 6790, or 17·8 per cent., went to a place of further education; 6048, or 15·8 per cent., became teachers (including pupil-teachers) in elementary schools, or entered training colleges for elementary-school teachers; 11,136, or 29·2 per cent., entered upon some professional, commercial, or clerical occupation; 3356, or 8·8 per cent., entered upon some industrial or manual avocation; 1001, or 2·6 per cent., took up agriculture or some rural pursuit; and of the residue—9869, or 25·8 per cent.—12·8 per cent. remained at home, 2·4 per cent. went abroad, 1·2 per cent. left owing to illness or died, and in the case of 9·4 per cent. the occupation was unknown or unclassified. Another table shows that on January 31, 1910, there were in the secondary schools on the grant list 141,149 pupils, of whom 106,248 were twelve years of age or over. Of these, 23·5 per cent. were twelve and under thirteen; 26 per cent. were thirteen and under fourteen; 23 per cent. were fourteen and under fifteen; 15·7 per cent. were fifteen and under sixteen; 8·1 per cent. were sixteen and under seventeen; 2·6 per cent. were seventeen and under eighteen; 0·8 per cent. were eighteen and under nineteen; and 0·2 per cent. were nineteen and over.

The Borough Polytechnic Institute authorities have issued a calendar under the title "Higher Education in Central South London," which takes the form of a joint prospectus of the Borough Polytechnic, Morley College, and affiliated evening-school centres. The varied programme of courses of study shows that the wants of every class of worker in the area served by the institute have been considered by the authorities, and met in a very thorough manner. Among other noteworthy departments of the institute may be mentioned the "national" school of bakery and confectionery, which forms a special department. It is managed—subject to the approval of the governing body of the polytechnic—by the Education Committee of the National Association of Master Bakers and Confectioners, which body contributes an annual sum not exceeding 500*l*. Any individual, society, or firm contributing not less than 25*l*. a year may appoint a representative upon the education committee. The London Master Bakers' Protection Society has contributed 50*l*. annually for some years past. A technical day school for boys has been founded for the purpose of affording opportunities for sound preparatory trade training, which will give London boys better chances of becoming skilled workers than they have hitherto had. The governors of the institute feel that the adequate training of bright boys who would be successful in various trades has been almost entirely neglected. They are of opinion that, owing to modern methods of manufacture, there is great need for the preparation of boys for trades on a broad basis, which will enable them to adapt themselves to changing conditions of employment and compete successfully in the industrial world. Boys are trained not to work mechanically, but to think for themselves. A similar trade school for girls has also been provided.

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, September 25.—M. Armand Gautier in the chair.—Paul **Appell**: The θ functions of higher degrees.—F. **Quénisset** and F. **Baldet**: The discovery of a comet at the Flammarion Observatory of Juvisy. The comet was noticed in the constellation Ursa Minor on September 23 as a slightly oval nebulosity, about 4′ in diameter, with a central nucleus. (For further particulars see Our Astronomical Column.)—A. **Demoulin**: The R and Ω surfaces.—A. **Blondel**: The influences of deadening the waves in orientation in wireless telegraphy.—M. **Reutter**: The analysis of a resin from an Egyptian sarcophagus. Besides mineral substances, there could be identified fragments of cypress or cedar wood, cedar resin, resins arising from styrax, mastic, Aleppo pine, and asphalte.—Jules **Cardot**: The mosses collected by the Antarctic expedition of the *Pourquoi-Pas?* The collection comprised thirty-four species, and enriched three genera of eleven species (seven of which are new), and two varieties (one new). The flora of the Antarctic region is poor compared with that of the Arctic region.—Paul **Marchal**: The obliteration of sexual reproduction in *Chermes piceae*.—E. A. **Martel**: The construction of roads and other works in limestone. It is pointed out that limestone is a dangerous material for public works, owing to the infiltration of water into fissures. In constructing roads and tunnels in limestone or dolomite, it should not be forgotten that these pseudo-compact rocks, owing to the existence of water in fissures and pockets, are especially delicate from the engineering point of view: very slight artificial derangement may have very serious effects on the stability of such a rock mass.—Ph. **Négris**: The discovery of the Carboniferous and Eocene formations at Mts. Guiona and Vardoussa, west of Parnassus.

CALCUTTA.

Asiatic Society of Bengal, September 6.—W. **Kirkpatrick**: Exogamous septs of the Gehara section of Kunchhandiya Kanjars. Whatever the social structure of the primæval hordes, the system which requires division into exogamous and endogamous septs and sections has taken on a fresh activity under Brahmanical influence. The exogamous septs of the Geharas are mostly of totemic origin, though an exogamous sept is not always totemic; one can be entirely independent of the other. An exogamous sept may be of local or communal origin, or it may be eponymous, as well as having an occupational origin. In the camp system of "marrying out" practised by the Kanjars and allied tribes of a Gypsy character we are near exogamy in its most primitive form.—Dr. P. T. L. **Dodsworth**: Some notes relating to the classification, habits, and nidification of the ravens of India. The author maintains that the Panjab raven is distinct enough from the Himalayan raven to be regarded as a distinct species, and should not be united with it into *Corvus corax*, Linn. Hume recorded it as different in note and in the sheen of the plumage, and Oates noted it as different in the character and shape of the throat hackles. It is a smaller bird. There is a need for extended observations on the Himalayan raven: (1) To what extent does it show a slight seasonal migration? (2) When does it nest? Mandelli took the eggs in Sikkim on March 5; Stoliczka found the bird building on May 4 at Aktash, and Walton near Kala Tso Lake in Tibet on April 6. (3) Does it habitually nest on cliffs? and (4) in successive years on the same site? (5) What is the number of eggs? (6) Do both birds share in hatching them? and (7) how long do the young stay in the nest? The author adds some observations on the nidification of the plains raven. Five is the usual number of eggs; the nest is built, 18 to 24 feet from the ground, of sticks, lined with rags, sheeps' wool, bits of paper, cows' hair, and grass. Various trees are chosen, such as *Acacia leucophloea*, *Dalbergia Sissoo*, and *Albizzia Lebbek*. When feeding these plains ravens are sociable, but in the breeding season they seem to scatter, and probably many cross into Afghanistan.—J. Coggin **Brown**: Shan and Palung Jew's harps from the Northern States. The Jew's harp used by the Shans and Palungs is distinct from all others in the presence of movable bamboo strips, by means of which the chamber in which the tongue vibrates can be altered and the tone changed in consequence.—R. K. **Bhide**: New and revised species of Gramineæ from Bombay. Diagnosis of the following new grasses:—(1) *Danthonia Gammiei*, from Castle Rock; (2) *Andropogon Paranjpyeanum*, from Castle Rock; (3) *Enteropogon Badamicum*, from Badami; and (4) *Tripogon Roxburghianum*, from Badami. Also a note on the identity of *Woodrowia diandra*, Stapf, with *Dimeria diandra*, Stapf.—I. H. **Burkill** and R. S. **Finlow**: *Corchorus capsularis*, var. *oocarpus*, a new variety of the common jute plant. *C. capsularis*, var. *oocarpus*, a variety distinguished by the elongation of its fruit, is a cultivated plant of south-eastern Mymensingh.—I. H. **Burkill**: The polarity of the bulbils of *Dioscorea bulbifera*, Linn. The bulbils of *D. bulbifera* are capable of growth from any part of their surface, but they grow most readily from the neighbourhood of the scar by which they were attached to the parent stem. If cut into halves equatorially, both hemispheres may put out shoots, and these shoots appear more readily near the cut than remote from it; but they appear in a much more restricted way on the abaxillary half (where almost all arise along the edge of the cut) than on the adaxillary half.—I. H. **Burkill**: Further spreading of *Croton sparsiflorus*, Morung. *C. sparsiflorus*, an alien which obtained an entrance into India by Chittagong, it seems, some fifteen to twenty years ago, and about 1905 reached the banks of the Hughli, and before 1907 had reached Gauhati along the Assam-Bengal Railway, has now reached Narayanganj, in a different direction. It has also appeared newly at many stations along the Assam-Bengal Railway.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part iii. for 1911, contains the following memoirs communicated to the society:—

April 4.—K. **Schwarzschild** and E. **Kron**: The distribution of luminosity in the tail of Halley's comet.

March 24.—K. **Stuchtey** and A. **Wegoner**: The *albedo* of the clouds and the earth (measurements made during six balloon voyages).—G. **Hamel**: Contributions to the problem of turbulent motion.

May 13.—G. **Tammann**: Contributions to the thermodynamics of equilibria in systems each composed of a single substance, i.

May 27.—E. **Riecke**: The theory of Michelson's interference experiment.

June 17.—K. **Wegener**: Aërological results for 1910 from the Samoa Observatory.—P. **Furtwangler**: General proof of the partition theorem for *Klassenkörper*.—O. **Mügge**: The structure of magnetite and its transformation into specular iron ore.

July 15.—G. **Tammann**: Contributions to the thermodynamics of equilibria in systems each composed of a single substance, ii.

CONTENTS.

THURSDAY, OCTOBER 12, 1911.

BIOLOGICAL PHILOSOPHY.

Creative Evolution. By Prof. H. Bergson. Authorised translation by Dr. A. Mitchell. Pp. xv+425. (London: Macmillan and Co., Ltd., 1911.) Price 10*s.* net.

NOT a few of the great philosophers of the past were expert students of science, especially of mathematics and physics. We think at once of men like Descartes, Leibnitz, and Kant, to mention three whose periods are in almost continuous chronological sequence. The widening of the field of knowledge and submission to a correlated division of labour have made it less possible in these later days for a man to be a mathematician in the morning and a metaphysician at night, but the tradition of an alliance between the two disciplines has not been lost. For to a greater extent than is generally recognised there have been of recent years, in the ranks of the philosophers, men having not merely—though that is much—an intelligent sympathy with scientific work, but familiarity therewith and ability to offer competent criticism. We think, for instance, of men like the late Prof. William James, Prof. Royce, Prof. James Ward, and Prof. A. E. Taylor. Within the same period, too, we have seen one department of science after another making its definite contribution to philosophy. Now a mathematician, and again an embryologist, has been as a Saul among the prophets. We think, for instance, of Mr. Bertrand Russell, Dr. Hans Driesch, and Prof. Lloyd Morgan. It seems then that the time is ripening for a closer cooperation of philosophy and science, and the man of the time is Henri Bergson.

Metaphysician as he is, M. Bergson seems to be equally at home with mathematical and biological concepts, and he appreciates the aim of science with a rare sympathy. He recognises that metaphysics, in its endeavour to discover the general conditions of a complete and consistent formulation of experience, may be of great service to science, but he is equally clear that, in forming its coherent conception of the whole scheme of things, metaphysics must utilise the materials which the sciences furnish. It is indeed one of the outstanding features of his "Creative Evolution" that its author insists on finding in a more complete appreciation of the manifoldness of nature a basis for his new philosophy of life.

One of the main motives of the essay before us is the conviction that *theory of knowledge* and *theory of life* are inseparable inquiries. They must join each other and "push each other on unceasingly." In their common enterprise, "they would dig to the very root of nature and of mind."

"For the false evolutionism of Spencer—which consists in cutting up present reality, already evolved, into little bits no less evolved, and then recomposing it with these fragments, thus positing in advance everything that is to be explained—they would substitute a true evolutionism, in which reality would be followed in its generation and its growth."

The book is divided into four chapters, the sequence of which the author explains. In the first chapter "we try on the evolutionary progress the two ready-made garments that our understanding puts at our disposal," mechanism and finalism; neither will fit, but finalism "might be recut and resewn, and in this new form fit less badly than the other." In the second chapter, to get beyond the concepts which the understanding puts at our disposal, the author reconstructs the main lines of evolution along which life has travelled—to vegetative torpor, to instinct, to intelligence. Besides the line of evolution which ends in man, there are others which "also express something that is immanent and essential in the evolutionary movement." Perhaps certain powers within us that are complementary to conceptual and logical thought, "will become clear and distinct when they perceive themselves at work, so to speak, in the evolution of nature." The third chapter is an effort to bring back the intellect to its generating cause, "which we then have to grasp in itself and follow in its movement." "A fourth and last part is meant to show how our understanding itself, by submitting to a certain discipline, might prepare a philosophy which transcends it."

Prof. Bergson's book, the translation of which reflects the highest credit on Dr. Arthur Mitchell, has been called both brilliant and profound, and it is too big for us to praise. We wish to say, however, that we have read it three times with increasing enjoyment and gratitude. When we have read it other three times we may perhaps understand it more perfectly, for it is useless to pretend that it is easy. The style is so brilliant and picturesque, the play of the sword is so fascinating, there is such abundance of interesting illustration that the pages slip easily past, yet for the student of organic evolution, seeking for fresh light, the thought often seems very abstract and subtle. For example, specialists may find no particular difficulty in the conception of "durée," which is so essential to the argument, but that has not been our experience. For the pages of NATURE it may be most suitable that we should leave the more purely philosophical part of the book alone, and confine ourselves to a few of the salient biological ideas, *e.g.* of the organism as a historic being, and of evolution as a succession of creations—expressions of sustained "effort."

One of the pivots of the essay is its conception of the organism, from which, as it seems to us, modern biology has something to learn, something to translate into its own universe of discourse. Bergson dwells on the likeness between the life of the organism and our own personal experience. We change without ceasing and the organism continually exhibits its characteristic metabolism. But both have the mysterious quality of "durée"—a word so difficult to translate, for Bergson means more than duration in the merely physical and chronological sense; he means "the continuous progress of the past which gnaws into the future and which swells as it advances." "Our personality shoots, grows, and ripens without ceasing. Each of its moments is something new added to what was before. We are creating ourselves continually." So of an organism it may be said that "its past, in its entirety, is prolonged into its present, and abides there, actual and acting."

"Continuity of change, preservation of the past in the present, real duration—the living being seems, then, to share these attributes with consciousness. Can we go further and say that life, like conscious activity, is unceasing activity?"

Bergson answers this question by an emphatic affirmative. The spontaneity of life is manifested by a continual creation of new forms.

Many biologists and others have previously expounded the idea of the organism as a historic being, but Bergson has given it a new vividness. "Wherever anything lives, there is, open somewhere, a register in which time is being inscribed." For it is of the essence of Bergson's thinking that time has an effective action and a reality of its own.

"We perceive duration as a stream against which we cannot go. It is the foundation of our being, and, as we feel, the very substance of the world in which we live."

"The evolution of the living being, like that of the embryo, implies a continual recording of duration, a persistence of the past in the present, and so an appearance, at least, of organic memory."

It is this conception, in part, which leads Bergson to reject radical mechanism with some emphasis, and, for that matter, radical finalism as well, though he ends with leaving us with a theory that partakes of finalism to a certain extent.

Prof. Bergson thinks of life as

"the continuation of one and the same impetus, divided into divergent lines of evolution. Something has grown, something has developed by a series of additions which have been so many creations." "Evolution has taken place through millions of individuals, on divergent lines, each ending at a crossing from which new paths radiate, and so on indefinitely."

He believes that the essential causes working along these diverse roads are "of psychological nature." It is to be expected therefore that "they should keep something in common in spite of the divergence of their effects."

"Something of the whole, therefore, must abide in the parts; and this common element will be evident to us in some way, perhaps by the presence of identical organs in very different organisms."

It is this idea which leads Prof. Bergson to devote particular attention to the phenomenon of convergence in evolution, to the occurrence, for instance, of closely similar eyes in molluscs and in vertebrates—eyes which differ greatly in development, and must have had a quite independent evolution.

"What likelihood is there that, by two entirely different series of accidents being added together, two entirely different evolutions will arrive at similar results?"

Of course, the conventional Darwinian and Lamarckian interpretations are carefully considered.

"But such similarity of the two products would be natural, on the contrary, on a hypothesis like ours: even in the latest channel there would be something of the impulsion received at the source. *Pure mechanism, then, would be refutable, and finality, in the special sense in which we understand it, would be demonstrable in a certain aspect, if it could be proved that life may manufacture the like apparatus, by unlike means, on divergent lines of evolution; and the strength of the proof would be proportional both to the divergency between the lines of evolution thus chosen and to the complexity of the similar structures found in them.*"

This is one of the ingenious arguments of this brilliant essay, but we doubt if it would convince anyone against his will.

Prof. Bergson considers various theories of evolution, which he regards as each true in its way. The neo-Darwinians are probably right in teaching that the essential causes of variation are the differences in the germs borne by the individual, but probably wrong in regarding (or if they regard) these differences as purely accidental and individual. Eimer was probably right to some extent in his idea of variation continuing from generation to generation in definite directions, but probably wrong in his claim that combinations of physical and chemical causes are enough to secure the result. The neo-Lamarckians are probably right in insisting on causes of a psychological nature, but they are probably wrong in thinking merely of the conscious effort of the individual and in assuming the regular transmission of acquired characters. The author's own position may be gathered from the following sentences:—

"A hereditary change in a definite direction which continues to accumulate and add to itself so as to build up a more and more complex machine, must certainly be related to some sort of effort, but to an effort of far greater depth than the individual effort, far more independent of circumstances, an effort common to most representatives of the same species, inherent in the germs they bear rather than in their substance alone, an effort thereby assured of being passed on to their descendants."

So we come to the idea of—

"an *original impetus* of life, passing from one generation of germs to the following generation of germs through the developed organisms which bridge the interval between the generations. This impetus, sustained right along the lines of evolution, among which it gets divided, is the fundamental cause of variations, at least of those that are regularly passed on, that accumulate and create new species. In general, when species have begun to diverge from a common stock, they accentuate their divergence as they progress in their evolution. Yet, in certain definite points, they may evolve identically; in fact, they must do so if the hypothesis of a common impetus be accepted."

This remains too shadowy for the working naturalist, but it is a fresh attempt to express what must some day become clearer, the essential thought of Lamarck, of Goethe, of Robert Chambers, of Samuel Butler, and of later vitalists—the idea of variations as intrinsic self-expressions of the organism.

Another cardinal idea of Prof. Bergson's book is that the evolution of life has taken a number of divergent directions, leading to quite different goals. It is neither a series of adaptations to accidental circumstances, as the mechanistic view sees it, nor the realisation of a plan, as the finalist view would have it. A plan is given in advance, but evolution is a creation unceasingly renewed, a development of an original impetus in various directions. Two of these directions are represented by the world of plants with their fixity and insensibility, and the world of animals with their mobility and awakened consciousness.

"But the waking could be effected in two different ways. Life, that is to say, consciousness launched into matter, fixed its attention either on its own movement or on the matter it was passing through; and it has thus been turned either in the direction of intuition or in that of intellect."

Intuition could not go very far, and shrank into instinct. Intelligence became more and more free, and "it can turn inwards on itself, and awaken the potentialities of intuition which still slumber within it." While Bergson shows very finely how the plant may sometimes rouse itself from its torpor and the animal sink into vegetativeness, how instinct may be mingled with intelligence, and intelligence penetrated by instinct, yet his definite conclusion is that the differences between vegetative torpor, instinct, and intelligence are differences of kind.

"*The cardinal error which, from Aristotle onwards, has vitiated most of the philosophies of nature, is to see in vegetative, instinctive and rational life, three successive degrees of the development of one and the same tendency, whereas they are three divergent directions of an activity that has split up as it grew.*"

And it is from this that the author passes to his even more important conclusion that while intelligence guides us into matter and delivers to us the secret of physical operations, it is instinct—which is sympathy—that will give us the key to vital operations.

"Intelligence goes all round life, taking from outside the greatest possible number of views of it, drawing it into itself instead of entering into it. But it is to the very inwardness of life that *intuition* leads us—by intuition I mean instinct that has become disinterested, self-conscious, capable of reflecting upon its object and of enlarging it indefinitely."

Thus while nature-poetry is in no sense biology, it may be a very important complement.

J. A. T.

TIDES AND ORBITS.

Scientific Papers. By Sir George Howard Darwin, K.C.B., F.R.S. Vol. iv., Periodic Orbits and Miscellaneous Papers. Pp. xviii + 592. (Cambridge: University Press, 1911.) Price 15*s*. net.

IN this fourth volume Sir George Darwin has for the present completed the task of editing his papers, a task which he commenced four years ago on the invitation of the syndics of the Cambridge University Press. If we may judge from the fact that nine papers in the present volume have appeared since the publication of the work was started there is reason to hope that a supplementary volume will be needed before many years are past. That volume when it comes will have to contain, if it is to be consistent with former volumes, pioneer investigations of a high order in some difficult branch of applied mathematics. To one who desires to speculate along what line Sir George Darwin's future work is likely to take him the present volume is of especial interest. For in the papers classed under the head "Miscellaneous Papers in Chronological Order" will be found several early papers containing the germ of much of the later more important work. Several of these papers (notably 11, 12, 13) would appear to be by-products of larger investigations which were already (we judge from the chronological list of papers) well in hand when these investigations were published. But the paper "On the perturbation of a comet in the neighbourhood of a planet," which was followed after an interval of four years by the historic investigations on periodic orbits, does look like the first attempt along a new and fruitful line of investigation. In fact, though differing in scope and nature from the larger work, the small paper to which we have just referred might quite fairly, from a historic point of view, have been placed in the section containing the periodic orbits papers, as a preliminary piece of research. This section is the most important part of the volume under review, and we must discuss it in some detail.

In the introduction to the well-known memoir in the *Acta Mathematica*, the author speaks of the prodigious amount of numerical work involved in his attack on the problem of periodic orbits. He adds:—

"It is not for me to say whether the enormous labour I have undertaken was justifiable in the first instance; but I may remark that I have been led on, by the interest of my results, step by step, to investigate more, and again more cases. Now that so much has been attained I cannot but think that the conclusions will prove of interest both to astronomers and mathematicians."

Recent successful applications to problems of celestial astronomy of what are to a large extent Sir George Darwin's methods would alone justify his heavy work. But quite apart from these applications the paper has great intrinsic value. The important stability discussion and the useful account of the method of mechanical quadratures practically developed by the author both serve a very useful purpose to the student. The presence of a paper by Mr. S. S. Hough, his Majesty's astronomer at the Cape, is a valuable addition to the section. It not only serves to bridge over the gap between Darwin's first and third papers and to supply an important addition to the theory of the subject, but it also supplies an account of the orbit work from a different point of view from that of the author. It may not unfairly be compared to Schwarzschild's account of Poincaré's work on revolving bodies, and its presence alongside Darwin's papers is of great value. It should be added that the illustrations have been well reproduced, and that from an interesting appendix some idea may be gleaned of the heavy computing work involved in these researches. Here it seems not unreasonable to refer to Sir George Darwin's generous and thoughtful appreciation of his great co-worker's investigations in his own field. His address on presenting the gold medal of the Royal Astronomical Society to M. Poincaré is full of interest. This, with his two British Association addresses, will form the chief item of interest in this volume to the non-mathematical reader. We can only glance at two points of interest here.

The idea that some physical truth underlies Bode's empirical law seems to persist in these addresses, and we could hope that there lies the germ of Darwin's next attack on the problems of cosmogony. We naturally cannot agree with all the statements made in what are essentially popular addresses, and we signal as one instance of doubtful reasoning the reference to a condensing ring on p. 537. The effect of a mobile central nucleus inside the ring seems to be left out of account.

Among the miscellaneous papers we select first for mention those dealing with mechanical designs, where the collaboration of the author's brother, Horace Darwin, is again suggestive of later developments; the sandthrust and ripple experiments also give evidence of a side of Darwin's nature not suspected from a casual knowledge of his work. It was with something of a start that the writer found in "A Geometrical Puzzle" a note (dated 1877) referring to an old puzzle which has only recently had a return of popularity. The papers on "Marriages between First Cousins and their Effects" form an appendix which is still of considerable interest to the biological statistician. But if we may judge from the preface the paper to which Darwin would ascribe the greatest value himself is the one on "The Mechanical Conditions of a Swarm of Meteorites." The author notes that the paper has received but little notice, and the reason for this does not seem far to seek. The seat of the controversy has moved away from the point to which the investigation was directed, as is indeed clear from Darwin's own addresses referred to above. The assumptions of a spherical distribution do not apply to a spiral nebula—which has become of recent years the chief source of speculative interest. Lastly, we must mention the paper on the Antarctic tides. It is curious to compare Darwin's forecast of a great unsuspected bay in the Antarctic with Harris's forecast of a large piece of undiscovered land in the Arctic Ocean. Both suggestions have been based on tidal observations, supported to some extent by rival theories. Both are open to proof or disproof through subsequent voyages of exploration.

We have left until last the English text of the important article, "Bewegung der Hydrosphäre," in the "Encyklopädie der Mathematischen Wissenschaften." Here again Mr. Hough has collaborated and added a lucid discussion of the dynamical theory of the tides. The practical application of the theory by the harmonic and synthetic methods are fully discussed, though the treatment is somewhat too condensed for the average reader. A useful bibliography and schedule of the symbols in common use is added, and an account of many miscellaneous investigations, such as the Bidston tidal-load experiments. It is perhaps disappointing to gather that we cannot yet with any confidence make any wide generalisations as to the nature of the tide-wave in the open ocean. But in each unsolved problem lies the charm of the unknown, the fascination which lures the born researcher on to investigation after investigation. That George Darwin by right of descent and by natural aptitude is one who must pursue the search in the unknown is amply testified in his collected works. That he has pursued his investigations in the right spirit his own words testify.

"Man is but a microscopic being relative to astronomical space, and he lives on a puny planet circling round a star of inferior rank. Does it not then seem as futile that he can discover the origin and tendency of the universe as to expect a house-fly to instruct us as to the theory of the motions of the planets? And yet, so long as he shall last, he will pursue his search, and will no doubt discover many wonderful things which are still hidden. We may indeed be amazed at all that man has been able to find out, but the immeasurable magnitude of the undiscovered will throughout all time remain to humble his pride. Our children's children will still be gazing and marvelling at the starry heavens, but the riddle will never be read."

THE SCIENCE OF MODERN ARTILLERY.

Modern Artillery in the Field: a Description of the Artillery of the Field Army, and the Principles and Methods of its Employment. By Colonel H. A. Bethell. Pp. ix+393. (London: Macmillan and Co., Ltd., 1911.) Price 7s. 6d. net.

THIS book is a welcome sign that the country is beginning to wake up to the importance of the study of artillery science, in which we see such superior interest everywhere abroad.

The territorial is very keen to make himself acquainted with the science of his arm; and in the absence of official financial support this treatise of Colonel Bethell will prove useful to make him without practice into the theoretical gunner, contrasted with the regular gunner, practical man without practice.

In opposition with what can be seen on the Continent, here in this country we have no practice ranges for artillery—*Champs de Tir*, so plentiful in France. We shall have to trust to territorial enthusiasm in antagonism to official neglect for providing at private expense the best amateur substitutes possible, which the regular gunner will be glad to utilise on an emergency when once a system is started; he too is starved in practice to an equal extent.

The retired general officer is not forgotten—landowner and on a pension, who at the end of the last century was so decided in his refusal to give any facility to volunteer rifle shooting; but soon was sorry he had been so outspoken, when the bad news came streaming home from South Africa shortly after.

Modern artillery has been revolutionised by the introduction of the quick-fire (Q.-F.) gun, described with useful diagrams by Colonel Bethell; but the name should be changed to Q.-A. (quick-aim).

By allowing the gun a long recoil of three or four feet over the carriage, the reaction can be reduced until the wheels do not jump off the ground; the carriage remains still, so that a slight adjustment only is required for the next shot.

Without this Q.-A. arrangement the Q.-F. principle cannot be utilised; and one of these guns is a match for six of the type we used in South Africa.

The gunner who fires the gun is still called by official misnomer the "layer"; but he does not "lay"; he merely keeps the telescopic sight on the mark and fires as fast as the gun can be loaded—twenty times a minute. He is the *pointeur*; other gunners attend to laying of the gun, in giving the elevation to correspond with the range finder, and in setting the fuse, for which a special instrument has at last been introduced; others traverse the gun when required and hand over the ammunition, and all can work in security behind a steel shield. But the man who fires the gun gives his individual attention to "pointing."

Official optimism at the end of the last century had declared our artillery to be perfect—a sure prelude to disaster. We know now that it was fit only for the scrap heap, and would have been knocked out in the first encounter with a European Power; and the German mercenary gunner in Africa was more than a match for our regular artillery.

We must look to France for the most modern development of artillery science, as our military authority is quite content on a back seat.

Parts iii. and iv. have the appearance of being lifted from a French source. The territorial gunner will profit at his leisure by a study of these parts and the useful hand sketches; also in walking over the ground in his neighbourhood with eyes open; his opportunity of actual insight at manœuvres will be small.

The word mobility is always in vogue, with little grasp of its meaning.

After a war the cry is always for a more powerful gun; and our eighteen-pounder weighs 24 cwt. on a pair of wheels. This is too much for the road and the team, and is putting the cart before the horse according to the proverb modified. A field gun must be able to leave the road and cross a ploughed field, so that the old definition of the Act of Parliament of Henry VII. still holds good, of a ton as a cartload, in fixing the standard weight to be carried on a pair of wheels.

But in a long peace, when smart evolutions are considered of more importance than gunnery, and mobility comes to mean a gallop with no reality between the team, the weight decreases to an opposite extreme.

The horse scarcity is becoming acute with the advance of the motor-car. Territorial gunners will have to learn their drill indoors with blocks of wood and toy soldiers, like naval officers playing a war game on the gun-room table; and this book will provide plenty of ideas for abstract tactical problems.

The artillery tactics of the flying machine come in for discussion. These tactics have been worked out long ago by the French, and the dirigible balloon was directed to take up a place of safety hovering vertically overhead, as then the enemy would not dare to fire with the prospect of the shot descending on his own head or his friends'.

We prefer to think of the flying machine as a dragon-fly, in the German name, harmless and lovely for our delectation. But no public funds would be available if it could not be shown that the flying man could be utilised for human destruction, employed as "the light militia of the lower sky."

G. GREENHILL.

INSULATING MATERIALS AND ARMATURE WINDINGS.

(1) *Les Substances Isolantes et les Méthodes d'Isolement utilisées dans l'Industrie Électrique.* By Jean Escard. Pp. xix+313. (Paris: Gauthier-Villars, 1911.) Price 10 francs.

(2) *Les Enroulements Industriels des Machines à Courant continu et à Courants alternatifs: Théorie et Pratique.* By E. Maree. With a preface by Paul Janet. Pp. vii+240. (Paris: Gauthier-Villars, 1911.) Price 9 francs.

(1) A TREATISE on insulating materials conceived in a scientific spirit would certainly be welcome to many electrical engineers, and on reading the author's preface to his attempt to write such a treatise one concludes he has approached his subject from this point of view. He tells us that his work is not intended to be a mere enumeration of the various insulating materials available, but a critical investigation, such as will help the practical engineer to make in each case the best selection possible. Good as the author's intentions were, his performance falls short of them.

There is, to begin with, a good deal of matter in his book which has nothing whatever to do with insulating materials. The first forty pages are devoted to a discussion of metallic and liquid conductors, and here we find merely a repetition of statements and figures which will be found in any text-book on physics. This is padding; so is the picture of a drilling machine, that of a shop in which tissue paper is pasted on to transformer plates, and so are the illustrations of various wooden and ferro-concrete telegraph poles. To drag in the coherer used in wireless telegraphy is also padding, pure and simple. That the insulating properties of concrete are discussed is quite right, but it is misleading to draw any conclusions from it in respect of the insulation of dynamos. Yet on p. 128 we are told that small machines are generally placed on timber, and are thus sufficiently insulated from earth. Large machines must be put on a concrete foundation, and although this is not an absolute insulator, it is a sufficiently poor conductor to prevent any considerable escape of electricity to earth. But precautions are necessary; the foundation must be kept dry, and to this end one must avoid the neighbourhood of steam and water pipes, and one must dry the air in the engine-house by ventilating fans. How a steam dynamo is to be driven without steam and water pipes coming near it the author does not explain.

As regards special insulating compositions, there is little more than enumeration accompanied by some general remarks, such as one might find in a trade list. In some cases the composition is given in detail, but no definite electrical data. We find such trade names as "Radoonite," "Terracite," "Refragor," "Megotalc," "Micacementite." The last-mentioned material is said to withstand vibration, and we are told that certain traction motors which were not insulated with it broke down after a run of 20,000 km., whereas after this material was used they were able to run 40,000 km. Information of this kind is simply valueless.

A good deal of space is devoted to air as an insulating material, and reference is made to the investigations of Ryan, Steinmetz, Scott, and Mershon (the latter's name being persistently spelled Merthon). There is, however, nothing said about Watson's research on the increase of the dielectric strength of air under high pressure, and the practical application he made of it, and brought before the Institution of Electrical Engineers a few years ago. The best chapter in the book is that on porcelain as an insulator. Here we get some definite data, both as to the various types used and the methods of testing.

(2) Formulæ for armature windings are a fascinating subject to the mathematician. It is, of course, possible to represent any winding, no matter how complicated, by some mathematical expression, or even to devise a general winding formula of formidable aspect which, by a suitable choice of coefficients and constants, may be reduced to represent any winding, even the simplest. To an accomplished mathematician there must be a great temptation to treat the subject in this comprehensive way; and we may feel grateful to the author for having withstood the temptation and given us a treatise which restricts the subject to those windings that are of importance to the manufacturer. But these he treats thoroughly, not only as mathematical problems, but also from the manufacturer's point of view, that is, including detailed descriptions of the various special tools required. The use of winding tables instead of drawings of connections is, of course, well known, but the author's way of arranging the winding table is extremely useful. It contains not only the sequence of the conductors (or in a coil winding of the coil sides) proper, but also the sequence of slots and commutator sections, so that the division of current between the armature circuits and the potential difference between any two conductors or any two commutator segments can be seen at a glance.

The use of open slots and binding hoops is recommended for peripheral speeds under 6000 feet a minute; beyond that wooden wedges should be used, or, better still, slots with an overlapping lip. As regards equipotential connections the author seems to think them of equal importance for wave and lap winding, and he fails to point out that with four-pole machines, even if lap wound, they are not nearly so necessary as in a six-pole machine. This is, however, a minor matter, and, moreover, does not affect the system of winding, which is, strictly speaking, a geometrical and not a dynamical problem.

In the second part of the book we come to windings for alternating-current machinery. These are generally more simple than direct-current windings, but the author treats them with equal thoroughness. Even such questions as the shape of the e.m.f. curve as influenced by the number of slots per phase per pole, the comparative merits of six-phase and three-phase windings for converters, those of two-phase *versus* three-phase generators, and other more theoretical matters receive due attention. The special tools required are fully discussed and illustrated, and questions of insulation, such as the thickness of cotton covering, thickness of micanite tubes, covering and protection of coil ends, are not overlooked. The work is profusely illustrated both with line drawings and with perspective views of windings in different stages. These are very clear, and, as examples, well chosen. Polyphase winding diagrams are shown in different colours, so that it is easy to follow out the circuits for each phase separately.

GISBERT KAPP.

AGRICULTURAL BACTERIOLOGY.

(1) *Handbuch der landwirtschaftlichen Bakteriologie.* By Dr. F. Löhnis. Pp. xii+907. (Berlin: Gebrüder Borntraeger, 1910.) Price 36 marks.

(2) *Landwirtschaftlich-bakteriologisches Praktikum.* Anleitung zur Ausführung von landwirtschaftlich-bakteriologischen Untersuchungen und Demonstrations-Experimenten. By Dr. F. Löhnis. Pp. vii+156. (Berlin: Gebrüder Borntraeger, 1911.) Price 3.40 marks.

AS the fertility of virgin soils becomes exhausted and the world's population increases, man will become more and more dependent on artificial methods for increasing the fertility of the soil and on intensive cultivation. Research during the last twenty years has shown how important lowly forms of life are in these connections. The microbiologist has already indicated that, for instance, by increasing the nitrogen-fixing micro-organisms in the soil by inoculation, or by partial sterilisation whereby forms inimical to them may be destroyed, much may be done to increase the yield of crops without the actual addition of plant-food elements by means of manures.

(1) There has of late been an enormous output of work from various laboratories and experimental stations, and the first work under review gives an admirable summary of the more important researches on agricultural microbiology. It is a large volume of 900 pages, and has been compiled with true German industry from the original papers, the references to which are given. The latter occupy from a quarter to one-half, and in many cases three-quarters, of every page, often with a line or two of comment or explanation appended, so that the book forms a very complete bibliography of the subject, and it is pleasing to note that British, Colonial, and American work appears to have received full recognition, which is not always the case in German literature. The volume is divided into five main sections, which respectively deal with the occurrence and activity of micro-organisms in (1) fodder and agricultural foodstuffs, (2) the "retting" of flax and of hemp, and tobacco fermentation, (3) milk and milk products, (4) manure, and (5) the soil, and the treatment of each is very complete. Thus, in the first named, after a general discussion of the number and nature of micro-organisms in fodder and foodstuffs (hay, straw, grain and seeds, meal and roots), the subjects of the influence of micro-organisms in the preparation, heating, and firing of hay, in ensilage, in the decomposition of the starchy, saccharine, protein, and fatty constituents of fodder, &c., on digestion in the animal which consumes them,

and on its intestinal flora, are all treated. Finally, to every section or subdivision of a section a description of the physical, chemical, and biological methods of investigation is appended.

That we have much yet to learn concerning many of the natural processes involved is apparent from a perusal of such a section as that on the heating and firing of hay. This appears to take place in three stages, a first in which the temperature rises to 45–50° C., a second in which the temperature rises from 50° C. to 70° C., and a third which proceeds above 70° C. The first two stages are caused by the activities of micro-organisms involving processes of decomposition and oxidation ("thermophilic" bacteria being active between 50° and 70° C.), but the cause in the third stage of the production of heat above 70° C. and ultimately culminating in ignition is not so obvious. It is probably a physico-chemical process due to the production of carbonaceous and other matters which adsorb, condense, and oxidise the hydrogen, marsh and other inflammable gases, which have resulted from decomposition in the earlier stages, and cause their ignition, much in the same way as spongy platinum causes the ignition of hydrogen.

Nor is the subject-matter strictly confined to "bacteriological" details, but if others are of importance in relation to the general treatment of a subject, they are included. Thus, as regards milk, not only is the importance of streptococci discussed, but the nature and significance of the cellular elements which are constantly present in less or greater number are reviewed. These cellular elements when in small numbers have generally been considered to be leucocytes, when in large numbers as pus cells and to be abnormal, but investigation has shown that under normal conditions and with perfectly healthy cows these cells are occasionally present in enormous numbers; all this is summarised.

Considerable space is also devoted to the chemistry of the changes and decompositions which occur in the various processes, and while the vegetable micro-organisms claim most attention, some reference is made to the protozoa and higher animal organisms, *e.g.* earth-worms and their importance. Had the work been compiled later, doubtless more space would have been devoted to the protozoa, the treatment of which as it stands is too brief.

The book, which is not illustrated, is clearly printed on good paper with numbered lines for facility of reference, and concludes with very full and complete indexes of authors and subjects.

(2) This little book, by the same author as the preceding, gives in the briefest outline a general account of bacteriological methods followed by a series of simple practical lessons on the bacteriology and biochemistry of milk, manure, and soil. The student who works through these lessons will certainly gain a considerable amount of knowledge of the subjects treated, and will be ready to undertake more advanced work. Many illustrations are given, most of which are good and appropriate, though the methods of inoculating tubes given in Figs. 19 and 24 seem clumsy and archaic. R. T. H.

OUR BOOK SHELF.

British Rainfall, 1910. *On the Distribution of Rain in Space and Time over the British Isles during the Year* 1910, *as recorded by nearly* 5000 *Observers in Great Britain and Ireland, and discussed with Articles upon Various Branches of Rainfall Work.* By Dr. H. R. Mill. The fiftieth annual volume. Pp. 112+328. (London: Edward Stanford, 1911.) Price 10*s.*

THE author remarks in his report to the trustees that the chief object of the rainfall organisation is to present the results of the labours of the observers in the best and most useful way. An inspection of the volume under review leaves no doubt that this desirable aim has been fully attained. As in former years, the work is divided into three principal sections, including, *inter alia*, (1) organisation and special articles, (2) monthly and seasonal rainfall and its relation to the average and heavy falls of rain (see NATURE, February 2), and (3) general table of annual rainfall and number of rain-days at 4874 stations. The cartographic treatment has been carried further than in previous volumes; the maps referring to heavy falls on rainfall days are of exceptional interest, and include a series of remarkable thunderstorms which occurred chiefly in the south of England from June 5 to 10, with a coloured map (as frontispiece) showing the distribution of torrential rains in the Thames valley on June 9.

The most laborious of the changes this year is the more satisfactory arrangement of the stations of the general table for England and Wales in river basins, although for convenience of reference the counties are retained as the units. This forms the subject of a special article, illustrated by maps of each division showing the county boundaries and watershed lines. The treatment of the stations in Scotland and Ireland has been postponed. Another laborious piece of work has been the introduction of a new rainfall average based on the thirty-five years 1875–1909. For the British Isles generally and for Ireland this makes practically no change, so far as the annual totals are concerned, from the thirty years' average. For England the new average is 5 per cent. less, in Wales 3 per cent. less, and in Scotland 4 per cent. more.

In a special article on the greatest rainfall which may occur on the wettest day of the year it is shown that during the last forty-seven years falls of 4 inches have occurred in a great number of counties, even exceeding 6 inches in a few. Another useful article on the rain-gauge in theory and practice will remove several of the difficulties usually experienced by beginners of rainfall observations. We cannot conclude this notice without expressing regret that this very valuable organisation is not self-supporting, and that a considerable financial burden has to be borne by the director.

Partridges and Partridge Manors. By Captain A. Maxwell. Pp. xii+327. (London: A. and C. Black, 1911.) Price 7*s.* 6*d.* net.

WHAT the author accomplished with the assistance of Mr. George Malcolm in 1910 for the grouse he has succeeded in doing single-handed for the partridge in 1911, and the praise we felt bound to accord to his former effort we have pleasure in re-echoing in the case of the present beautifully illustrated volume. It contains, in fact, practically all that the sportsman ought to know with regard to the plump brown gamebird of our stubbles, and much that ought to interest the ornithologist. For Captain Maxwell appears to be a good field observer himself, and has likewise availed himself largely of the stores of information possessed by the better class of gamekeepers. Among such information, it may be mentioned, is a heavy and apparently conclusive indictment against the hedgehog as a game-poacher of the blackest dye.

Partridge-preserving the author considers to be decidedly beneficial to the farmer, as it not only brings money into country districts, which otherwise would be spent elsewhere, but it provides him with "a small machine [in the shape of the partridge] which turns noxious weeds and useless insects into a valuable food." After discussing the economical question in chapter i., the author takes the natural history of the partridge as the subject of chapter ii. Here we are told at the outset that "no fewer than 152 species of partridges and their affinities" are recognised by ornithologists—a statement difficult to understand owing to the ambiguity of the term "affinities." A few other minor criticisms might be made on this chapter, but in the succeeding chapters, dealing with rearing, driving, and shooting partridges, the author appears to be thoroughly in his element and a master of his subject. Every sportsman should buy a copy of the book. R. L.

Practical Drawing. A Preliminary Course of Work for Technical Students. By T. S. Usherwood. Pp. viii+163. (London: Macmillan and Co., Ltd., 1910.) Price 2*s*.

THIS useful little manual provides an excellent course of instruction in instrumental drawing, very suitable for the junior classes of technical institutes. The beginner is first shown the use of the rule and callipers in the making of dimensioned hand sketches of simple objects. Then full explanations are given of the manipulation and handling of drawing instruments, including tee and set squares, in the production of accurate work to scale. Facility in the use of instruments is acquired along with a working knowledge of geometrical principles, by the plotting of lines, angles, figures, vectors, and the drawing of simple mechanical and architectural details.

The subsequent work in plane geometry includes the construction of scales, circles, triangles, polygons, geometrical patterns, and similar figures; also graphing on squared paper, the calculation of areas, and the plotting of the paths of points moving under geometrical or mechanical constraint. The author wisely devotes a chapter to the method of representing solid objects by plans and elevations, and by metric projections to scale. The book is provided with an index, and the student with answers to the numerical exercises. The author is evidently an experienced teacher. He supplies good examples in great variety. The scheme of instruction is a sound and desirable one, and affords a thorough groundwork for subsequent study.

Die praktische Bodenuntersuchung. By Prof. E. Heine. Pp. xii+162+plate. (Berlin: Gebrüder Borntraeger, 1911.) Price 3.50 marks.

WHILST there are many works in German dealing with the properties of soil from the purely scientific point of view, there is none, according to the author, that gives the practical farmer the kind of knowledge he wants in order to understand the nature of the soil and the processes going on therein. While it is not denied that a farmer can get on sufficiently well without this knowledge, nevertheless he will find not only a source of interest, but also of profit, in learning something about the fundamental properties and laws on which the cultural operations and the fertility relationships of the soil are based. The author therefore deals in successive chapters with the soil as a medium for plant growth, the physical properties, chemical composition, and biological relationships of soils, methods of classification and improvement. In the second part of the book the soils of North Germany are described, and instructions are given for the use of soil maps.

The information is clearly set out, and in its general style will appeal to the farm student and to the young farmer who has sufficient energy and interest to read after his day's work is done. Indeed, the information is better than the method: a book written for the same class of readers in England would be expected to give many more actual illustrations of the application of general principles than are here attempted. The reviewer's experience is that general principles as such have little meaning to the farm student, and copious illustrations are necessary to give point to them. The present book is deficient in this respect.

More stress might well have been laid on the part played by calcium carbonate in soil fertility. No soil deficient in calcium carbonate can be regarded as very satisfactory; vegetation relationships are markedly different according as calcium carbonate is present or not. Thus in the description of humus the differences between the various types is attributed to differences in air supply, the part played by calcium carbonate not being considered important. It is evident, also, that the German method of mechanical analysis is less satisfactory than our own, which would have formed the basis of several of the chapters in such a book.

But apart from these points the little book is very good, and conveys in simple language an accurate presentation of our present ideas on the soil.

E. J. R.

Conic Template. J. T. Dufton's design. For Junior Students of Conics. (London: Macmillan and Co., Ltd.) Price, nickel-plated metal, 4*d*. net; transparent celluloid, 8*d*. net.

STUDENTS of geometrical conics should not fail to provide themselves with this accurately made and handy little "Conic Template." By merely passing a pencil round its curved edges, a true ellipse, parabola, and hyperbola can be drawn, the three curves having closely related elements, which are specified in the instructions accompanying each instrument. The regular employment of accurate figures, instead of rough diagrams sketched freehand, will add interest to the work, and will materially assist in fixing on the mind of the student the forms and properties of these important curves.

How to become a Pharmacist in Great Britain. With Appendixes on Pharmaceutical Qualification in Ireland, Pharmaceutical Registration in the British Empire, Degrees in Pharmacy, and the Schedule of Poisons. Edited by John Humphrey. Pp. 52. (London: The Pharmaceutical Press, 1911.) Price 1*s*. net.

CLEAR and precise information is given here about each stage in the preparation for the work of a pharmaceutical chemist, from apprenticeship to the passing of the major examination of the Pharmaceutical Society. The appendixes give details as to the particular conditions under which qualification to practise pharmacy may be secured in Ireland and in other parts of the British Empire. The advice offered is sound and helpful; and the view throughout is to regard the work of the pharmacist as a branch of applied science needing the practice of scientific methods for its successful performance.

LETTERS TO THE EDITOR.

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

The Simultaneity of Certain Abruptly-beginning Magnetic Disturbances.

IN the first volume of my work "The Norwegian Aurora Polaris Expedition, 1902–3," I stated (p. 63), after studying the magnetograms from seventeen stations in all quarters of the earth, that the characteristic sudden similar magnetic changes occurring often during positive equatorial perturbations "appear *simultaneously*, or rather, the differences in time are less than the amount that can be detected by these registerings." "The above question on simultaneity, which is of great importance, cannot be definitely decided until we are in possession of rapid registerings."

In the spring of 1911 I made an investigation of the zodiacal light in the Sudan and Egypt, during which I had mounted two complete sets of registering apparatus, the one for slow, the other for rapid, registrations, which were working every night near Aswan for one month under the supervision of Mr. Krogness.

The instruments were set up in the depth of an ancient Egyptian tomb, in which the temperature was fairly constant. Thanks mainly to Mr. Keeling, the superintendent of the Khedivial Observatory in Helwan, we enjoyed all the facilities for our work that we could desire.

In order to obtain "quick-run" magnetograms from other stations taken at the same time, I published in NATURE for March 16 (No. 2159, p. 79) a letter requesting other observatories to take such registrations at the same hours as we. I have, unfortunately, not received any intimation of any such "quick-run" registrations having been taken except in Samoa, where Dr. Augenheister commenced the registrations on April 10, while the only sudden equatorial storm registered in the prescribed period of one month occurred on April 9.

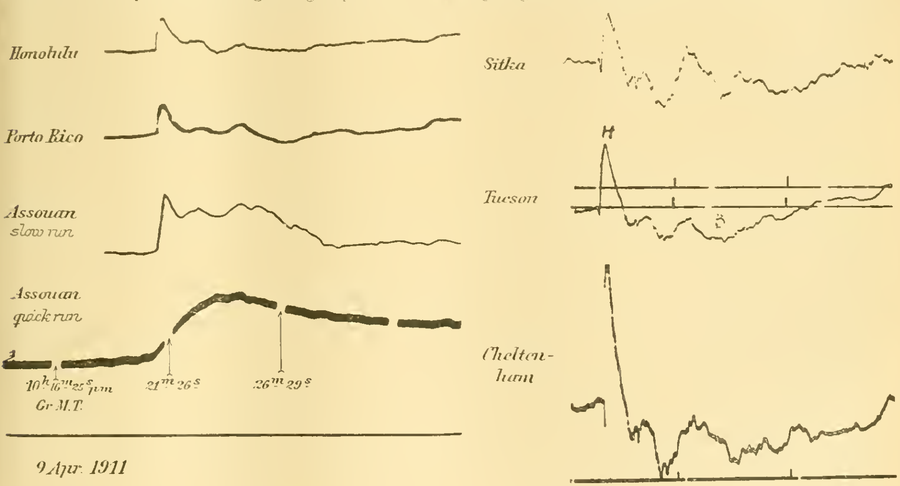
Mr. Tittmann, superintendent of the U.S. Coast and Geodetic Survey, has been good enough to send me some copies of slow-run registerings for April 9 from Cheltenham, Porto Rico, Tucson, Sitka, and Honolulu. Of these, the curves from Honolulu (158° W.) and Porto Rico (65° W.) are of special interest, because these stations, together with Aswan (33° E.), form a particularly happy distribution of stations about the earth.

The figure shows that on this day an equatorial perturbation occurred the character of which on these three stations is very similar. The times of commencement in H are as follows:—

Honolulu		Porto Rico		Aswan
10h. 20m. 7s. p.m. G.M.T.	...	20m. 8s.	...	20m. 44s.

The changes in D at the same time were very small, as might be expected would be the case with this kind of perturbation.

The first notices of time are given in a letter from the Coast and Geodetic Survey; the last value is found by the quick-run magnetogram from Aswan, as shown by the diagram. The time-marks here, which refer to the central point for the obliterated parts, are certainly correct to one second, but a greater uncertainty arises when it is a question of determining when the perturbation shall be said to have commenced. I consider we may be safe when we estimate the possible error at ±4 seconds. But the values of the slow-run magnetograms lie within this margin in Honolulu and Porto Rico, where, however, the readings are naturally not so trustworthy as those of the quick-run magnetograms from Aswan.



9 Apr. 1911

The curves from Sitka, Tucson, and Cheltenham show that the perturbations in those places have had a somewhat different character from those at the three first-named stations, for it appears as though a magnetic polar storm interferes. The curves for D and Z show the same thing.

The times we have been given from the Coast and Geodetic Survey for these stations are:—for Sitka, 10h. 21m.; Tucson, 10h. 20m.; and Cheltenham, 10h. 21m. 9s.; and these refer to the "larger displacement" in H. This occurs shortly after the first abrupt beginning, and the times are, as may be seen, with the exception of Tucson, slightly greater than the others.

As regards Tucson, we notice that the first time-mark is considerably smaller than the later ones; for this reason I think this value perhaps ought to be taken with some reservation.

From Trondhjem I have only one slow-run magnetogram, as the corresponding quick-run, unfortunately, is wanting for the only hour in question. At this station the polar character of the storm is distinctly apparent, as might be expected from so high a latitude. On the occasion of the magnetic storm we are here studying, the similar sudden changes occurred thus around the terrestrial equator *simultaneously* within the limits of error in the observations.

When several observations of such magnetic storms around the equator, obtained by quick-run registerings, are available, as I hope may be the case soon, this important question on simultaneity will be finally determined.

It may be of interest in connection with this to call to mind that, in 1900, quick-run registerings were taken simultaneously in Potsdam and at my observatory at Haldde, near Bossekop. In my work "Expédition Norvégienne de 1899–1900 pour l'étude des aurores boréales," Christiania, 1901, photographs of these registerings are given which show that corresponding small sudden alterations in D were simultaneous within three seconds in Potsdam and Bossekop.

According to my theories of magnetic storms, it might be expected that sudden similar magnetic changes which occur in different parts of the earth arise rather simultaneously. When the sun suddenly sends forth a strong pencil of kathode rays towards the earth, this pencil will, owing to earth-magnetism, be broken up in such a way as to form different partial systems of magnetic impulses—polar and equatorial. The various groups of rays have to travel different way-lengths in space before reaching nearest to the earth, and may arrive at very different earth-regions for the different groups. But the difference in time between these various impulses affecting any particular locality on the earth can scarcely be more than a couple of seconds, while the difference in the intensity of the effects can be very considerable. We know of corresponding phenomena in the case of aurora, as I demonstrate in my first above-cited work.

Christiania, September 29. Kr. Birkeland.

The Library and the Specialist.

Nature of August 17 has just come to hand, and I am much pleased to see the article in it (p. 222) on "The Library and the Specialist." The reference there made (not quite accurately) to my own difficulties as a bibliographer and student I gladly pass over: the troubles of an individual are of little moment when they are known to be shared by practically all scientific men.

The general argument in favour of reform is excellently put in the last paragraph of the article, and there is no need to add to it. I ask leave merely to bring things to a practical issue by stating briefly and clearly what steps are necessary to be taken to attain the important object we all have in view.

(1) A hand-list has to be drawn up containing the names of all current mathematical serials. This could be done in a few hours by any competent librarian having a mathematical adviser within reach, the material being all ready to hand in the lists given in the *Jahrbuch*, the *Revue Semestrielle*, and the International Catalogue.

(2) Six copies would have to be made of the said hand-list when finally revised, and one each sent to the librarians of the Mathematical Society, the Royal Society, the British Museum, University College, South Kensington, and the Patent Office, in order that each librarian might indicate which of the serials his library possesses. From all I know of these libraries, I am sure that there is not one of them but would wish to help.

(3) A new list would then have to be made containing the combined details provided by the six, and a copy of this to be furnished to each library.

Any serious obstacle in the way of accomplishing this scheme it is impossible for an outsider to conceive. One of your influential correspondents in 1906 seemed to imply that the librarians would "stand upon the order of their going." Personally, I esteem them too highly to believe this. Any one of three of them might fairly expect the others to follow, the Mathematical Society having a claim to lead because of the special science concerned, the Royal Society because of its outstanding position among scientific bodies, and the British Museum because of its unique position among libraries. Will none of the three risk a rebuff for the work's sake?

I fail even to see that there is a money difficulty in the way. The libraries concerned are constantly being put to greater expense by private individuals. But if money really be wanted, the least we can ask for is to be told the amount. Thos. Muir.

Cape Town, South Africa, September 5.

I am glad to be able to assure Dr. Muir and others interested in the matter that steps are about to be taken to carry out the plan he suggests, and to supply each of the six London libraries with the list in its final form. It may even be possible to draw up a more comprehensive scheme, and to publish the list in a periodical readily accessible to mathematicians. If the librarians will give their aid, the minimum for which Dr. Muir appeals will be accomplished before the meeting of the International Congress in 1912.

The Writer of the Article.

Two Undescribed Giraffes.

A piece of tanned giraffe-skin in my possession, which I intend to present to the British Museum, indicates, apparently, an undescribed race of the netted giraffe (*Giraffa reticulata*) of Somaliland and British East Africa. That species is characterised by the markings taking the form of a coarse network of narrow white lines on a liver-red ground, the dark meshes being large and quadrangular on the neck, but becoming smaller and more irregular in shape on the body. There may be small white spots in the centre of the dark patches, which are otherwise uniformly coloured, even in adult bulls. In the piece of skin referred to above, which is from the forepart of the body, and came from British East Africa—probably the Kenia district—the white lines are rather wider and the dark areas smaller and brownish rufous, with a tinge of blackness, and a distinct blackish streak or star in the centre. For this giraffe, which in a slight degree tends to connect *reticulata* with the eastern forms of *camelopardalis*, the name *G. reticulata nigrescens* will be appropriate.

The second race is typified by a mounted adult bull from north-eastern Rhodesia, the skin and part of the skeleton of which were presented to the British Museum by Mr. H. S. Thornicroft, Native Commissioner of the Petauke district. This giraffe—a member of a single isolated herd—is characterised by the low and conical frontal horn, the grey colour and scattered spotting of the sides of the face, the chestnut-brown forehead, deepening into black on the tips of the horns, the absence of a distinctly stellate pattern in the neck and body spots, which are light brown on a yellowish-fawn ground, and the uniformly tawny colour of the lower portion of the limbs. This giraffe, which I propose to call *G. camelopardalis thornicrofti*, appears to be related to the Kilimanjaro *G. c. tippelskirchi*, but differs by the more compact frontal horn, the brown, in place of grey, forehead, and the uniformly fawn lower part of the legs, the latter being whitish in adult bulls, but fawn and spotted in cows and young bulls. I have to thank the trustees of the British Museum for permission to describe this specimen. R. Lydekker.

The Distastefulness of *Anosia plexippus*.

In "Essays on Evolution," p. 274, 1908, Prof. Poulton directed attention to the instance of mimicry amongst Lepidoptera supplied by the American Danaine, *Anosia plexippus*, otherwise known as *Danaida archippus*, and its mimetic species. It occurred to me, therefore, that it would be interesting to test the distastefulness of this butterfly. This I was enabled to do through the kindness of Mr. F. W. Frowhawk, who at my request sent me a newly emerged female on September 22 of this year.

The following are the results of my experiments. Two Indian shamas (*Cittocincla macrura*) in succession tasted it, but left it alone after one or two pecks. It was then taken by an Indian sibia (*Sibia capistrata*), which quickly dropped it. A red-vented bulbul (*Pycnonotus haemorrhous*) then pounced upon it, with the same result. A ground thrush (*Geocichla cyanonotus*) tried it, but soon left it. A mynah (*Gracula intermedia*) took it, but quickly let it fall. Two South African bustards (*Otis ludwigi*) persevered for a long time, but finally rejected it. A kagu (*Rhinochaetus jubatus*), a kind of rail or crane from New Caledonia, behaved in the same way, shaking his head after each peck. An Australian water-hen (*Tribonyx ventralis*) and a crow-shrike (*Barita destructor*) pecked it only once, the latter vigorously shaking his head and wiping his beak after the taste. A Cuban mocking-bird (*Mimus orpheus*) and a Brazilian hangnest (*Ostinops viridis*) attempted it, but after a few pecks gave it up. Finally, the mangled remains were eaten with much hesitation by a rufous tinamou (*Rhynchotus rufescens*). Whether the latter would have eaten it, if given the first refusal, it is, of course, impossible to say; but there is no doubt that the other birds found the butterfly highly distasteful. I was particularly impressed by its rejection by the two bustards, which on previous occasions have eaten some of the most unpalatable of British insects (see Proc. Zool. Soc., 1911, pp. 809–68).

The birds used for these experiments belong to tropical American, Asiatic, Australian, and African species, and were purposely selected from a variety of families. *Anosia plexippus* has, I understand, comparatively recently invaded the Old World from the New; and the result of the above-recorded experiments suggests that no serious barrier to its dispersal will be offered by insectivorous birds. If it succeeds in widely distributing itself it may, as a useful model, bring about marked mimetic changes in the Lepidoptera of the districts in which it settles.

The Zoological Society. R. I. POCOCK.

The Arithmetic of Hyperbolic Functions.

THROUGHOUT the books treating of hyperbolic functions, although elaborate series for their determination are given, the possibility of calculating them directly from their definitions, by means of common logarithms, is never suggested, and it would appear, therefore, that the merits of the direct method are insufficiently recognised.

If the hyperbolic functions of a quantity U are required, it is convenient, for purposes of writing and printing, to get rid of the exponential and to write $A=e$. Then $\log_{10} A = 0{\cdot}43429448\,U$, and A is thus found at once from a book of common logarithms. The functions can then be calculated by a slide-rule, or by logarithms, in the simple form

$$\cosh U = \tfrac{1}{2}(A + 1/A)$$
$$\sinh U = \tfrac{1}{2}(A - 1/A);$$

and similarly for tanh U, coth U, sech U, cosech U, and versh U—all in terms of A.

For example, calculate cosh 2 and sinh 2. Here

$$\log_{10} A = 0{\cdot}43429448 \times 2 = 0{\cdot}86858896;$$

A is therefore 7·389060, and 1/A is 0·135335. Hence cosh 2 = 3·76220 and sinh 2 = 3·62686

In the more general case the functions of a complex quantity $(U+i\theta)$ are required, and they have consequently to be expanded in terms of cosh U, sinh U, cos θ, and sin θ. So far as cosh U and sinh U are concerned, the direct method by common logarithms is still available, and the result is best dealt with in the form, for example,

$$\sinh(U+i\theta) = \tfrac{1}{2}\{(A - 1/A)\cos\theta + i(A + 1/A)\sin\theta\}.$$

The only real difficulty then left for the student is in ensuring that cos θ and sin θ are given their proper signs. That is to say, he must be clear regarding how many quadrants are contained in θ, how many degrees there are in θ beyond that number of quadrants, and the proper sign of cos θ and sin θ, respectively, in each quadrant.

In general, as is well known, if the functions are not required to a greater degree of accuracy than 1 in 10,000, it is permissible for all real values of U greater than 5 to write

$$\cosh U = \sinh U = \tfrac{1}{2}A;$$

and the direct method has obvious advantages. For values of U less than 8, Ligowski's excellent tables give sinh U and cosh U, proceeding by increments of 0·01 of U; but for practical purposes these 0·01 steps are too great, and "difference" columns have to be used. Consequently, to find the functions for values of U less than 5, where U is given to three or more places of decimals, it will usually be as quick and as accurate to adopt the direct method as to worry through the irksome arithmetic involved in estimating "differences."

In cable problems it is, as a rule, desirable to retain at least four significant figures for U.

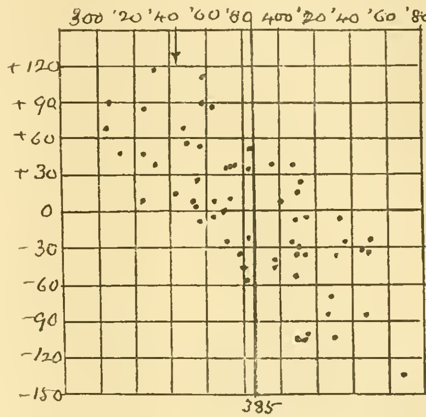
October 3. ROLLO APPLEYARD.

Hot Days in 1911.

BY a "hot day" will here be meant one with 70° or more. There are about seventy-seven of these at Greenwich, on an average, in the year. I propose to show how a method of forecasting recently described would apply to those days in 1911.

The series of annual numbers (1841–1910) is first smoothed with sums of five; then we compare, in a dot-diagram, each sum with the difference between it and the fifth after.

The last comparison before this summer was that between 324 (for 1903) and its difference with 335 (for



Comparison of hot day numbers, Greenwich.

1908), *i.e.* +11. Next we come to 343 (for 1904) and the position of the new dot (for 1909, representing the sum of 1907–11).

Placing an arrow-head at 343 in the horizontal scale, we might fairly expect the new dot to be above the zero line. Suppose, however, to be on the safe side, we say not below −10. Then 343 − 10 = 333. Now the four years 1907–10 yield 243, and 333 − 243 = 90. So that we might say the year 1911 was likely to have at least 90 hot days.

The actual number is 101.

The method may be commended, perhaps, for application to various weather items. ALEX. B. MACDOWALL.

Frequency of Lightning Flashes.

A LETTER on rainless thunderstorms in NATURE of August 31 leads me to ask if any accurate counts have ever been taken of the frequency of lightning flashes.

Watching a severe storm from my bungalow about a year ago, I made an attempt to separate and count the flashes—to the unassisted eye the lightning was as continuous as a flickering arc-lamp.

The only thing I could find to help me was a gramophone; I took its top works off, and on the horizontal disc I put one radial white chalk line. The speed of the disc was adjusted, by trial, exactly to 100 revolutions per minute, and the instrument was placed where the storm-light fell directly on it.

The appearance of the revolving disc was as if irregularly spaced phosphorescent spokes were being shown instantaneously in sections of various sizes in continually changing positions. It was difficult to estimate the number of separate streaks in one revolution, but I finally settled on eight as a fair average during the whole storm—sufficiently exact to show the order of figures being dealt with.

This works out at 800 flashes per minute, or, say, 50,000 an hour. H. O. WELLER.

Jamalpore (Dist. Mymensingh), E. Bengal,
September 19.

THE AUTOMATIC TELEPHONE EXCHANGE.

AT an ordinary or manual telephone exchange, as is generally known, the subscribers' lines terminate on "jacks," and are put through to each other by means of "plugs" and flexible conductors. The jacks, mounted on a suitable surface, form a "switchboard," and it is the business of the exchange operator to make the necessary connections and to sever them at the proper time, to answer calling subscribers and to ring up wanted ones. Large modern exchanges are worked on the common-battery plan; that is, no batteries whatever are placed at the subscribers' offices, but a large single battery is installed at the exchange, and this supplies all the current for speaking and signalling. The switchboard is of the "multiple" type. All the subscribers are brought to each division or section of the complete board; that is, all the subscribers' jacks in the entire exchange are repeated or multipled at each section, the latter forming a kind of unit of area representing the maximum reach of an operator. Every subscriber is thus within the reach of every operator. A simple "busy" test is arranged, so that before making a connection it can instantly be seen whether the required subscriber is free or already engaged at some other section. This grouping of the jacks, or "multiple" proper, is used only for ringing up and connecting to wanted subscribers. In addition, each operator has a certain number of subscribers brought to other—"answering"—jacks, placed in her immediate vicinity, and it is on these that calls from subscribers are received. At the subscriber's end everything is arranged with a view to simplicity. The signalling is automatic; that is, the subscriber has simply to lift his receiver and the exchange is called automatically, and when the conversation is finished the replacing of the receiver upon its hook advises the operator that the connection is to be severed.

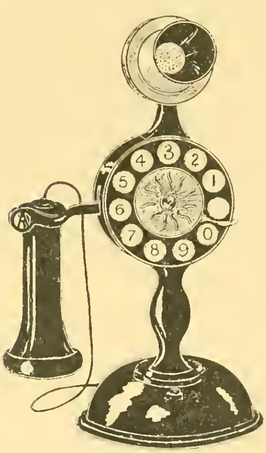


FIG. 1.—Subscriber's Telephone, with calling arrangement.

For automatic exchange working we have to substitute mechanism for the exchange operator, and the place of the large common switchboard is taken by a number of small individual switches, one of which is allotted to each subscriber and is entirely under his control. The plan which we are about to outline is the Strowger system, as applied to a small exchange of less than a hundred subscribers and operated on the common-battery plan. Other excellent systems are in use, but it is thought that some degree of detail of one system will be more useful than the statement of the main principles of several.

Considering the subscriber's end first. In addition to the usual speaking apparatus, transmitter, receiver, &c., we have the selecting and calling mechanism, as the subscriber has to "get through" to his correspondent by his own unaided efforts. Fig. 1 illustrates a "table set." In the central portion the figures 1 to 0 are arranged in a circle, and over them is a movable disc, perforated near the edge so that the figures, which are fixed, are visible through the holes. Suppose subscriber No. 58 is required. The receiver is first removed from its hook. A finger is then inserted in the hole through which the figure 5 shows, and the disc turned in a clockwise direction until a stop bars the way. This turning of the disc winds up an inner spring. The finger is then withdrawn and the spring carries the disc back again. In its return journey it causes one of the lines of the loop to be earthed (momentarily) five times, and at the

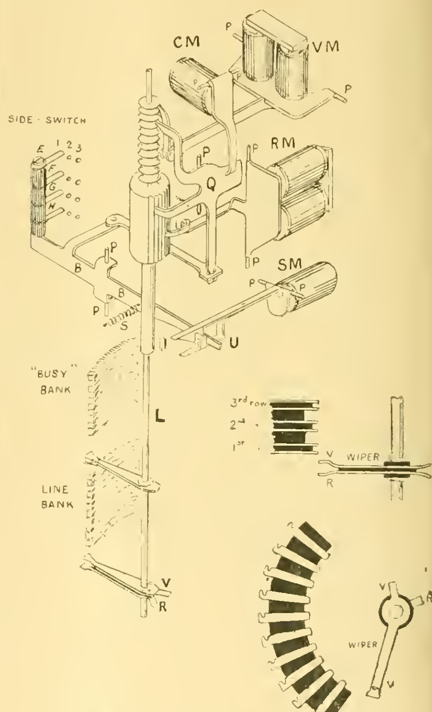


FIG. 2.—Details of Subscriber's Switch at Exchange.

end of this series the other line is earthed once. The finger is then inserted in the hole over the 8 and the disc brought round again—again winding up the spring. Its release and return to normal earths the first line eight times and then the second line once, as before. As the exchange battery is permanently on the lines, this earthing causes impulses of current to be sent over them by way of certain apparatus, and the calling subscriber is now through to No. 58 line. When any subscriber's receiver is on its hook, a magneto bell, in series with a condenser, is across the two lines. The calling subscriber now depresses a push-button, which action again earths the first wire of his own loop and actuates a relay at the exchange, which applies the generator to the required line.

After conversation, both subscribers hang up their receivers, this action momentarily earthing both wires of each loop. In the case of the originating subscriber, the effect of this is to "clear," and to restore to normal his mechanism at the exchange.

At the exchange end of each loop a separate switch is placed, the mechanical outlines of which are given in Fig. 2 and the electrical connections in Fig. 3. Considering the former, we have an upright steel shaft L which has on its upper portion a series of horizontal teeth, cut the whole way round the shaft. VM is an electromagnet having a pawl on the end of its armature, the latter being pivoted at PP. When VM is energised, this pawl lifts the shaft by means of one of the horizontal teeth. Below these teeth the diameter of L is much increased, and on the surface of the cylinder thus formed, a series of vertical grooves or teeth are cut. RM is another electromagnet, the armature of which, pivoted at PP, carries at its extremity a second pawl. When this armature is attracted L is forced round a tooth. The double pawl Q engages with both the horizontal and vertical teeth, and prevents the return of the shaft after its movements in an upward and rotary direction. Each of these two electromagnets is placed, in turn, in the local circuit of a relay at the required time, and whenever an impulse passes through VM the shaft L is raised a tooth, whilst an impulse through RM causes the shaft to be rotated a tooth. They are therefore termed the "vertical" and "rotary" magnets. CM is the clearing magnet; when this is energised, its armature strikes the double pawl Q and causes it to release the shaft. The latter, in its previous turning movement, winds up a spring, and on its release the spring brings it back, and by its own weight the shaft falls to its normal position.

At the lower end of L two arms are carried which, when desired, make connection with any one of a series or "bank" of contacts. The essential parts of these contacts and of the arms are best seen in the right-hand lower corner of Fig. 2. First we have a thin semicircular strip of fibre or other insulating material. On the upper surface of this ten thin strips of metal are placed radially, and on the under surface ten other similar strips are placed. To an upper and a lower metal piece the lines of each loop

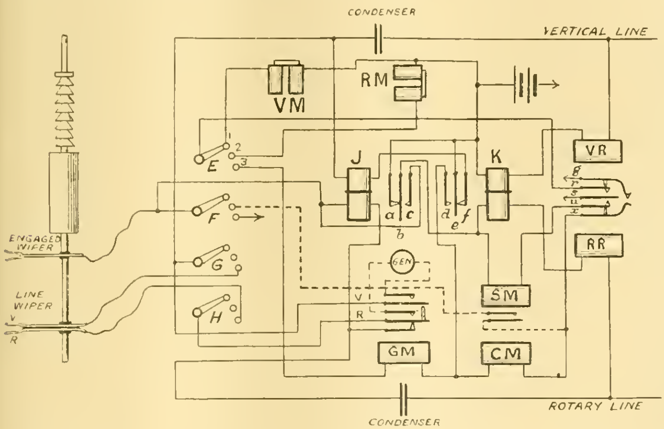


Fig. 3.—Subscriber's Switch—Connections.

are connected, so that one semicircular piece carries the twenty contacts of ten loops. Above this horizontal row of ten circuits a second, third, and tenth semicircular pieces are placed, each being separated from its upper and lower neighbours by further insulation. We have thus the contacts of a hundred loops arranged in ten layers of ten each.

As already seen, every subscriber has one of these switches, and the banks are all multipled together. That is, No. 58 line is brought to the fifty-eighth position on the banks of all the hundred switches constituting the exchange.

The two arms, or "wipers"—so called from their brushing or wiping action in passing over the contacts—each consist of two metallic strips, insulated from each other and from the shaft, the outer ends having a slight inward tendency, so that when they engage the two springs of a loop there is sufficient friction to ensure electric contact.

As will be seen from Fig. 2, there are two banks of contacts, one above the other, and two arms or wipers to engage with them. On the lower bank are the hundred loops as already detailed. The upper bank is employed for giving the "busy" signal. Its arm has the two contacts connected together, so that only a single connection is made in any one of the hundred positions. Like the lower bank, these are multiplied on all the switches of the exchange. There are indeed, two multiples, the line multiple and the "busy," or "engaged," multiple. In the normal position of the shaft the wipers are just to the left of the banks and just beneath them. When L is raised one, two, &c., teeth, the wipers rise to the level of the first, second, &c., row. A single rotary movement then brings the wipers to the first loop in the row; two three, or more rotary movements bring the wipers to corresponding loops on that horizontal level.

Returning to the upper mechanism of the switch. BB is an arm pivoted at PP, and carrying on its left a four-lever switch. On its right it engages with the escapement U, which is carried on a long extension of the armature of the switch-magnet SM. A spring S keeps the right-hand end of BB against U. When SM is actuated, the movement of attraction and release allows BB to slip forward one step in the escapement, and causes E, F, G, and H to quit their first contact and move to the second. The action of this "side-switch" is to bring the various pieces of apparatus into action at the required time. A second movement of SM allows BB to move forward another step in U and brings the side-switch into the third position. Any further movement of SM does not affect BB. When, however, the clearing magnet CM is actuated, the movement of Q restores BB to its original position, the escapement springs opening and allowing the right-hand end to pass. The side-switch thus returns to position 1.

The electrical conditions are shown in Fig. 3. VM, RM, CM, and SM are the electromagnets already described. VR and RR are the vertical and rotary relays, mounted side by side. The armatures of these when attracted act upon the contacts shown between them. If VR is energised, *g* is pressed forward together with *r*. The latter then makes contact with the centre spring *s*, but the movement is not suffi-

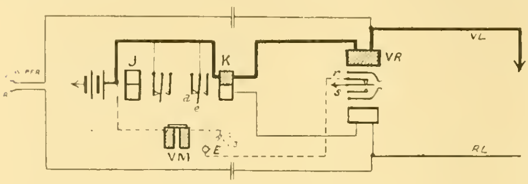


FIG. 4.—Earthing of Vertical Line.

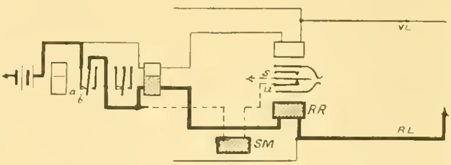


FIG. 5.—Earthing of Rotary Line.

cient to bring *g* and *x* together. When RR is actuated *x* is pressed forward, carrying *u* with it to make contact with *s*, but *x* does not reach *g*. When both relays are energised, *g* and *x* make contact in addition to the other two. Two other relays, J and K, are mounted together, and act upon the springs shown between them. Each of these two relays has two coils. If current circulates in one coil the armature responds: similarly if current flows in both coils in the same direction. If, however, the two currents are in opposite directions, they nullify each other's effects, and the armature is not attracted. The movement of J's armature breaks the contact between *b* and *a*, and makes a new one between *b* and *c*. Similarly with K: *e* breaks from *f* and makes with *d*. GM is the generator magnet. When this is actuated the two long springs move upwards, disconnecting from the lowest and bringing the generator on to the levers G and H of the side-switch, and thence (when in position 3) *via* the line wiper to the desired subscriber's line.

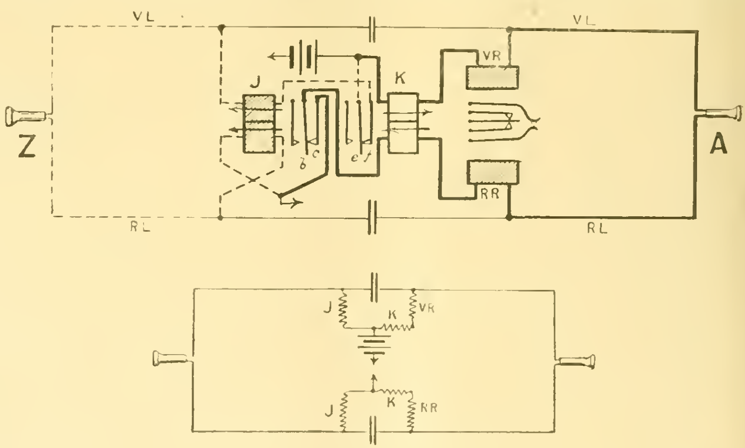


FIG. 6.—Two Subscribers "through."

We are now able to trace the results of the subscriber's call. He desired No. 58. By the first movement of his disc we saw that he earthed the vertical line five times and the rotary line once. Fig. 4 gives the result of this. By the earthing of the vertical line (as indicated by the arrow-head) a path, shown as a heavy line, is open to the battery from its positive pole through one coil of K and the vertical relay and line to earth. This current actuates both K and VR, as shown by the shading. The spring *r* being earthed at *s*, a second path, shown dotted, is open to the battery *via* VM and the lever E of the side-switch. The shaft L is therefore raised five teeth, corresponding to the number of current impulses passed over the vertical line. The earthing of the rotary line (once), as shown in Fig. 5 by the heavy line, actuates K by its lower coil and RR. The latter closes *s* and *u* and completes the circuit (shown dotted) of the switch magnet SM. This brings the side-switch into position 2.

The calling subscriber now inserts his finger in the eighth hole, brings the disc round, and then liberates it. The vertical line is then earthed eight times, and the rotary once. As the side-switch is in position 2 a circuit is open to the eight currents through the upper coil of K, VR, and the vertical line. K and VR are actuated, the latter connecting *r* and *s* and providing a second path from the battery through the rotary magnet, switch-lever E, and earth. The state of affairs is precisely as in Fig. 4, saving that RM is substituted for VM. The rotary magnet armature rotates the shaft (already on the level of the fifth row), and brings the wipers on to the eighth contact in that row. The final earthing of the rotary line repeats the operation shown in Fig. 5, and shifts BB another tooth in the escapement U, thus bringing the side-switch into position 3.

The wipers are now on the contacts of the desired loop and the calling subscriber depresses his push-button, which operation again earths the vertical line. VR is operated, and spring r making contact with s puts earth on the left-hand side of GM by way of switch-lever E (position 3). K also is operated by its upper coil, and the closing of its springs e and d brings the battery on the right-hand side of GM. The movement of GM's armature puts the generator (which is running continuously) on to the wipers, and thence to the required subscriber's (Z) loop, across which is placed his magneto bell, in series with a condenser. When Z replies, the current circulates through springs e, f, through the upper coil of J, round the loop, through J's lower coil, switch-lever F (position 3) to earth. J's two coils are now assisting each other, and spring b moves over to c. As b is joined to K's lower coil, this movement takes the battery from K's lower coil and puts on earth instead. The current now passes through K's upper coil, through VR, round A's loop, through RR and K's lower coil to earth *via* c. The currents in K, however, are opposing each other, so that the armature is not affected. The two subscribers are now "through," as in Fig. 6. The path traversed by the current on the left is shown by the dotted lines, and on the right by the heavy lines. The arrows through J and K show the direction through the separate coils, and the shading indicates the energised relays. The small skeleton diagram in Fig. 6 shows how the speaking circuit is made up. On Z's side the two coils

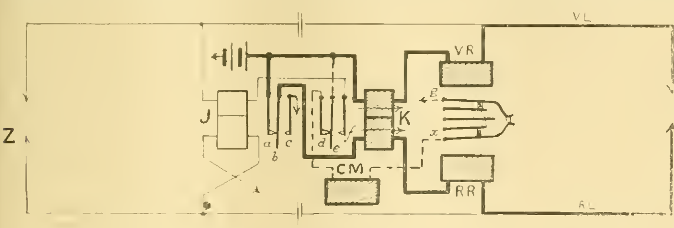


FIG. 7.—Clearing.

of J serve as impedance coils, whilst K's upper coil, plus VR and K's lower coil, plus RR, serve the same function on A's side.

On the conclusion of the conversation both subscribers hang up their receivers. In its passage downwards the switch-hook (momentarily) earths both the vertical and rotary lines simultaneously. The result of this action on A's part is that his rotary line is earthed at both ends. RR and the lower coil of K are thus short-circuited. K is then actuated by his upper coil, and by the movement of e from f to d current is cut off from J, which, ceasing to be energised, allows its armature to fall back. This causes b to leave c and return to a, substituting the battery for earth on the lower coil of K. Current now passes through both coils of K in the same direction, and thus continues to energise K, whilst both VR and RR being actuated, their outer springs make contact with each other and put earth on the right of the coils of CM, the clearing magnet. The other side of CM being connected with the battery through d e, the clearing magnet is energised. This is shown in Fig. 7, where the dotted line indicates the circuit of CM. The shaft is thus restored to its normal position and the circuits are cleared.

When a second caller attempts to get through to another subscriber who is already engaged, the following action takes place. As shown in Fig. 6 the earth on the left hand of J's lower coil is made by the lever F of side-switch in its third position. This puts earth on the "engaged" wiper, and through it on to all Z's contacts in the busy multiple. The new caller turns his disc twice in the usual way, thus getting on to Z's contacts in the line multiple. His (the newcomer's) side-switch, however, is still in position 2, so that, although his line wiper is on the required contacts, the wiper itself is still isolated. The final current over his rotary line causes RR and SM to be actuated. A contact on the latter (shown only in Fig. 3) is closed. The battery is already connected to the left hand of the newcomer's clearing magnet by means of his springs d and e. The closing of the contact on SM put the right-hand side of CM through to the earthed busy bank by way of lever F (position 2) of his own side-switch. His clearing magnet thus acts and his lever L returns to zero. By another contact (not shown) the busy signal from the generator is given over the newcomer's line, advising him that the required subscriber is engaged.

From the foregoing brief sketch it is hoped that the principle of working may be seen: the actual arrangements in practice involve large modification and extension. As only a certain percentage of the switches are in use at the same time, it is easily seen that it is unnecessary to provide one for every subscriber. A much simpler piece of apparatus, the "line switch," is therefore substituted, and only a comparatively small number of switches proper provided. The function of the first is simply to put a calling subscriber through to a disengaged switch—now slightly modified and called a "selector"—by which a certain group is selected. The subscriber having got through to the required group, now utilises a second switch, arranged practically as we have described and termed a "connector," through which he obtains access to the required correspondent. A still larger exchange will require a first selector, a second, &c., selector, and finally a connector. Taking the common case of an exchange with a maximum of 9999 subscribers: the line switch puts the caller through to a first selector, by which the thousands digit is selected. The hundreds figure is then picked out by the second selector, and the tens and units by the vertical and rotary movements of the connector.

ARTHUR CROTCH.

THE SUMMER OF 1911.

THE summer of 1911 has been remarkable in so many ways that without doubt it will receive the special attention of meteorologists, and will in course of time be dealt with very thoroughly, as it well deserves to be. Having for many years past kept touch with the published Greenwich weather records, a comparison of the present summer with the observations of the past seventy years, from 1841, may be of interest from one not officially attached to the Royal Observatory.

The exceptional character of June, July, and August lead naturally to the supposition that the summer proper, as limited to the three months, would beat all previous records in many ways, and this impression is amply supported by weather statistics.

The summer six months, April to September, can also claim a record so far as temperature is concerned. The mean temperature for the six months is

60·7°, which is the highest for any similar period since 1841. The next means are 60·6° in 1893, 60·4° in 1868, and 60·1° in 1865. These are the only summer six months with the mean temperature at Greenwich above 60°, and there has not been any summer with the mean temperature above 58° since 1901.

The following are the results for the several months:—

	Air Temperature			Rainfall		Sunshine
	Mean max.	Mean min.	Mean	Days	Total	Hours
	°	°	°		Inches	
April	55	39	47	13	1·75	150
May	69	47	58	9	1·88	212
June	71	51	61	12	2·11	224
July	81	56	68	3	0·26	335
Aug.	81	57	69	8	1·35	260
Sept.	72	50	61	8	1·34	234

The aggregate rainfall for the six summer months is 8·69 inches, which is more than 3·5 inches less than the average; there are several summers, comprised by the six months April to September as dry.

The mean temperature for the three summer months June, July, and August is 66·1°, which is 4·9° in excess of the average for the past seventy years; this is 1° warmer than any previous summer. The next warmest three summer months occurred in 1868, when the mean was 65·1°, and in both 1859 and 1899 the mean was 65·0°. August was the warmest summer month, the mean being 1° higher than in July.

The warmest days during the summer were as follows:—

Day	Temperature	Daily mean n excess of average
	°	°
July 21	94	15
,, 22	96	15
,, 28	92	14
Aug. 9	100	19
,, 13	91	14
Sept. 7	92	12
,, 8	94	13

There were in all during the summer seven days with a temperature above 90°, and the only other summer during the last seventy years with an equal number of warm days is 1868. In 1876 there were six days with the thermometer above 90°, whilst the only other years with as many as four such warm days were 1846, 1881, 1893, 1900, and 1906. There were forty-five days during the summer, from April to September, with the shade temperature at Greenwich above 80°, and previously the greatest number of such warm days was forty in 1868.

The absolute temperatures are very exceptional:—95·6° was recorded on July 22, which was the highest previously recorded at any period of the summer since 1841, with the exception of 97·1° on July 15, 1881, and 96·6° on July 22, 1868. The maximum reading of 100° at Greenwich on August 9 is 3° higher than any previous record at the Royal Observatory since 1841. On September 8 the shade temperature was 94·1°, which is higher than any previous reading in September, and the mean of the maximum readings from September 1 to 8 was warmer by 2° than the mean for any corresponding period since 1841. The mean maximum temperature for August is 81·1°, which is the first occasion of the mean of the highest day readings in August exceeding 80°.

The aggregate rainfall at Greenwich for June, July, and August is 3·72 inches, which is 2·80 inches less than the average. The only instances of a drier summer are 3·65 inches in 1849, 2·01 inches in 1869, and 2·50 inches in 1864. The driest month of the summer was July with 0·26 inch.

The periods of absolute drought were twenty-three days from July 1 to 23 and seventeen days from August 2 to 18.

There was an unusual amount of bright sunshine throughout the summer—the aggregate duration in the three months, June to August, was 819 hours, which is 189 hours more than the average for the last fifteen years.

The black-bulb thermometer exposed to the sun's rays exceeded 160° on July 22, August 4 and 9.

CHAS. HARDING.

A VULCANOLOGICAL INSTITUTE.

IN the *Nuova Antologia* of July 16, a copy of which has recently reached us, there is an interesting article by Mr. Immanuel Friedlander, in which he points out reasons which justify the attempt now being made to establish an International Vulcanological Institute. This is a matter to which we have already referred (see NATURE, April 6, 1911, p. 180). Among the many reasons why volcanoes should receive special attention is the fact that they bring to the surface fused silicates and other materials from the deeper parts of the crust of our earth which otherwise we should not be able to reach. Two lines of study are open to us. One is to investigate the phenomena presented by a given volcano, whilst the other is based upon the consideration of their geographical and geological distribution. In connection with this distribution we are told that the Atlantic and Pacific types of volcanoes differ in the chemical characters of their products. Attention is next directed to the fact that although many volcanoes follow faults or lines of weakness in the crust of the earth, examples are given of vents which seem to be independent of such lines.

The materials which have been erupted from selected volcanoes are enumerated in some detail. These fall under three heads, namely, materials which are Basaltic, Andesitic, and Trachitic, the quantities of silica in which are respectively 56, 60 and about 70 per cent. The volcanoes with the more acid lavas are the most irregular and violent in their activity. A curious feature connected with volcanic eruptions is that the nature of the material ejected is not necessarily constant. The first eruption from Panteleria was basaltic, after which materials which were andesitic together with acidic Liparites appeared. The last efforts at this island, like the first, revealed materials which are basic.

From the softening of glassware and the ignition of various materials, the temperature of the dust-cloud which was shot out laterally to destroy St. Pierre and its 30,000 inhabitants was estimated at about 600 or 800 degrees. The needle-like pinnacle which grew upwards from the crater of this mountain is compared with the one which in 1909 grew in the crater of Mount Tarumai in Yezo.

These, together with many other curious appearances and phenomena observed by the vulcanologist, suggest that much remains open for investigation.

One interesting section in the paper is a brief discussion of certain theories respecting the cause of volcanic action. It is pointed out that water could not pass to regions of heated rock through cracks or fissures. Suess considers that the aqueous vapour which escapes from volcanic vents represents water which reaches the surface of the earth for the first time, while Alfred Brun, of Geneva, denies the presence of water in volcanic eruptions. Stübel, who has worked amongst the volcanoes of Central America, holds the view that each volcano derives its materials from a special reservoir left in the crust of the earth during its solidification, but he does not explain why these reservoirs are arranged in chains or lines. With a few words respecting the part that radio-activity and the expansion of silicates in solidification may play in connection with volcanic action, the writer points to these various theories as indications of the uncertain and contradictory knowledge we possess respecting such phenomena. After a brief *résumé* of the investigations to be carried out at the new institute, the author tells his readers that the International Institute of Weights and Measures at Paris, that of Seismology at Strasburg, and that of Agriculture at Rome, have conferred upon those cities a great prestige. In like manner an International Institute of Vulcanology will be a new glory for Italy and for Naples.

J. M.

THE ARCHÆOLOGICAL DEPARTMENT OF INDIA.

LORD CURZON has done good service to the cause of archæology by his spirited protest published in *The Times* of October 7 against the change of system in regard to the ancient monuments of the country proposed by the Government of India. Up to the time when, as Governor-General, the attention of Lord Curzon was directed to this question, the State policy in connection with the excavation of sites of historical interest and the conservation of the Buddhist, Hindu, and Mahomedan religious and civil buildings was ill-considered and ineffectual. In the early days of our rule these buildings, which are due to the munificence of vanished dynasties or the religious devotion of their subjects, were usually neglected and often desecrated. Excavations were undertaken by unskilled workers in a haphazard way, and many objects of interest and value were lost or destroyed. Under General Cunningham as director, between 1870 and 1885, some useful excavations were carried out. But the result of the work as a whole was not commensurate with the expense which had been incurred.

When Lord Curzon took up the question in 1902, the department was reorganised under Mr. J. H. Marshall, a good scholar and competent archæologist, as director-general. Lord Curzon quotes many examples to show the urgent necessity of this course of action. At Lahore the exquisite Pearl Mosque had been converted into a Government treasury, the Audience Hall into a barrack, the Sleeping Hall of Shah Jahan into a church. The beautiful mosque at Ahmedabad was used as a revenue office; the pavilion at Selimgarh in the Agra Fort as a canteen; the marble pavilion of Shah Jahan at Ajmer as the Commissioner's dining-room; a fine mosque at Lahore as the office of the railway traffic superintendent; one at Mijapur as a dâk bungalow, another as a post-office; the gilded palace at Mandalay had been utilised partly as a church, partly as a clubhouse.

Under the new system such destruction and desecration were discontinued. Many beautiful buildings have been tenderly repaired. Museums have been opened at the chief historical cities, and whenever excavations have been conducted the scientific principles established by the work of Prof. Flinders Petrie in Egypt, the British School at Athens, and in many other places, have been followed. Mr. Marshall has published a series of progress reports which have been received with admiration by scholars in Europe and America.

Now it is proposed, from some petty considerations of economy, to bring to a close this admirable work, which costs 30,000*l.* *per annum* out of a revenue of eighty millions. The control of the head archæologist is to cease, and the provincial governments are to start again the inefficient methods of which we have had disastrous experience. These governments are habitually pressed for funds, and they neither possess nor can employ a staff competent to undertake the care of the ancient buildings or to conduct excavations.

Now that this proposed change of policy has been brought to the knowledge of the scientific world by the one man competent to express an opinion on such a subject, the result cannot be doubtful. The indignant protests of archæologists throughout Europe and America must compel the Indian Government to abandon these ill-considered proposals. It will be a bad omen for the future administration of India if, in the year when his Majesty the King-Emperor visits the country, a scheme which has commended itself not only to archæologists, but to the princes and rulers of India, is suddenly, without adequate reason, brought to an end, and the old system of neglect and maladministration re-established.

LOUIS JOSEPH TROOST.

BY the death of Troost, on September 30, at the ripe age of eighty-five, France loses the last surviving member of that group of workers—pupils of Henri Sainte-Claire Deville at the École Normale—who created, mainly under his inspiration and leadership, what was practically a new department of chemical science. Thermal chemistry, as we understand it to-day, may be said to have originated in mid-Victorian times. It may be urged that the relations of chemistry to heat are so intimate that the study of these relations is necessarily as old as the study of chemistry itself. But it was only at the beginning of the latter half of the last century that the subject of thermal chemistry was attacked. Systematically, and for the most part in France, at the instigation of Deville, who, with the aid of Troost, Debray, Isambert, Hautefeuille, and Ditte, laid the foundations of that imposing superstructure to which this special department of knowledge has now attained.

Troost, who was born in 1825, was educated at the Lycée Charlemagne. He entered the École Normale in 1848, becoming an assistant there in 1851, and receiving his doctorate of science in 1857. For some time he taught in the provinces, but ultimately took charge of the chair of chemistry at the Lycée Bonaparte at Paris, and then, in 1868, became Maître de Conférences at the École Normale. In 1874 he became a professor in the faculty of sciences of Paris, where he remained until 1900, when he retired. In 1884 he succeeded Wurtz at the Academy of Sciences. For many years he was a commander of the Legion of Honour.

Troost was an indefatigable experimentalist and a prolific writer. His published memoirs, either alone or in association with Deville, Marie-Davy, and Hautefeuille, number close upon a hundred. His earliest essays were in pure inorganic chemistry: he prepared and studied the salts of lithium, which, in the middle of the nineteenth century, was regarded as a rare element. By the student, however, Troost is mainly remembered by reason of his work with Deville on the determination of vapour densities at high temperatures, the study of which had received an enormous impetus on account of the applications of the doctrines of Avogadro and Ampère. The values so obtained have become classical and are to be found in practically every systematic treatise of chemistry. With Deville, he largely developed the conception of dissociation, and his memoir on the vapour density of chloral hydrate gave rise to a memorable controversy on the value of volumetric considerations in the determination of equivalents. In conjunction with Hautefeuille he followed Debray in elucidating the laws governing dissociation, the recognition of the fundamental phenomena of which we owe to Deville. In this connection we may cite the memoirs on the conditions determining the absorption of hydrogen by palladium, potassium, and sodium, the dissociation of the sesquichloride of silicon, and the transformations of cyanogen into paracyanogen, and of cyanic acid into cyanuric acid. With Deville he studied the porosity of metals at high temperatures, and with Hautefeuille the solubility of gases in metals.

Troost was a frequent contributor to metallurgical chemistry, and made important contributions to our knowledge of the parts played by silicon and manganese in determining the physical properties of the various forms of commercial iron. His treatise of chemistry, which originated out of his connection with the Sorbonne, has gone through innumerable editions, and for many years past has been a standard text-book to successive generations of pupils.

Troost, in spite of his advanced years, enjoyed excellent health up to a short time before his death. He preserved his faculties practically unimpaired, and was active and industrious to the last on the numerous commissions in which he took part, and more particularly on the Commission des Inventions at the Ministry of War, of which he had been president for some years past.

NOTES.

We notice with regret the announcement of the death, on October 7, of Dr. J. Hughlings Jackson, F.R.S., consulting physician to the London Hospital, at seventy-six years of age.

The Decimal Association announces that a weights and measures law, rendering the use of the metric system compulsory in Bosnia-Herzegovina, will come into force on September 1, 1912.

The Harveian oration will be delivered by Dr. C. Theodore Williams at the Royal College of Physicians of London on Wednesday next, October 18.

Recent progress in model or small-power engineering, both as a hobby and as a useful factor in technical education, will be demonstrated at the Model Engineer Exhibition—the third of its kind—to be held at the Royal Horticultural Hall, Westminster, on October 13–21.

We notice with regret that the death is announced, on September 25, in his sixty-eighth year, of Prof. Auguste Michel-Lévy, the distinguished geologist and member of the Paris Academy of Sciences.

The *Terra Nova* of Captain Scott's British Antarctic Expedition returned safely to Lyttelton, N.Z., on October 7. Lieut. Filchner, the leader of the German South Polar Expedition, left Buenos Aires a few days ago for the Antarctic in the *Deutschland*. It is announced from Sydney that the fund for Dr. Mawson's Antarctic Expedition now amounts to 43,000*l*.

Dr. J. H. H. Teall, F.R.S., director of H.M. Geological Survey, will take the chair at the first of the Selborne lectures of the season, to be held on Monday, October 16. The subject will be "The Evolution of Scenery," and the lecturer Mr. F. W. Rudler.

Dr. W. E. Adeney, of Dublin, who has devoted particular attention to questions of sewage pollution, has been invited by the Metropolitan Sewage Commission of New York to advise it in reference to the over-pollution of the waters of the harbour of that city. Dr. Adeney served as a member of the recent "Whisky Commission."

Dr. Wilhelm Dilthey, whose death is announced at the advanced age of seventy-seven, was professor of philosophy at the University of Berlin until 1905, when he resigned owing to ill-health. He held his chair as successor to Lotze, and had previously been professor of philosophy in Basel, Kiel, and Breslau. Although, perhaps, best known for his "Leben Schleiermachers," which brought him into notice in 1870, he published a number of other essays and books, some of which are of considerable philosophical importance.

In connection with the Exhibition of British Fisheries, &c., at Manchester, which was opened on Saturday, October 7, by his Excellency the Greek Minister, the Hull Museums Committee has an extensive exhibit of old whaling appliances, paintings, models, &c., of the old whaling ships. Mr. T. Sheppard, the curator, has issued an illustrated guide to the collection (32 pages, one penny) which is a useful account of the various weapons and tools used by the old Hull whalers. It is interesting to learn that both the present enormous fishing and oil industries at Hull have developed from the whaling trade.

The fifty-seventh report of the Postmaster-General on the Post Office, which has just been issued as a Blue-book (Cd. 5868), records that the number of radio-telegrams dealt with showed a satisfactory increase, the outward messages to ships reaching a total of 5640, as compared with 3266 in 1909–10, and inward messages from ships 34,161, as compared with 27,727, the total increase being 8808, or 28·4 per cent. During the year 97 licences, covering 107 land stations, were granted under the Wireless Telegraphy Act, and, with one exception, these were for experimental purposes. Connected with this subject, we notice the announcement in *The Morning Post* that the wireless telegraph station at Spitsbergen is now completed and ready for use. The machinery is working satisfactorily, and messages are received at Spitsbergen from Poldhu, in Cornwall, and communication is being established with the station at Ingö, in the north of Norway.

Coal is said to have been discovered on the estate of Sir Harry Verney, Bart., at Calvert, in Buckinghamshire, within fifty miles of London. It appears that exploratory work has been carried on intermittently for several years at this locality, and that a boring, which was sunk six years ago in quest of water, encountered coal-gas under pressure of about 60 lb. per square inch at a depth of 470 feet. Two bore-holes are now being sunk, and it is announced that one of them, after passing through an outburst of gas, reached coal at a depth of only 530 feet from the surface. Should this announcement be confirmed, it will justify the belief of those who hold that concealed coalfields may exist at workable depths between the Midland fields and those of Bristol and Somerset. So far back as 1877 a famous boring at Burford, in Oxfordshire, struck Coal-measures at a depth of 1184 feet, beneath a cover of Jurassic and Triassic rocks. At Batsford, in Gloucestershire, Coal-measures have likewise been found beneath Secondary strata.

At the monthly meeting of the Pharmaceutical Society, held on October 4, the president, Mr. C. B. Allen, handed the Hanbury gold medal and a cheque for 50*l*. to M. Eugène Léger, of Paris. The Hanbury gold medal is competed for every two years, and the winner receives also

50*l.* from a fund left by the late Sir T. Hanbury, brother of the late Mr. Daniel Hanbury, of whom the medal is a memorial. The council of the Pharmaceutical Society are the trustees of the fund, and the adjudicators the respective presidents of the Linnean, Chemical, and Pharmaceutical Societies and of the British Pharmaceutical Conference, together with Mr. Walter Hills. M. Léger is a member of the committee of revision of the French Pharmacopœia, and his work in connection with the chemistry of the active constituents of drugs is well known. A short time ago M. Léger was elected an honorary member of the Pharmaceutical Society.

THE trustees of Lake Forest University, Illinois, send particulars of the second decennial prize of 6000 dollars on the Bross Foundation. The prize was founded in 1879 by William Bross, of Chicago, as a permanent memorial of his son, Nathaniel Bross, who had died in 1856. Its object is to stimulate the production of the best books or treatises "on the connection, relation, and mutual bearing of any practical science, or the history of our race, or the facts in any department of knowledge, with and upon the Christian religion." The scope of the gift is so comprehensive that any phase of science, of literature, of human history, or of modern life that may throw light upon the Christian religion, or upon any phase of the same as it is received by the great body of Christian believers, would be a fitting theme for a book offered in the competition. The prize will be given to the author of the best book on any of the lines above indicated which may be presented on or before January 1, 1915. The manuscripts, accompanied by a sealed envelope containing the name of the writer, must be sent on or before the above date addressed to the President of Lake Forest College, Lake Forest, Illinois. It is requested that no manuscript be sent in before October 1, 1914. A copy of the circular containing all the essential conditions made by the deed of gift, or any further information desired as to this competition, may be obtained on application to President John S. Nollen, Lake Forest, Illinois.

A LECTURE on "Emotions and Morals" was delivered on October 4 by Dr. William Brown at the inauguration of the new session at King's College, London. In the course of his address, Dr. Brown said that modern theories of ethics are finding it more and more necessary to take account of the psychological nature of man in formulating their moral ideal. This is particularly the case with respect to the emotional side of consciousness, since it is in the emotions that all values reside. After rapidly reviewing the more important modern theories held as to the nature of the emotions, and their classification under the two main headings of simple and complex, and showing by a detailed analysis that love and hate are not emotions, but systems of emotional dispositions dominated by a fixed idea, he proceeded to sketch out the modern theory of *values* in its most general form, and to show (after Ribot) that the feelings have a logic of their own, distinct from, and not necessarily inferior to, that of pure reason, and that the logical primacy of pure reason over feeling, though generally held by the classical philosophers, is not by any means complete. In a digression on the psychology of music he discussed the intellectual "arabesque" theory of Hanslick and the more generally accepted emotional theory to which Schopenhauer and all the great creative musicians have subscribed, and stated his own view that music expresses a system of emotions *sui generis*, but in dynamic relation with the ordinary emotions, and is therefore of ethical importance. The imperative of duty may be expressed in the form, "Seek always the highest good," which would seem to be personality for ourselves and others.

The Times of October 4 announces the death, in September, at Bandra, a suburb of Bombay, of Lieut.-Colonel A. S. G. Jayakar, late of the Indian Medical Service, who when stationed at Muscat—latterly as surgeon-general—collected and presented to the British Museum during the last two decades of the nineteenth century a number of specimens of mammals, birds, reptiles, and fishes indigenous to the Oman district of south-eastern Arabia and the adjacent sea. When describing the mammals in 1894 (Proc. Zool. Soc.), Mr. Thomas remarked that Colonel Jayakar's collection was the first ever received from that district; it included a new and small species of thar (*Hemitragus jayakeri*), a genus of wild goats previously known only from India, and a new hare, while it also showed that the range of the Syrian hyrax extended to Oman. The birds included a new eagle-owl, described by Dr. Sharpe in *The Ibis* for 1886, and a new bee-eater, figured by Mr. Dresser in his monograph of that group. A fine skeleton of the short-beaked sword-fish (*Histiophorus brevirostris*), exhibited in the fish gallery at the British Museum (Natural History), was the gift of Colonel Jayakar, although there is no intimation of that fact on the descriptive label. Colonel Jayakar was born in Bombay in 1845, where he received the first part of his education; in 1867 he came to London, where, after taking the degrees of M.R.C.S. and L.R.C.P., he entered the Indian Medical Service, to which but few natives had been admitted up to that date. The greater part of his service was passed as residency surgeon at Muscat, where he remained for thirty years.

WE regret to announce the death of Dr. Joseph Bell, one of Edinburgh's distinguished surgeons. He was born in Edinburgh in 1837, educated at the Academy and University, and graduated M.D. in 1859, becoming soon afterwards resident house-surgeon under Prof. Syme. He thus followed the family tradition, for his father, grandfather, and great-grandfather had been surgeons. Dr. Bell became a Fellow of the Royal College of Surgeons of Edinburgh in 1863; in the same year he commenced to teach systematic surgery, and in the following year operative surgery. These courses were continued, with growing success, until 1878, when Dr. Bell was appointed senior acting surgeon in the Royal Infirmary. On his retirement he was made consulting surgeon, an appointment which he held to the last. Dr. Bell was one of the originators of the Royal Edinburgh Hospital for Incurables, and was surgeon to this, to the Eye Hospital, and the Royal Hospital for Sick Children, and consulting surgeon to many medical institutions in the city. He was the author of a manual of the operations of surgery, of useful notes on surgery for nurses, and of papers, describing some of his most interesting cases, published in *The Edinburgh Medical Journal*, of which he was editor for twenty-three years. For many years Dr. Bell was examiner in surgery in the Royal College of Surgeons, Edinburgh; for some time he was honorary treasurer, and later, for a period of six years, president, an office which his father had held twenty years previously. Dr. Bell was a man of strong and sympathetic personality, and was highly esteemed in the community in which he worked so zealously. He possessed to a remarkable degree the power of keen perception and of quick deductive reasoning; his surprising deductions from apparently trivial details suggested to Sir A. Conan Doyle, who was a student under Dr. Bell, the character of Sherlock Holmes.

Mr. R. Campbell Thompson, in *The Times* of October 9, has issued a further report on the excavations at Carchemish, which were started in the early part of the present year by Mr. D. G. Hogarth. The mound presents a record of continuous human occupation, beginning with that of a primitive race using flint knives, obsidian flakes, and hand-made pottery. These people were succeeded by the Hittites, who were enabled by the use of bronze weapons to overcome the primitive occupants of the site. Finally, in B.C. 717, the Assyrians captured the place, and bricks have been found inscribed with the title of "Palace of Sargon, King of Nations, King of Assyria." A remarkable result of these excavations is the discovery of numerous small pottery horses, which served some religious purpose or were used in some game. The Hittite sculptures already unearthed add considerably to our knowledge of the beliefs of that people, consisting of guardian door figures, winged lions, and protecting demons, like those of Assyria. A remarkable bas relief depicts the overthrow of an Assyrian, and proves that the latter race practised circumcision.

Prof. Boyd Dawkins, in *The Times* of October 6, remarks that the discovery of an ancient canoe on the edge of the Baddiley Mere, used for the water supply of Nantwich, reminds us that the recent drought offers an exceptional opportunity for the examination of the desiccated margins of all sheets of water in Great Britain. A similar protracted failure of rain in 1853–4 led to the discovery of numerous pile dwellings in Switzerland. Similar erections are found in considerable numbers in Ireland and in Scotland; but, so far, the discoveries of this kind in England and Wales are singularly poor. In the Lake District only one settlement of the Neolithic age, that on Ehenside Tarn, has been discovered. Wales has yielded one of doubtful age in the lake of Llangorse, Breconshire. There is one in the Vale of Pickering and the Marshes of Holderness, and in Norfolk one in Barton Mere and two near Thetford, all three of the Bronze age. If we add to these the three lake settlements at Glastonbury and Mere, the total amounts only to eight. Prof. Boyd Dawkins believes that careful search during this exceptional season, before the lake margins are covered by the autumn rains, would reveal prehistoric settlements in almost every county, and throw as much light on the daily life of the early inhabitants as the discoveries made elsewhere have done. It is not yet too late to seize the present unusually favourable opportunity for making these investigations.

The August issue of *The National Geographic Magazine* is largely and appropriately devoted to Morocco and Tunis. It includes an interesting article by Mr. G. E. Holt, American Vice-Consul General, describing two religious dances performed at Tangier. These displays are provided by two separate sects which have widespread influence, not only over Morocco, but in Algeria, Tunis, and even so far eastward as Egypt. One of these is the Aisawa, followers of the saint M' Hammed Bin Aisa; the second the Hamadsha, founded by Sidi Ali Bel Hamdush, a later and less influential body than the former. Each motion in these dances is a symbol of some phase of the Mohammedan religion or of one of the sectarian beliefs. One position, for instance, represents Islam on the defensive against Christianity; another the final triumph of the faith of the Prophet. Women share in these performances; and in one movement a male and female dancer bend down and tear the earth with their teeth, symbolising the Creation, when Adam and Eve lived on the fruits of the soil, an ideal of the simple life recommended to their descendants. These dances, well illustrated by photographs, describe an interesting phase of that active sectarian fanaticism which, in the near future, is likely to be a serious embarrassment to those European Powers which are at present engaged in adventures in North Africa.

We have received the September number (vol. i., No. 12) of *The Child*, a monthly journal devoted to child welfare, which completes the first year's issue. This number, which is well printed and illustrated, contains, among others, an excellent article by Dr. Mary Scharlieb on adolescent girls from the viewpoint of the physician. Valuable advice is given on diet, exercise, dress, and moral training for the adolescent girl.

Messrs. E. Leitz, Oxford House, London, W., have issued a circular respecting dark-ground illumination and ultra-microscopic vision. They direct attention to the fact that these methods of microscopical investigation, while often rendering visible objects which by ordinary illumination cannot be seen, do not enhance resolving power. The methods depend on the principle that brightly illuminated objects can be better seen on a black background than on one which is itself bright.

The *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* for July (T. 115, No. 7) contains a report by M. F. Grenet on porous porcelain filters, particularly the form known as the Pasteur-Chamberland. By osmotic pressure determinations, it is calculated that the pores vary in size from $1{\cdot}08\,\mu$ to $2{\cdot}16\,\mu$ ($\mu=0{\cdot}001$ mm.) as minima and maxima. Collodion tubes also form extremely fine-pored filters, capable of retaining ultramicroscopic particles. By using a porous porcelain filter tube as a support for the collodion tube, the "life" of the latter may be much prolonged; M. Grenet has had one in use for a year, and it is still perfect.

The variation of micro-organisms, particularly bacteria, is at the present time attracting considerable attention. Mr. Cecil Revis describes the artificial production of a permanent variety of *Bacillus coli* (*Centr. f. Bakt.*, 2te Abt., Bd. xxxi., 1911). It was obtained by growing a strain of *B. coli* in broth containing 0·05 per cent. of malachite-green. After fifteen subcultivations, at intervals of about three days, its power to produce gas (formerly active) in lactose, dulcitol, mannitol, and glucose was completely lost, but the capacity to produce acid was retained. With salicin, at first acid was formed, but after the treatment this substance was no longer attacked. Acid-formation and curdling in milk remained practically unaltered, as well as the characters of the growth on gelatin. The new physiological condition of the organism is quite permanent, and all attempts to reproduce the power of gas-formation have been unavailing.

A form of paralysis, particularly attacking certain muscles of the lower limbs in children, and known as infantile paralysis, has been the subject of much research by Flexner, Levaditi, Landsteiner, and others during the last two or three years. The disease is sudden in onset, and sometimes occurs in epidemics, and is due to an inflammatory condition of the large motor cells in the anterior horns of the grey matter of the spinal cord. In the *Revue générale des Sciences* for September 15 Dr. Levaditi gives a good summary of our present knowledge of the causation, &c., of the disease. It is infective, *i.e.* is due to a micro-parasite, which is so minute that it passes through the pores of a porcelain filter, and is hence beyond the limit of visibility with the microscope. The disease can be transmitted to apes, injection of material from a human case reproducing the disease in these animals.

In No. 1860 (vol. xli., p. 297) of the Proceedings of the U.S. National Museum Mr. C. W. Gilmore describes, under the new generic and specific name of *Brachychampsa montana*, a crocodilian skull from the Cretaceous of Montana. The specimen indicates an alligator-like reptile, distinguished from all other members of the alligator-group by the absence of a posterior expansion of the hinder part of the premaxillæ to roof over the front of the nares. There are fourteen pairs of upper teeth, five of which are borne by the premaxillæ.

A new species (*B. tener*) of the stegocephalian genus Branchiosaurus, from the Rothliegendes of north-western Saxony, is described by Mr. G. Schönfeld in the *Abhandlungen Ges. Isis* for 1911, p. 19. It is characterised by the gills persisting at least to a late period of life, by the slenderness of the bones of the middle of the roof of the skull, the presence of teeth on the vomers and palatines, and in the young state on the pterygoids, and by the small scales being marked with a radiating sculpture and concentric growth-lines.

The "Bibliotheca Geographica" for 1907 has been published by the Gesellschaft für Erdkunde of Berlin, having been edited, as in the preceding years, by O. Baschin. In size this most useful volume of reference remains about the same; a few changes in the classification have been made as experience has shown to be desirable, and this sixteenth volume fully maintains the high reputation of its forerunners as a most convenient and comprehensive guide to geographical literature.

In the *Mitteilungen der k.k. Geographischen Gesellschaft* of Vienna (Heft 8) a detailed account is given of the construction of a map from the photographs taken by Dr. Pietschmann during a recent expedition in Mesopotamia. An ordinary camera and stand, slightly modified to enable him to take rounds of views suitable for cartographical purposes, enabled him, it is claimed, to obtain material sufficient for producing a far more complete and accurate map than he could otherwise have done, and that without too great interference with his other occupations.

In the August and September numbers of *The Geographical Journal* Mr. J. C. Brauner discusses at some length the geological structure of Bahia and the form and position of the principal mountain ranges of this part of Brazil, in which he spent eight months in 1907 when studying the geology. The paper contains a great deal of interesting geological material, but, as a geographical description, lacks that coordinating treatment which is needed to give a full and explanatory account of an area.

Prof. Otto Nordenskjöld, in the September number of *The Geographical Journal*, discusses some questions of general importance relating to the nature of the Antarctic regions. The general orography of the north-western portion, which faces the South American continent, is sketched out, and the Antarctic climate and the character of its glaciation is considered, especially with reference to the influence of land-ice. The great masses of it which collect lower the summer temperature and tend to make that of winter somewhat milder, so that the land is gradually wrapped in ice, and vegetable and animal life is extremely sparse. Full discussion of such matters will appear in the course of the year in the geographical part of the results of the Swedish South Polar Expedition.

The Meteorological Chart of the North Atlantic Ocean for October, published by the Deutsche Seewarte, shows that at the beginning of September icebergs were seen in the Belle Isle Strait, and were still met with to the eastward on the ocean routes. A useful series of synoptic charts illustrates the very stormy weather which occurred between the Azores and the European coast from April 18–22, 1909, inclusive. It rarely happens that storms of hurricane force travel eastwards from the Azores in April. The monthly charts show that at this period depressions originating to the west of those islands usually take a northerly course. The disturbance in question travelled in an E.N.E. direction until April 21 at the rate of 400–500 miles a day, then struck northwards, joined an area of low pressure coming from N.W., and arrived off the south of Ireland early on April 22. The sudden and unexpected appearance of this storm is referred to in the report of the Meteorological Committee for the year ended March 31, 1910.

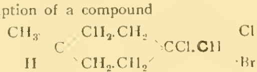
We have received the first four numbers of the Journal of the Washington Academy of Sciences, to be published semi-monthly except in July, August, and September, when monthly. The academy publishes a series of Memoirs, of which the first volume is dated 1866, the second 1884, the third 1885, and the remaining volumes at somewhat irregular intervals; these memoirs contain long papers. In 1899 a series of Proceedings was commenced containing papers shorter than those in the Memoirs, issued to members at intervals; at the end of each year these are collected into volumes, with indexes and title-pages. The present serial will replace the Proceedings, and is intended for shorter papers written or communicated by resident or non-resident members of the academy, for abstracts of scientific literature published in or emanating from Washington, for proceedings and programmes of the affiliated societies, and for notes of events connected with the scientific life of Washington. Parts i. and ii. (published together) contain 48 pages, and part iii. 56 pages. Many of the papers are of considerable interest, and extend over a wide range of subjects. The abstracts appear to be well done; the references give the name of the publication, the volume and pages of the beginning and end of the paper, and they are all from papers of the present year, indicating the desire to print the abstracts so soon as possible after the appearance of the originals. The Journal of the academy will be more useful both to residents and non-residents than the Proceedings of which it takes the place.

The July number of *Science Progress*, which was not received until last month, while particularly strong on the biological side, is sufficiently catholic in its articles to ensure that its readers have a wide and accurate knowledge outside their own special grooves. Dr. Waller, one of the advisory committee of the journal, proves that to Magendie rather than to Bell must be ascribed the discovery of the functions of motor and sensory nerves. Dr. Russell shows how the work of the Bureau of Soils of the United States Department of Agriculture has suffered materially owing to their neglect of the biological, as distinct from the chemical, processes going on in the soil. Prof. Bragg gives an outline of the facts of radio-activity, and shows that they force us to give up the idea of the impenetrability of matter.

Publication No. 149 of the Carnegie Institution of Washington consists partly of a reprint of a paper from *The Philosophical Magazine*, partly of new matter, and deals with a detailed investigation by Prof. C. Barus and his son of the conditions under which light produced by diffraction at a plane grating can be made to give interference fringes. The grating is mounted at one end and the eye-piece at the other end of a rod, the ends of which slide along tracks at right angles to each other, as in the

Rowland mounting for a concave grating. If a beam of parallel light from a collimator falls on a transmission grating, and is observed through a telescope after reflection, the spectrum is crossed by bands, which are due to the interference of rays diffracted at the grating surface and reflected from the back surface; rays transmitted through the grating surface without diffraction, then reflected and diffracted on their return; and, lastly, rays diffracted at the grating surface only. The authors develop the method, and produce an interferometer which is easily set up and possesses two degrees of sensitiveness, the higher corresponding to about half a wave-length of light.

AN interesting sequel to their observations on optically active substances containing no asymmetric carbon atom (NATURE, 1910, vol. lxxxvi., p. 93) is described by Profs. Perkin and Pope in the August number of the Journal of the Chemical Society. For this type of asymmetry they propose the name "centroasymmetric," and their last communication deals with the conversion of "centro-asymmetric" compounds into derivatives containing asymmetric carbon atoms, and *vice versa*. It is shown that, although two isomeric derivatives are sometimes produced, the optical activity of the compounds persists in all cases in which the molecule remains asymmetric. The models used by Prof. Pope in describing his observations to the Chemical Section of the British Association at Portsmouth are reproduced as photographs, the careful orientation of which makes them even easier to understand than the original solid figures. A point of considerable interest is the description of a compound



which owes its optical activity to an asymmetric atom linked to the three univalent radicles H, Cl, Br, the asymmetric carbon atoms of all active compounds described hitherto having been linked to at least two other carbon atoms.

A NUMBER of new uses of explosives in agriculture are described by Mr. F. H. Gunsolus in the Journal of the Franklin Institute for August. In the North-Western Pacific States dynamite is largely used for clearing land of tree-stumps; but a more novel application is to drill holes from 2 to 5 feet into the soil and to explode dynamite cartridges in them, in order to break up and loosen the subsoil. This process may be carried out on land where orchards have already been planted, the quantity of dynamite used varying from 25 to 100 lb. per acre. Explosives are also being used very largely in the Western States for digging ditches, especially in swampy clay ground. Slanting holes are punched at intervals of about 2 feet along the line of the proposed ditch; the middle hole is loaded with two or three cartridges, the explosion of which serves to detonate the charges in the other holes, with the result that a mile or more of ditch may be blasted simultaneously. The earth from the ditch is scattered evenly over the adjoining land, and the presence of stumps, trees, and underbrush interferes scarcely at all with the success of the operation.

A COPY of the October issue of the catalogue of second-hand instruments for sale or hire, by Mr. C. Baker, of High Holborn, London, has been received. The list contains particulars of more than 1500 pieces of apparatus, including a large selection of microscopes and astronomical telescopes. Customers unable to call at the showrooms to inspect pieces of apparatus can, on certain conditions, have them on approval for three days.

THE latest catalogue of general chemical apparatus and laboratory accessories issued by Messrs. A. Gallenkamp and Co., Ltd., of Sun Street, Finsbury Square, London, E.C., is likely to become a much consulted work of reference in chemical laboratories. The profusely illustrated volume runs to 800 pages, and provides full particulars, conveniently arranged, of all apparatus required for general use in the laboratories of every grade of educational institution, and those of industrial works where apparatus for research is employed.

OUR ASTRONOMICAL COLUMN.

BELJAWSKY'S COMET, 1911*g*.—From positions determined on September 29 and October 1 and 3, Dr. Kobold has calculated the following elements for the orbit of comet 1911*g*, which has now become an object for evening observations:—

$$T = 1911, \text{ October } 10{\cdot}196.$$
$$\left.\begin{array}{l}\omega = 71^\circ\ 39' \\ \Omega = 88^\circ\ 44' \\ i = 96^\circ\ 38'\end{array}\right\} 1911{\cdot}0$$
$$\log q = 9{\cdot}4823$$

From the ephemeris derived from these elements we give the following:—

Ephemeris 12h. Berlin Midnight.

1911	α (true) h. m.	δ (true) ° ′	log r	log Δ	mag.
Oct. 12 ...	13 37·6 ...	+8 59·1 ...	9·4931 ...	0·0051 ...	2·4
,, 14 ...	14 1·0 .	+6 30·3 ...	9·5190 ...	0·0201 ...	2·6
,, 16 ...	14 21·2 ...	+3 43·9 ...	9·5545 ...	0·0375 ...	2·9
,, 18 ...	14 38·5 ...	+0 54·3			
,, 20 ...	14 53·2 ...	−1 52·6 ...	9·6355 ...	0·0752 ...	3·4

The calculated magnitude at perihelion was about 2·3, but, owing to the rapid increase in distance, from both the sun and the earth, it is decreasing rapidly, and with the decreasing northerly declination the object is becoming a difficult one to observe; as the tail is approximately vertical, however, it may be possible to observe it, low down in the west, after the head has set, as was done in the case of comet 1910*a*.

Observations show that the tail, unlike that of Brooks's comet (1911*c*), is of the broad parabolic type often associated with great comets and small perihelion distances.

According to a *Times* communication, Mr. Hinks observed the comet between 16h. 30m. and 16h. 45m. on October 5, and estimated the magnitude of the nucleus as 3·5; only about 2° of the tail was visible. He also saw a strong zodiacal light just before dawn.

A tail 15° long was seen by Prof. Nijland, at Utrecht, on October 1.

QUÉNISSET'S COMET, 1911*f*.—The following is a further extract from Dr. Ebell's ephemeris for comet 1911*f*, which is still observable throughout the earlier part of the night:—

Ephemeris 12h. M.T. Berlin.

1911	α (true) h. m.	δ (true) ° ′	log r	log Δ	mag.
Oct. 12 ...	15 33·1 ...	+38 19·3 ...	9·9903 ...	0·0252 ...	6·7
,, 14 ...	15 35·2 .	+35 11·9			
,, 16 ...	15 37·0 ...	+32 14·4 ...	9·9707 ...	0·0499 ..	6·7
,, 18 ...	15 38·5 ...	+29 26·4			
,, 20 ...	15 39·8 ...	+26 47·5 ...	9·9519 ...	0·0754 ...	6·8

All these positions lie near to a line joining μ and δ Coronæ, the comet's apparent path lying almost due south.

BROOKS'S COMET, 1911*c*.—Brooks's comet passed the sun on October 12, and became a morning comet; as shown in the following abstract from Dr. Kobold's ephemeris, its apparent path now lies through Coma:—

Ephemeris 12h. M.T. Berlin.

1911	α (true) h. m.	δ (true) ° ′	log r	log Δ	mag.
Oct. 11 ...	13 10·8 ...	+30 2·5 ...	9·7970 ...	9·7899 ...	4·3
,, 13 ...	13 2·6 ...	+27 10·7			
,, 15 ...	12 55·4 ...	+24 14·5 ...	9·7583 ...	9·8178 ...	2·8
,, 17 ...	12 49·1 ...	+21 16·1			
,, 19 ..	12 43·9 ...	+18 15·5 ...	9·7241 ...	9·8498 ...	2·8
,, 21 ...	12 39·7 ...	+15 13·1			

The last four lines are taken from Dr. Ebell's continuation of the ephemeris, which appears in No. 4528 of the *Astronomische Nachrichten*.

THE SYDNEY OBSERVATORY.—In these columns on March 23 (vol. lxxxvi., p. 122) we expressed regret that the proposal to reorganise the New South Wales State observatory was not being taken up by the Government of that State. We now learn from a Sydney correspondent that at last the Government has agreed to the proposal, and has issued instructions for the appointment of a State astronomer, who is also to be professor of astronomy in the Sydney University; at present, we understand, there is no chair of astronomy in Australia.

In making this appointment, the Public Service Board is acting with the University authorities, and they have fixed the salary at 800*l*. per annum, with 100*l*. for quarters; the professorship will carry with it the usual pension allowance.

The first duty of the new State astronomer will be to organise the erection and equipment of a new observatory, for, as we pointed out previously, the present site is condemned; and since the death of Mr. H. C. Russell the work has, despite the untiring efforts of Mr. Raymond, fallen seriously into arrears.

The intended appointment is about to be advertised, and will, we understand, be dealt with by an influential committee in London. When this is done, and the Federal Government has organised its proposed Solar Physics Observatory at the new capital, it is hoped that astronomy will again flourish in Australia; meteorology has already been taken over by the Federal Government.

A NEW MINOR PLANET.—Advices from Vienna announce that Prof. Palisa has discovered a new minor planet which, having an increasing right ascension at opposition, may prove to be another object of the Eros type. The position on October 3 is given as

$$\text{R.A.} = 0\text{h. } 42\text{m. } 5\text{s., dec.} = +0^\circ\ 15'\ 38'',$$

and on October 4 was

$$\text{R.A.} = 0\text{h. } 43\text{m. } 59\text{s., dec.} = -0^\circ\ 17'\ 49''.$$

In No. 4528 of the *Astronomische Nachrichten* Prof. Palisa gives the daily motion as +2m. 8s., −32′, and the magnitude as 12·0. The advance in R.A. is greater than that of Eros at opposition, so that it may prove that the new planet, 1911 MT., approaches nearer than does Eros. It would appear that the orbit has a great eccentricity, and that the planet is near perihelion.

NEW WATER SUPPLY WORKS.

THE town of Birkenhead, containing a population of 120,000 inhabitants, at present depends for its supply of water on local sources; the wells in the Wirral Peninsula, however, are liable to salt water filtering from the sea and rendering the supply brackish. The Corporation of Birkenhead so far back as ten years ago realised that the condition of the water supply was not satisfactory, and appointed a committee to inquire as to a source from which a purer supply could be obtained. After a long inquiry, and acting on the advice of their consulting engineer, the late Mr. Deacon, a site was selected in Wales, fifty miles distant, which involved the construction of a large reservoir in the Denbighshire mountains on the River Alwen, a tributary of the Dee. In 1907 an Act was obtained conferring the necessary powers for carrying out the scheme and borrowing the money required. A few days ago these works were inaugurated with some ceremony by the Mayor and Corporation, a large granite block being fixed in one of the masonry piers of the dam now in course of construction, the contract for which has been placed in the hands of Messrs. McAlpine and Co. The amount of the contract for the reservoir is 186,153*l*. This dam is 1250 feet above sea-level; its length is 458 feet, and height 90 feet. The reservoir will be three miles long and about 350 yards wide, and will hold three thousand million gallons of water. The area of the ground from which it will be supplied covers 6300 acres, part of which is covered by peat, which in some places is 20 feet deep. This will all have to be removed. The average rainfall over the district is 51 inches, and the estimated average yield of water eleven million gallons a day. At the present time a large staff of men is employed on the works, about 400 being housed in wooden huts erected for the purpose. The water is to be conveyed to Birkenhead through steel and iron pipes varying in diameter from 20 to 30 inches. The estimated total cost is $1\frac{1}{4}$ million pounds. The works have been designed and are being carried out under the direction of Sir A. Binnie and Co., who took the matter up after the death of Mr. Deacon.

At Lincoln on October 4 was inaugurated with much ceremony, including a service at the Cathedral, the opening of the new waterworks which have been constructed for supplying the city with a pure supply of water. A few years ago Lincoln was afflicted with a very serious outbreak of typhus fever, the cause of which was traced to the pollution of the water in the River Witham, from which the supply was then obtained, and water for drinking purposes had for some time to be brought by railway in tanks. After much inquiry it was found that an entirely fresh source must be obtained. Boring in the locality was first tried, and, after sinking to a great depth and encountering considerable difficulties and delay, although a plentiful supply was reached, the quality of the water was not sufficiently good for use, and had to be abandoned. Parliamentary powers had then to be obtained for authorising the works now completed. The water is obtained from the pebble beds in Nottinghamshire at Eckersley, near the River Trent, at a depth of 500 feet below Sherwood Forest, the distance from Lincoln being twenty-three miles, the mains being carried across the river by a bridge built for the purpose. The water is raised from four boreholes 570 feet in depth, and pumped into 21-inch mains by engines of 500 horse-power, capable of raising 3,600,000 gallons a day. The machinery is all in duplicate, so as to provide against any accident that may occur. The total cost of the work is about 230,000*l*. The whole of the scheme has been carried out under the direction of Mr. McBarron, the city waterworks engineer.

PRECIOUS STONES.

THE chapter on precious stones which Dr. G. F. Kunz contributes to vol. xix. of *The Mineral Industry*, dealing with mining operations in 1910, contains, in addition to statistics of output, prices, and sales, much of general interest. Two-thirds of it is occupied with diamond. The main shaft of the Kimberley Mine has reached the considerable depth of 3527 feet. The extreme variation in the quality of the stones from the different mines is evinced by the average price per carat; thus 85*s*. is obtained for the stones from the Vaal River diggings, and 45*s*. from the De Beers group, while the Lüderitz Bay stones realise 26*s*. 6*d*., and the products of the Premier Mine only 14*s*. per carat. The occurrence of microscopic diamonds in decomposed olivine, with enclosed chromite, at Olivine Mountain, in the Tulameen River, Yale district, British Columbia, is of considerable scientific interest, though of no commercial importance. Students of political economy will be interested in the means whereby the powerful International Diamond-cutters' Union, with an income of about 3000*l*. a week, maintains a high level of wages. Apprentices are selected from sons of members of the union only, and their number is restricted to 5 per cent. of the whole. The great difference in price between manufactured and natural rubies calls for the note of warning that the qualifying term—scientific or artificial—demanded by law is sometimes inconspicuously written on the invoice. A specimen, weighing $98\frac{1}{2}$ carats, of the pink beryl, morganite, was discovered in Madagascar, and a magnificent aquamarine in Brazil; Madagascar is also supplying fine tourmalines. Unworked deposits of peridot have been found in the islands Rahamah and Kad-Ali, in the Red Sea. It is curious to learn that peridots have been dug up at Alexandria, where apparently they had been buried some 1500 years ago in the foundations of the houses in the belief that they would add to their stability. The best means for preserving the pearl-mussel is being studied at the station recently provided by Congress at Freeport, Iowa, U.S.A.

MATHEMATICS AND PHYSICS AT THE BRITISH ASSOCIATION.

The address of the president of Section A, Prof. H. H. Turner, has been already printed in this journal (August 31, p. 289).

Cosmical Physics and Astronomy.

The address was followed by a meteorological paper by Prof. W. J. Humphreys (of the U.S. Weather Bureau) on the earth as a radiator. Since our climates are not now perceptibly growing either colder or warmer, the total amount of heat received by the earth is substantially equal to the loss during the same time. But this statement does not apply to limited regions; and therefore to map the earth as a radiator it is necessary first to obtain temperature records within the isothermal region, where radiation alone is the controlling factor. From the experimental results the author deduces that the outward radiation is least near the equator, where the inward radiation is greatest, and greatest in temperate latitudes, a secondary minimum at the pole being indicated by the ascents in high latitudes. In the discussion it was pointed out that the results depend largely on the assumption that the atmosphere acts as a "grey" body. The values might be subject to considerable correction for irregularities in the absorbing power for different spectral regions. Dr. Shaw directed attention to the need for examining the influence of different thicknesses of water vapour in the atmosphere, and considered that reflection from cirrus clouds would introduce a considerable disturbing influence. A suggestion by Prof. Hicks that possibly the results were a consequence of the preponderating amount of ocean near the equator was met by Dr. Humphreys replying that the same results were obtained over ocean as over land.

Mr. L. Vegard, of Christiania, contributed a suggestive paper on the radiation producing aurora borealis, in which he starts from Birkeland's view that auroræ are caused by electric solar radiations, and endeavours to deduce the properties of these radiations. From the form and structure of the luminosity he infers that the electric radiations behave as though they are α rays. It is found, from the relation between range and velocity, that α rays will get down to heights varying between 70 and 300 km., which agrees with observations. Further, calculations show that α rays will strike the atmosphere at an angular distance from the magnetic axis of about 17°, which gives the right position of the auroral zone. The equidistant bands so characteristic of the draperies he explains by assuming groups of homogeneous rays, starting under the same initial conditions, such as would be provided by radium and its disintegration products in the sun. The author made a strong case for his explanation of these interesting phenomena.

Dr. W. N. Shaw communicated an account of the thunderstorms of July 28 and 29. The London storm on July 28 was accompanied by a squall of wind which reached fifty-four miles an hour at South Kensington, and the storms on July 29, which occurred over nearly the whole of England and Ireland, were preceded by violent squalls which raised clouds of dust, particularly noticeable in South Wales. At Watlington (Mr. W. H. Dines) the disturbance occurred while the passage of a depression was in progress, and the barograph curve took an M form instead of the usual ✓. The records of temperature, wind direction, and rainfall have still to be examined with the object of tracing the physical processes underlying the disturbance.

In the same department Commander Campbell Hepworth communicated a paper on the effect of the Labrador current upon the surface temperature of the North Atlantic, and of the latter upon the air temperature and barometric pressure over the British Isles. The purpose of the paper was to show the importance of the Labrador current in modifying the influence of the Gulf Stream.

Dr. Shaw showed models representing air currents up to heights of 10 kilometres which had been obtained from the observations of pilot balloons made at Ditcham Park by Mr. Cave. The models showed some of the types of motion which occur, and were very instructive to those unfamiliar with the details of upper-air observations.

Dr. Humphreys read a paper on the water vapour in the atmosphere on clear days, a quantity of great importance in the determination of the solar constant. He found a value of 87 per cent. of the value found by Hann from observations made in all kinds of weather.

Mr. Gold gave a brief account of the results obtained from the ascents in Ireland, undertaken by the committee for the investigation of the upper atmosphere. Three successful ascents had been made from Mungret College, Limerick, in the present year, and on July 6 values for the temperature had been obtained up to 21 km.

Dr. Dickson put forward the suggestion that the treatment of general atmospheric circulation might be simplified by taking the equatorial circulation to form a system by itself. It was pointed out in the discussion that general dynamical considerations rendered such an hypothesis untenable.

Mr. Craig read a paper by Dr. Ball and himself on the use of diagrams in the classification of climate. The diagrams dealt with temperature and humidity, and showed the annual course of these elements by a single closed figure for each of a selection of places from different parts of the world. The shape and orientation of the figure varied with the climate, and showed at once its principal features. Mr. Craig pointed out how they could be used not only by the man who was considering his health, but also in connection with such problems as cotton-growing.

Prof. J. Milne presented the sixteenth report of the committee on seismological investigations. Of the many interesting things in this report we may instance the observations on tidal load at Ryde in the Isle of Wight. By means of an instrument installed in a cellar in the Royal Victoria Yacht Club at Ryde and with its boom oriented east and west, a 10-foot tide in the Solent is found to produce an angular deflection of 0·85″. At Bidston a 10-foot tide gives at a distance of two miles a tilt of 0·2″. A curious feature of the Ryde photograms is the flatness of many of the crests and hollows of the deflections, which seems to indicate that from time to time the water remains high (or low) for several hours. When the boom was pointed north, or toward the advancing and retreating tide, the resulting photograms were practically straight lines.

Prof. H. H. Turner read a note on the periodogram of earthquake frequency from seven to twenty years, in which he investigated by Schuster's methods the possibility of periodicities in earthquakes, making use of the data in the "Catalogue of Large Earthquakes" recently edited by Prof. Milne. Within the range of periods examined, the only chance of a real periodicity is one of nineteen years, suggesting a nutational effect depending on the moon's nodes.

A paper by Mr. F. Napier Denison, on horizontal pendulum movements in relation to certain phenomena, was read by Prof. Milne, who also read one on the solar cycle, the Jamaica rainfall, and earthquakes cycles, by Mr. Maxwell Hall, dealing with observations extending from 1870 to 1910. Excepting a rainfall minimum in 1875, the minima for rainfall follow sun-spot maxima and minima by 1½ or 2 years. The rainfall maxima are more irregular. The earthquake maxima follow solar maxima by 2 years, while the minima follow solar minima by 2 or 3 years. Prof. O. Pettersson followed with a very interesting paper on parallactic tides set up in the bottom layers of the sea by the moon (see report of Section E).

Stellar Distribution.

The proceedings on Tuesday, September 5, commenced with a discussion on stellar distribution and movements, opened by Mr. A. S. Eddington, who stated that in attempting to form a conception of the structure of the universe as revealed by modern researches, we have to take into account the following principal phenomena. The great mass of the stars are distributed in a lens- or bun-shaped system, in which our sun occupies a nearly central position; round this, and in the same plane, are coiled the clusters, which make up the Milky Way. In the central parts of this the stars form two great streams moving in opposite directions; this is most easily explained as being the result of two more or less independent systems of stars having become intermixed. We have also to take note of "moving clusters," that is, groups of stars widely separated in space, which have almost identical motions, and are thus clearly connected in their origin. A whole class of stars, those of the helium type of spectrum, are exceptional, as they do not show the phenomenon of the two star-streams, and have very little motion of any sort, individual or systematic. This is perhaps due to the fact that they are extremely remote, and lie beyond the region through which the star-streams prevail. Finally, there is the recently discovered connection between spectral type and linear motion; the later the type of spectrum (as regards evolutionary development) the greater the average speed of the stars.

By considering the stars known to have a parallax greater than 0·2″ (seventeen in number), some important results are illustrated, notably the sparsity with which stars are distributed in space, the very heavy proportion of binary systems, the very different degrees of intrinsic brightness of stars, and the fact that the relative frequency of the different spectral types as seen in the sky is utterly misleading as an indication of their abundance in space. The publication by Prof. Boss last year of more than 6000 well-determined proper motions of stars distributed over the whole sky has greatly assisted investigations of the two star-streams. The bipolarity of the stellar motions is very clearly shown in the new data. Besides the theory of two star-drifts, an ellipsoidal theory, and more recently a three-drift theory, have been employed to represent the distribution of velocities. The theories have much in common, and it will be very difficult to distinguish between them. An attempt has been made to arrive at the law of velocities directly from the observations, without recourse to a particular theory; but the work, which involves an integral equation, has presented some difficulties, and is not yet completed.

The remarkable result that a star's motion appears to increase with its age, apparently implying that a star is born with practically no motion, leads us to inquire into the causes which produce stellar motions. From the consideration of the moving clusters it appears that the chance approaches of neighbouring stars have no appreciable effect, and the cause must be the resultant attraction of the whole mass of stars—a solution which, however, is not without its difficulties. Dr. Halm has suggested a law of equipartition of energy among the stars implying that the dependence of velocity is not really on the spectral type, but on the mass of the star; it seems that the stars of later types are progressively less heavy than those of early type. A third possibility is that distance from the centre of the stellar system is the determining cause. The hypothesis has recently been revived that the stellar system forms a spiral nebula similar to the thousands of spiral nebulæ in the sky. This theory, though highly speculative, appears to represent fairly well the observed distribution of the stars and the Milky Way, and the double-branched spiral form presumably involves motion in two opposite directions in the centre of the system similar to that presented by the two star-streams.

During the subsequent discussion Prof. Turner exhibited a model of the Ursa Major "moving cluster," specially showing that the component stars were nearly in one plane. Mr. A. R. Hinks emphasised that at present we are only getting at the central parts, and we do not know what fraction this part bears to the whole. In reference to the bun-shaped system, he considered that absorption of light had not been taken account of as it should be. He thought the spiral nebula conception was unnecessarily grandiose; he did not think that the star clouds of the Milky Way were well represented by the arms of a spiral nebula, as the latter seemed generally to be gaseous. He questioned whether anyone had yet explained the dynamics of the spiral motion in a nebula. He considered it premature to assume that there were not more than seventeen stars with parallax greater than 0·2″. He also criticised various points in nomenclature; in particular, the term star-cluster was being used in two senses.

The Astronomer Royal (Prof. F. W. Dyson) emphasised the value of the information given by measured parallaxes and the importance of making more determinations. The real difficulty is a lack of a knowledge of the actual distances of stars. He thought that the best way was to try to explain the velocities of stars gravitationally, and alluded to Lord Kelvin's satisfactory attempt in this direction to connect the total mass of the stars with the observed velocities. Prof. Turner and Mr. F. Bellamy explained the work done at Oxford in determining large proper motions; these were (unlike the stars as a whole) distributed nearly uniformly round the sky, the slight excess being in directions at right angles to the Milky Way. Father Cortie asked if there was not a contradiction in the fact that whereas the later-type stars had the larger velocities, yet they were relatively more abundant in the slow-moving drift than in the fast one. Mr. S. Stratton pointed out the anomalous position of the planetary nebulæ; their large velocities would place them at the end as the last stage of evolution. Mr. H. Hilton asked whether the velocity would not be least at the centre of a system of stars and increase outwards.

Mr. Eddington, replying to Prof. Turner, explained that the excess with large proper motions at right angles to the Milky Way was due to the solar motion coming in with greatest effect there in the Oxford zone. Replying to Mr. Hilton, he explained that he had regarded the stars not as moving in orbits, but as moving from outside to inside, and *vice versa*. Replying to Father Cortie, he explained that it is the individual motions of later-type stars that are greatest, as distinct from the drift motions.

Father Cortie and Mr. J. H. Worthington gave some particulars in regard to endeavours to view the recent eclipse.

The programme for Wednesday, September 6, contained two papers by Mr. S. Stratton, which in his enforced absence had to be taken as read. One of these, on an unusual meteor observed at Portsmouth on August 31, described a meteor with an apparent path in the form of a letter J, which probably arose from foreshortening accompanied by swerve. The swerve might be traced to spin and resistance or to unequal heating effects. The second paper, on the possible relations between sun-spots and the planets, contained a discussion of sun-spot material tabulated to show phase effects due to Venus and Jupiter. The conclusion is against the validity of conclusions come to recently by Prof. Schuster in connection with the influence of Venus and Mercury. A longer period of observation is apparently necessary before trustworthy results can be obtained.

Mathematics.

In the department of mathematics Lieut.-Colonel Allan Cunningham, R.E., read a paper on Mersenne's numbers. These numbers are of the form $M_q = 2^q - 1$, where q is a prime number. Since the appearance of Mr. W. W. Rouse Ball's paper in 1892 Prof. F. N. Cole has factorised M_{67}, Lieut.-Colonel Allan Cunningham has factorised M_{71}, M_{163}, and M_{197}, while H. J. Woodall has recently factorised M_{181}. This leaves still unverified (as composite) only fifteen out of the forty-four numbers (with $q<257$) originally affirmed by Mersenne to be composite, viz. when

$$q = 101, 103, 107, 109, 137, 139, 149, 157, 167, 173, 193, 199, 227, 229, 241.$$

A complete list of all the possible divisors <1 million of these fifteen numbers has been prepared by Mr. A. Gérardin (of Nancy, France) and Lieut.-Colonel Allan Cunningham, working independently. These trial divisors have been tested by the latter up to 500,000 without success (every "trial divisor" was tried twice).

Prof. J. C. Fields read a paper on relations between the double points and branch points of a plane algebraic curve $F(x,y) = y^n + F_{n-1}y^{n-1} +$, &c., which presents no singularities at infinity and the finite point singularities of which consist of nodes and ordinary cusps. On representing an arbitrary polynomial in (x,y) of degree $n-2$ by the notation $G(x,y) = \Sigma_{rs} d_{rs} x^r y^s$ a simple proof was given of the formula $\Sigma_\lambda c_\lambda \frac{G(a_\lambda, b_\lambda)}{F''_{b_\lambda}(a_\lambda b_\lambda)} = d_{o, n-2}$ where the summation is extended to all points (a_λ, b_λ) which are ordinary branch points, nodes, or cusps of the curve, the coefficient c_λ having as value either 1, 2, or 3, according as the corresponding point is an ordinary branch point, a node, or a cusp.

Mr. H. Bateman then contributed a note on the transformation of an electromagnetic field into itself. It is hoped that a discussion of the infinitesimal transformations will lead to equations of motion which will complete the electromagnetic scheme. Following the work of Mr. Hargreaves on the effect of an infinitesimal transformation on certain integral forms, it is assumed that these integral forms are invariants for the infinitesimal transformation. The analysis then indicates that two forms are exact differentials. Some types of infinitesimal transformations satisfying the conditions were obtained for particular electromagnetic fields, and the transformations were interpreted geometrically.

An account of the report of the committee for the further tabulation of Bessel and other functions was given by Mr. Nicholson. In the report tables are given (calculated by Mr. J. R. Airey) of the Neumann functions $G_n(x)$ and $Y_n(x)$ to seven decimal places for $n=0$ and $n=1$, and for values of the argument from 0·1 to 16·0 by intervals of 0·1. During the course of the year Sir G. Greenhill has brought forward a scheme for the rearrangement of the elliptic functions tables on a new basis. This scheme has now received the approval of the association, and a grant has been made towards the expenses of computation.

In this department Mr. H. Bateman contributed a paper on a geometrical theorem connected with six lines in space. PP′, QQ′, RR′ are three pairs of lines in space. LL′ are the common transversals of QQ′, RR′; MM′ the common transversals of RR′, PP′; and NN′ the common transversals of PP′, QQ′. If QQ′RR′ belong to a regulus, then MM′NN′ also belong to a regulus.

Mr. H. Hilton read a paper on the canonical form of an orthogonal substitution. After pointing out a short method of reducing a real orthogonal substitution to a canonical form, he discussed the analogous problem for an orthogonal substitution with complex coefficients. A canonical form was obtained in which the linear equations of the substitution were arranged in blocks, some of which contained two and others only one member. The leading coefficient occurring in one type of block was the reciprocal of the corresponding coefficient occurring in an associated block.

Prof. J. C. Fields read a paper on proof of certain theorems relating to adjoint orders of coincidence, viz.:—(1) In the reduced form of a rational function of (z, u), which is adjoint for the value $z=a$ (or $z=\infty$), the coefficient of u^{n-1} is integral with regard to the elements $z-a$ (or $\frac{1}{z}$). (2) If a rational function is adjoint for the value $z=\infty$, the degree of its reduced form is $\leqq N-1$. (3) The reduced form of a rational function adjoint for the value $z=a$ is integral with regard to the element $z-a$ if the equation $f(z, u)=(u-P_1) \ldots (u-P_n)=0$ (where $P_1 \ldots P_n$ are power-series in an element $z-a$ (or $\frac{1}{z}$) with exponents integral or fractional) is integral with regard to this element.

The Principle of Relativity.

The proceedings on Friday, September 1, opened with a discussion on the principle of relativity, led by Mr. E. Cunningham, who pointed out that the scope of the hypothesis of relativity is exactly coincident in extent with its scope in Newtonian dynamics. The acceleration of a point is not physically indeterminate as its velocity is. The theory of relativity is, for example, quite consistent with the magnetic effects apparent to terrestrial observers being explained as arising from the rotation of the earth with a nearly stationary distribution of charge. Within the limits indicated above and within the realm of phenomena in which the sole determinative laws are those of the electron theory, the hypothesis becomes a mathematically demonstrable fact in the sense that it is not possible to choose a unique frame of reference for which alone the laws will hold good. Mr. Cunningham then sketched the transformations connecting the measurements made according to two frames of reference, each of which is equally adequate to express known phenomena, and explained what deductions can be drawn.

In the subsequent discussion Dr. W. F. G. Swann pointed out that the compliance of a system with the electromagnetic scheme is by no means a sufficient criterion for the possibility of its existence; for instance, a system of two singularities, moving along at a constant distance apart, with the field at each point the sum of the ordinary fields due to the separate motions, is a system in accordance with the scheme, but it is one impossible of existence in practice. The explanation of the impossibility of the existence of such systems is to be found in the fact that they could never evolve out of any actually existing system. In fact, if we take the electromagnetic scheme as complete, those uniformities in nature which we call "laws" are to be looked upon as due in part to the compliance of the universe with the scheme and in part to the individuality of the initial system started. A complete knowledge of the field at every point in space, both inside and outside the molecules, would, in conjunction with the electromagnetic scheme, theoretically give us all that we should need to ascertain both the past and subsequent history of the universe. Since we cannot know the complete field at some instant, we are driven to make up for our incomplete knowledge by formulating certain "subsidiary laws," such as laws involving the conception of forces between the singularities, electrical surface conditions, gravitation, &c., the function of these laws being to *restrict those systems which satisfy the scheme, and are also to be considered as possible of existence, to those which can spontaneously evolve out of the actually existing universe.*

Mr. H. Bateman emphasised the mathematical interest attached to the principle, because it unites several branches of mathematics, such as geometry, partial differential equations, generalised vector analysis, continuous groups of transformations, differential and integral invariants, &c. He pointed out that there are two different types of transformations which can be used to transform one mathematical specification of an electromagnetic field into another. Those transformations which depend upon the electromagnetic fields which they can be used to transform form a much wider class than the spherical wave transformations, which can be applied to any electromagnetic field. The new transformations provide us with some very interesting analogues of mental phenomena.

Prof. P. Zeeman stated that the value of Fresnel's coefficient is easily deduced by means of the principle of relativity provided that no account is taken of dispersion. In that case the results of Fizeau's and Michelson and Morley's experiments on the propagation of light in flowing water agree with theory. The agreement is not so good if a dispersion term formally calculated by Lorentz be introduced. He asked whether the correction term would be the same if the principle of relativity were applied from the beginning to a dispersive medium. Prof. G. N. Lewis outlined some of the views which he has recently expressed in full in *The Philosophical Magazine*. Prof. A. E. H. Love warned one to be on the alert, because in the factor $K=(1-\beta^2)^{-\frac{1}{2}}$ we may be dealing only with a first approximation. Secondly, he suggested that it was conceivable that terrestrial magnetism might be only an apparent phenomenon due to the rotation of the earth. He had, however, tested whether by taking rotatory axes one could obtain effects of the magnitude of terrestrial magnetism; but they turn out to be very small, and it seems hopeless to think of magnetism as due solely to the rotation.

Dr. C. V. Burton, after expressing his satisfaction that none had confessed a disbelief in the æther, urged the importance of a search for residual phenomena not falling within the electromagnetic scheme. Conceivably gravitation is such a phenomenon. There is, further, a question as to whether neighbouring electrically neutral masses exert forces upon one another in virtue of their motion through the æther. Such forces would be non-electromagnetic; experiments designed to detect them are in progress, but have so far given a null result. The entire absence of such forces would imply that matter takes up no room (positive or negative) in the æther.

So much time had been taken up by the discussion that none was left to Mr. Cunningham to reply adequately to the numerous points raised. His scholarly paper introducing the discussion has been ordered to be printed *in extenso*; we look forward to perusing it in its extended form, and no doubt the answers to many of the questions will appear therein.

GENERAL PHYSICS.

In the department of general physics Mr. N. E. Dorsey gave an account of the work done at the Bureau of Standards on the absolute measurement of electric current. The measurements were made with a balance of the Rayleigh type; the coils were wound bifilarly, of enamel-insulated wire, upon brass forms. A novel feature of the fixed coils is the provision, in the forms and back of the windings, of a channel, through which water can be pumped so as to maintain the coils at a constant temperature. A double-walled jacket with water circulation surrounded the movable coils for the same purpose. The mean value obtained of the electromotive force of the mean Weston normal cell (as defined at the Washington conference) at 20° C. in terms of the international ohm and the Bureau balances is $1{\cdot}01822_4$ (with a mean deviation of 9×10^{-6}), which is 4 in 100,000 higher than the value obtained at the National Physical Laboratory. The cause of the discrepancy is not settled.

Prof. F. T. Trouton followed with a paper on peculiarities in the adsorption of salts by silica. Starting with very dilute solutions and gradually increasing their strengths, the amount of salt adsorbed first increases fast, then more slowly (or even decreases), then more quickly again. The thickness of the layer which exhibits the anomaly is calculated as being comparable with the usually given value for the range of molecular forces.

Dr. J. W. Nicholson contributed a paper on the atomic structure of the elements, with theoretical determinations of their atomic weights, in which an attempt was made to build up all the elementary atoms out of four protyles containing, respectively, 2, 3, 4, and 5 electrons in a volume distribution of positive electricity. Representing the protyles by the symbols Cn (coronium), H (hydrogen), Nu (nebulium), Pf (protofluorine), the accompanying table indicates the deductions of the author with regard to the composition of several elements, allowance being made for the mass both of the positive and negative electrons.

Gas	Formula	Atomic weight	
		Calc.	Obs.
Helium .. .	Nu. Pf.	3·99	3·99
Argon	$5He_2$	39·88	39·88
Krypton	$5\{Nu_4(Pf.H)_3\}$	83·0	82·9
Xenon	$5\{He_4(Pf.H)_3\}$	130·29	130·2
Neon	$2(Pf.H)_3$	20·21	20·2

The coincidence between the calculated and observed values is very great, but the general attitude of those present seemed to be one of judicial pause pending the fuller presentation of the paper, stress being laid on the fact that any true scheme must ultimately give a satisfactory account of spectra. The rest of the morning was occupied with the reading of the reports of the committee for establishing a solar observatory in Australia and the committee on magnetic observations at Falmouth Observatory.

Prof. F. R. Watson contributed the results of experiments undertaken in connection with curing the echoes and reverberations in the auditorium at the University of Illinois. In accordance with theory, it is found that a broad sheet of warm air drawn over the head of the speaker and out at the rear of the auditorium acts as a partition, and more or less reflects and refracts the speaker's utterances to the audience. In the absence of the author, a paper by Mr. J. W. Gordon describing an ingenious new micrometer was taken as read.

Mr. W. H. F. Murdoch gave an exhibition and description of a friction permeameter. This is a development of one previously designed by the author. In the new form the defects of the old form are removed. Dr. J. A. Harker followed with a paper (by himself and Mr. W. F. Higgins) on the methods and apparatus used in petroleum testing. He stated that it is well known that the Abel-Pensky apparatus gives a higher result for the same oil than the Abel. The results of experiments made at the National Physical Laboratory by the authors show that large differences of temperature exist throughout the oil cup and vapour space above it at any stage during an experiment amounting to 5° F. or more, and they are different in the different types of apparatus. The size of the test flame is also shown to be of importance. The difference of temperature in the two types is found to be due to the cover in the Abel-Pensky form containing much more metal, and therefore requiring longer to warm up.

The proceedings on Monday, September 4, began with a joint discussion with Section G on mechanical flight. A special article on this discussion has appeared elsewhere in this journal, and consequently it will not be further mentioned here.

Corpuscular Radiation.

A discussion was opened by an extremely lucid and persuasive paper by Prof. W. H. Bragg on corpuscular radiation. Such radiation he defined as consisting of entities or "quanta" each moving in a straight line with uniform velocity and unchanging properties unless impressed forces cause a change. The α and β rays are corpuscular, but not sound or light as ordinarily conceived. With regard to X (and γ) rays, it must be observed that the speed and direction of a β ray produced by an X-ray depend on the quality of the X-ray and not on the nature of the atom. The energy of the β ray, therefore, cannot come from the atom; nor yet can it be the result of the accumulation in the atom of energy extracted from many X-rays, for it can hardly be supposed that the accession of the last infinitesimal amount of energy required would determine so effectively the direction in which the β ray is ejected. Therefore one X-ray provides the energy for one β ray, and *vice versa*, and Whiddington's results show that very little energy is lost in the transformation. Again, since the speed of the secondary β ray is independent of the distance which the X-ray has travelled, the latter cannot diffuse its energy as it proceeds. Again, X-rays can excite X-rays of less, but not greater, penetrating power than themselves; and they must have arisen from β rays of energy exceeding a certain limit, viz. that characteristic of the X-corpuscle of that substance. The spreading pulse of Stokes and the kink in a tube of force (Thomson) fail to account for these facts; only a corpuscular theory will do this. Prof. Bragg's working model of such a corpuscle is a "neutral pair."

Sir Wm. Ramsay in the ensuing discussion asked whether a similar explanation might not account for the sun remaining hot so long, assuming it only sends out radiations in the directions for which a body exists to receive them. He also directed attention to experiments of his own in which radium enclosed in a glass tube surrounded by a second vessel gradually excited radio-activity in the latter. If the outer vessel is dissolved, an active substance can be chemically precipitated. His own theory is that the β rays shot out from the radium excite an actual chemical change in which a radio-active substance is produced.

Dr. Lindemann suggested that a crucial test between corpuscular and wave theory is supplied by the value of radiation pressure being twice as great on the corpuscular theory, but the reply came that the pressure is too small to be measured at present. Pulses of genuine delight ran through the meeting while Prof. Bragg expounded his views, and it was clear that many were impressed by the cogency of his arguments.

In a paper on the dependence of the spectrum of an element on its atomic weight, Prof. W. M. Hicks showed how to represent by formulæ the lines of a spectrum which are related to the well-known series in the same way as the second or third set of a doublet or triplet series depends on the first, or as the satellite lines of a D series depend on the more intense set. Examples were given from the sharp series of Mg, Ca, and Sr, but the other series show similar connections. In the absence of Major E. H. Hills a paper by him on the arc spectra of certain metals in the infra-red (λ 7600 to λ 10,000) was taken as read. This paper details the results of measurements made on photographic plates coated with a collodio-bromide emulsion, as originally used by Abney in 1880. Measurements by others have usually been made with a thermopile or bolometer.

Dr. Harker read a paper, on behalf of Mr. H. C. Greenwood, outlining an investigation on specific heats of metals, especially in the neighbourhood of their melting points, and determinations of the latent heat of fusion. The metals dealt with in this paper are aluminium and zinc.

The first paper read on Wednesday was by Mr. H. Davies, on the laws of solution. Mr. Davies showed how the formula of Rudolphi, which had been suggested to represent the cases where Ostwald's law of dilution breaks down, can be placed upon a theoretical basis. Hitherto it has been held as a purely empirical formula (see in relation to this subject the address of the president of Section B, NATURE, p. 297). Mr. Davies's contribution is of great importance to the physical chemist, inasmuch as it elucidates "the outstanding practical problem in the domain of electrolytic solutions."

Prof. P. V. Bevan contributed a paper on anomalous dispersion and solar phenomena. If light from a non-uniform source, such as an arc light, be sent through a tube containing non-homogeneous vapour of a metal which can show anomalous dispersion, and then an image of the source be focussed on the slit of a spectroscope, an apparent double reversal of certain lines may be produced. An explanation is given based upon the bright images of the two poles of the arc being formed on a darker background of light which has come from elsewhere through the vapour; the essence of the explanation is that the source shall be non-uniform. It was suggested that such apparent reversals might have a bearing upon solar phenomena.

LINKS WITH THE PAST IN THE PLANT WORLD.[1]

UNDER the heading "Links with the Past," several letters were published in *The Times* rather more than a year ago in which the writers gave instances of human longevity, showing how in certain cases a chain of a very few individuals suffices to connect the present with a comparatively remote past. One writer, for example, said that his grandmother, who died about forty years ago, used to boast that her grandfather was twelve years old when Charles I. was beheaded. Striking as such instances are when applied to man, on the other hand they serve to illustrate the relative insignificance of the length of time represented by human lives as contrasted with the duration of many forest trees. It is probably not an exaggeration to say that a single oak tree may form a link between the present day and the Norman Conquest; a very short series of ancestors suffices to carry us back to the days when the progress of the Roman invaders was seriously impeded by dense forests, which have long since disappeared, and farther back to the age of Neolithic man, whose flint implements are occasionally met with in the submerged forests round our coasts.

It would be interesting, if time permitted and my knowledge were adequate, to consider some of our forest trees from the point of view of their past history. The great majority of existing woods in Britain are the result of cultivation, and do not come within our purview in dealing with links with a remote past. Moreover, many of our familiar British trees, such as the common elm, the lime, the chestnuts, and others, have no claim to be classed as native, but were introduced in Roman or post-Roman days. In a few places in Inverness-shire and Perthshire patches of primæval forest survive; one of them is represented by the group of Scots pines growing in the Black Wood of Rannoch, in north-west Perthshire. Excavations in the Scotch peat-moors have revealed a succession of forests and wet moorland; in some places, *e.g.* in the Outer Hebrides, these buried forests occur in districts which are now almost treeless. As shown in sections recently published by Dr. Lewis, a cutting through 20 or 30 feet of Highland peat gives us an epitome of the changing physical and climatic conditions from the close of the Glacial period to the present day. The remains of Arctic willows, the crowberry (*Empetrum nigrum*), and other northern species immediately above the glacial deposits testify to the influence of the Ice age. The Arctic plants are succeeded by vegetation indicative of a milder climate; layers of bog-moss and stumps of pines point to an alternation of forests and wet moorland.

The spruce fir, one of our best known trees, affords an example of a species which was once a native, but is no longer found in a wild state. The cone of the spruce fir shown on the screen was recently recorded by Mr. and Mrs. Clement Reid, together with the seeds and fruits of many other plants, from deposits on the Norfolk and Suffolk coast which were formed shortly before the Glacial period. The plants of this pre-glacial flora indicate a temperate climate, but the nearer approach of more severe conditions is shown by the Arctic willow and dwarf birch which have been found in beds next above those containing the spruce fir.

The occurrence of the Glacial period is a fact of primary importance in relation to the antiquity of the present flora of this country. We know that Britain in comparatively recent times, speaking geologically, was in very much the same condition as Greenland is to-day. Over nearly the whole of Scotland, Ireland, Wales, and England, with the exception of a narrow strip in the south, there is clear evidence of ice action on a large scale and of the presence of ice-sheets and local glaciers. Under these Arctic conditions it can hardly be doubted that only a very small proportion of the vegetation could survive. Opinions differ as to the extent to which the Ice age proved fatal to the pre-glacial flora, but it is perhaps not too much to say that the present flora, as a whole, is of post-glacial date. The vegetation which grew in this part of Europe before the Glacial period reached its maximum must have been in great measure destroyed or driven south beyond the British area. The important point is that what we call our native flowering plants may safely be described in general terms as immigrants from other lands, aided, it may be, by land-connections across the North Sea and English Channel.

Special interest attaches to a few plants which occur in the west and south of Ireland, and to a less extent in Cornwall and elsewhere in the south-west of England. In Connemara in the west of Ireland, where hard frosts are unknown and winter snows rare, there are three kinds of heath, St. Dabeoc's heath (*Dabeocia polifolia*), the Mediterranean heath (*Erica mediterranea*), and *Erica Mackaii*, which are not found elsewhere in the British Isles or in the whole of northern Europe, but reappear in the Pyrenees. The London pride (*Saxifraga umbrosa*), another Pyrenean species, grows on the south and west coasts of Ireland from Waterford to Donegal. *Arbutus Unedo* (the strawberry tree), scattered through the Killarney woods, has a wide distribution in the Mediterranean region, its nearest continental station being in the south-west of France.

The presence of this small group of Mediterranean and Lusitanian plants in Ireland has long been a puzzle to naturalists. A few years ago I came across a solution to the problem of these southern plants in Ireland in a collection of stories entitled "A Child's Book of Saints." An Irish monk, Bresal, was sent to teach the brethren in a Spanish monastery the music of Irish choirs. In later years he longed for a sight of his native land, to which he at length returned; his thoughts reverted to Spain, and he saw once more the little white flowers of the Saxifrage and the strawberry tree from which he had gathered the orange-scarlet berries. With heavenly vision the prior of the Spanish monastery, seeing Bresal gazing at the flowers of Spain, commanded them to go and make real his dream. Thus, to gladden the heart of the monk, were these southern plants miraculously introduced into Ireland.

One view is that Arbutus and its companions are entitled to be regarded as a very old section of the British flora, survivals from a time, the so-called Tertiary period, when the climate was much milder than it is to-day. It is believed by some authorities that these plants migrated from Portugal to Ireland long before the Glacial period, and by means of a land-bridge, which afterwards sank below the waters of the Atlantic Ocean. This explanation is open to criticism; even granting the former existence of a land-connection, it is difficult to believe that the strawberry tree, which is restricted to one of the warmest districts in the British Isles, could have survived the rigours of the Glacial period. Moreover, as Mr. Clement

[1] Evening discourse delivered before the British Association at Portsmouth on September 4 by Prof. A. C. Seward, F.R.S.

Reid asks, why do we not also find in Ireland Portugal laurels and oaks, which are hardier than Arbutus? An alternative view is that Arbutus and its compatriots came to Ireland *after* the Glacial period, not by migration overland, but by natural means of dispersal, which would be favoured by the small size of their seeds as contrasted with the larger seeds of oaks and other southern plants, which never reached our shores.

The possibilities of plant dispersal by natural agencies have recently received a striking demonstration in the recolonisation of the island of Krakatau, in the Sunda Straits. In 1883 Krakatau, then covered with a dense tropical vegetation, was partially destroyed by a series of exceptionally violent volcanic explosions. It is believed that no vestige of life remained. In 1906, twenty-three years after the sterilisation of the island, 137 species of plants were collected, and the vegetation was in places so dense that a party of botanists penetrated with the greatest difficulty beyond the coastal belt. Some of the trees had reached a height of 50 feet. The nearest islands, except the small island of Sebesi, about twelve miles distant, are Java and Sumatra, separated from Krakatau by a stretch of water twenty-five miles in breadth. This new flora, introduced by ocean currents, by wind, and by the agency of birds, affords a useful object-lesson in regard to the efficiency of plant-dispersal without the aid of land-connections.

Before passing to the consideration of questions necessitating frequent reference to different periods of geological history, it is essential to direct attention to the sequence of chapters as revealed by the earth's crust. It is from the scanty records of plant life preserved in the sedimentary deposits of former ages that we obtain such evidence as we have in regard to the relative antiquity of different types. The crust of the earth, as Darwin wrote, "with its imbedded remains, must not be looked at as a well-filled museum, but as a poor collection made at hazard and at rare intervals."

The oldest rocks, largely composed of gneisses and other products of igneous action, throw no light on the nature of the organisms which existed in the earliest epochs of the earth's history. The complex structure of the oldest known animals and plants compels us to believe that they are the descendants of simpler forms of much greater antiquity. As the Cambridge professor of modern history has aptly said, "All the epochs of the Past are only a few of the front carriages, and probably the least wonderful, in the van of an interminable procession." The foundation-stones of the earth's crust have been so much folded and altered in the course of geological time that it is no wonder they have been searched in vain for records of primitive life. Passing higher up the series through the vast thickness of Cambrian, Ordovician, and Silurian strata, it is in the Devonian rocks of Ireland and elsewhere that we first discover the records of Palæozoic floras, and these bear a fairly close resemblance to the still richer floras of the succeeding Carboniferous epoch.

Turning, now, to the top of the geological series, the submerged forests round our coasts and the tree-stumps buried in peat form connecting links between existing plants and those of a prehistoric age. A little further down occur the Boulder Clay and other legacies from the Glacial period, and below these are the fragmentary relics of a pre-glacial vegetation. Further down the plants become less familiar and show a closer agreement with those of subtropical and tropical countries than with the recent vegetation of Britain. From the London Clay, a marine deposit, which underlies London and Portsmouth, and is exposed in the Isle of Wight, the Isle of Sheppey, and in other places, fossil seeds and fruits have been found practically identical with those of existing tropical species. One of the London Clay fruits may be mentioned as an especially interesting sample of the early Tertiary flora, namely, the genus Nipadites, so called because of the very close resemblance it bears to the fruits of the common tropical plant Nipa. *Nipa fruticans*, often described as a stemless palm, grows in the brackish estuaries of many tropical countries. The occurrence of fossil fruits of this type in Tertiary beds in England, Belgium, and France affords a striking instance of changes in the distribution of an ancient plant now restricted to warmer regions.

Below the Tertiary rocks we descend to the Chalk period, when a clear and comparatively deep sea covered the areas now occupied by chalk downs and cliffs. "During the Chalk period," as Huxley wrote, "not one of the present great physical features of the globe was in existence. Our great mountain ranges, Pyrenees, Alps, Himalayas, Andes, have all been upheaved since the Chalk was deposited." Below the Chalk in the Weald district of Kent and Sussex a rich Wealden flora has been discovered in sediments laid down in a shallow lake which occupied the south of England and extended across what is now the English Channel. The Wealden plant-beds have as yet furnished no satisfactory specimen of a flowering plant. It is one of the most interesting facts in the history of the vegetable kingdom that the highest class of plants which now overspreads almost the whole world did not come into prominence until after the close of the Wealden period. When, in the course of evolution, the flowering plant became a competitor in the struggle for existence, it spread with amazing rapidity.

The sandstones and shales in the Yorkshire cliffs and slightly older rocks on the Dorsetshire coast have supplied data which enable us to reconstruct in some measure the vegetation of that stage in the earth's history known as the Jurassic period. Below the Jurassic strata in some parts of the world, as in the south of Sweden, Germany, and elsewhere, from rocks of Rhætic age numerous fossil plants have been obtained. Descending further, the plant records from strata belonging to the early days of the Triassic period afford evidence of changes in the nature of the vegetation, which become more pronounced in the still older Permian and Carboniferous floras. It is, however, not my intention to deal with the vegetation of the coal forests and other Palæozoic floras; they are composed of plants for the most part much less closely related to existing types than those which I have selected as examples of links with the past.

Probably the human race made its entrance on to the world's stage at some time during the Tertiary period; but in Britain abundant evidence of man's presence is not met with until after the Glacial period. An additional illustration of the enormous antiquity of some of the plants to be described later is furnished by the absence of flowering plants in the rich floras below, or even including, those of Wealden age.

The widely distributed class of ferns supplies some notable instances of links with the past. It is not infrequently the case that plants which are now characterised by a restricted geographical range have a wide range in time, and, conversely, plants which are now more or less cosmopolitan may be of comparatively recent origin. Antiquity and restricted distribution often go together. The bracken fern, which we are apt to regard as essentially British, occurs also in Tasmania, in the Malay Peninsula, in British East Africa, in the Himalayas, and in many other countries; it is one of the most cosmopolitan of all living ferns. It would seem probable that this injurious species is one of the more modern members of its class. On the other hand, the family to which the royal fern (*Osmunda regalis*) belongs, though widely spread at the present day, has been traced into the Palæozoic era. The recent researches of Dr. Kidston and Prof. Gwynne Vaughan have demonstrated the existence in the Permian flora of Russia of ferns exhibiting a close relationship to existing members of the Osmunda family. The section shown on the screen was cut from a petrified fern stem of Permian age, which shows in its anatomical characters a remarkable resemblance to a stem of Osmunda. Some of the commonest fern leaves in the Jurassic rocks of Yorkshire and in many other parts of the world, both north and south of the equator, may be referred with a considerable degree of certainty to the Osmunda family, the relationship being indicated, not by mere external resemblance, but by the structure of the spore-capsules, and in a few cases by the occurrence of petrified stems. It is by no means improbable that the royal fern and other existing members of the family are entitled to the distinction of an ancestry which extends farther back into geological time than that of any other section of living ferns.

The next example of an old type of fern is one which is widely spread in the warmer regions of both the Old and New World. Gleichenia may, as a rule, be easily recognised by the regular forked branching of the fronds, as also by the structure of its spore-capsules and by the anatomy of its stem. Fragments of fronds hardly distinguishable from those of some surviving species have been found in Upper Jurassic rocks on the Sutherland coast and in Wealden strata on the Continent. In rocks of Wealden age near Brussels, pieces of stems have been discovered by Prof. Bommer sufficiently well preserved to be submitted to microscopic examination, and showing anatomical features exactly like those of the living species. The occurrence of numerous Gleichenia fronds in sedimentary rocks of Lower Cretaceous age near the edge of the Greenland ice-sheet on Disco Island, in lat. 70° N., points to climatic conditions very different from those which now prevail. This is one of many instances revealed by a study of ancient floras of remarkable changes in geographical distribution as in climate. Gleichenia, like many other plants which have long ceased to exist in Europe, was formerly a common northern genus, and may have had its origin in the far north, whence it was driven by adverse conditions to seek a home in more congenial surroundings.

The fern genus Matonia is now represented by two species in the Malay region; one of them was discovered a few years ago by Mr. Hose in a locality in Borneo, and has not been found elsewhere; the other and better known species, *Matonia pectinata*, occurs in the Malay Peninsula and on the mountains of Borneo. It is a fern with a creeping stem, from which are given off large spreading fronds borne on slender stalks reaching a height of 6 to 8 feet. It is recognised by the shape of the leaf and by other more important characters, notably by the structure of its stem, in which it differs from all other members of the fern class.

Its isolated position among the ferns and its limited geographical range are in themselves suggestive of antiquity. The records of the rocks abundantly confirm this inference. Fossil fern leaves closely resembling those of *Matonia pectinata* occur in strata of Rhætic age in Germany and in other parts of the world. In England this type has been found in the Jurassic beds on the Yorkshire coast and in Wealden strata not far from Hastings. From Wealden rocks in Belgium pieces of stems have been obtained exhibiting anatomical features identical with those of the recent species. Fronds practically identical with those of the Malayan fern are recorded from an Austrian locality from rocks higher in the Cretaceous series, but no satisfactory evidence is available of the persistence of the Matonia family in Europe or in the northern hemisphere during the latest phase of the Cretaceous or throughout the whole of the Tertiary period. The existing species of Matonia are the last survivors of a family which once flourished over a wide area in Europe and extended to the other side of the Atlantic. Exposed to unfavourable climatic conditions, and possibly affected by the revolution in the plant-world consequent on the appearance of the flowering plants, Matonia gradually retreated across the equator until this "living fossil" found a last retreat in Malaya, the home of not a few links with a remote past.

Brief reference may be made to another fern, the genus Dipteris, which grows in association with Matonia on Mt. Ophir and elsewhere in the Malay Peninsula. Dipteris is represented by more species and has a wider geographical range than Matonia; it occurs in northern India, central China, in New Caledonia, and other islands. The fronds are distinguished by their long, deeply cut segments, spreading from the top of a slender stalk. In the Rhætic plant-beds of northern and central Europe, North America, Tonkin, and elsewhere, numerous fossil leaves have been discovered which bear a close resemblance to existing species of Dipteris. Similar fronds have been found in the Jurassic rocks on the Yorkshire coast and in Sutherland. It is impossible to say with confidence how nearly these Jurassic ferns are related to the existing species, but there can be no reasonable doubt that Dipteris, like Matonia, is a fern which connects the present with a past too far off to be measured by ordinary standards of time.

The large class of plants known as the conifers—though the name is in certain cases a misnomer, as some members bear no cones—including the pines, larches, firs, and several other trees, has a very much longer past history than the flowering plants. In rocks of all ages down to the Upper Palæozoic strata the remains of leafy shoots, pieces of petrified wood, seeds, and cones are abundant fossils, but the difficulty is to piece together the *disjecta membra* and to determine the degree of relationship between the extinct and the living.

I will confine myself to two genera of conifers which are especially noteworthy as persistent types—plants, like the fern Matonia, which formerly played a much more conspicuous *rôle* in the world's vegetation than they do now. Everyone is familiar with the Californian trees known as Sequoia or Wellingtonia.

The redwood, *Sequoia sempervirens*, occupies a narrow belt of country, rarely more than twenty or thirty miles from the coast, 300 miles long from Monterey in the south to the frontiers of Oregon. The tapering trunk, rising to a height of more than 300 feet, gives off short horizontal branches thickly set with narrow leaves dispersed in two ranks, as in the yew. The female flowers have the form of oblong cones from three-quarters to one inch long, and each woody cone-scale bears several small seeds on its upper surface. The second and more familiar species, *S. gigantea*, the mammoth tree, which is commonly cultivated in this country, has an even more restricted range, being confined to groves on the western slopes of the Sierra Nevada between 3000 to 9000 feet above sea-level. This species is at once distinguished from the redwood by its stiff, sharply pointed and scale-like leaves, and by its rather larger cones.

In the British Museum there is a section of a mammoth tree which shows on its polished surface 1335 rings of growth. On the assumption that each ring marks a year's growth, the tree when felled in 1890 was 1335 years old, and when Charles the Great was crowned Emperor at Rome it had already flourished for more than 200 years. These two giant conifers, remarkable as being probably the tallest trees in the world, become even more impressive when we know something of their past. The investigation of the herbaria buried in the earth's crust reveals the occurrence of similar, and in some cases apparently identical, species in many parts of Europe and in American localities far from their present home. It has been demonstrated that the big trees of California are the survivors of a once vigorous family which formerly flourished in many parts of the Old World, but as the result of altered circumstances, changed physical conditions, or unequal competition with other types in the struggle for life, dwindled in numbers and narrowly escaped extinction.

At Bovey Tracey in Devonshire there is a basin-shaped depression in the granitic rocks of Dartmoor filled with clay, gravel, and sand—the flood-deposits of a Tertiary lake containing the waifs and strays of the vegetation from the surrounding hills. Among the commonest plants is one to which the late Oswald Heer gave the name *Sequoia Couttsiae*, and his reference of the specimens to Sequoia has recently been confirmed by the researches of Mr. and Mrs. Clement Reid. This Tertiary species is represented by slender twigs almost identical with those of *S. gigantea* and by well-preserved cone-scales and seeds. Moreover, it has been possible to examine microscopically the carbonised outer skin of the leaves, and to demonstrate its close agreement with that of the superficial tissue in the leaves of the Californian tree. With the Bovey Tracey Sequoia are associated fragments of Magnolia, Vitis, the swamp cypress of North America, as well as other types which have long ceased to exist in the British Isles. Twigs and cones identified as those of Sequoia are recorded from several continental districts from both Cretaceous and Tertiary strata. The genus occurs in abundance in Tertiary beds on Disco Island and in Spitsbergen. Dr. Nathorst has obtained specimens from the Arctic Ellesmere Land almost as perfect as herbarium specimens. Remains of Sequoia have been found also in Tertiary rocks on the banks of the Mackenzie River, in Alaska, Saghalien Island, Vancouver Island, and elsewhere.

One of the most remarkable instances of the preservation of trees of a bygone age is supplied by the volcanic strata of Lower Tertiary age exposed on the slopes of Amethyst Mountain, in the Yellowstone Park district. At different levels in the 2000 feet of strata as many as fifteen forests are represented by erect and prostrate trunks of petrified trees. The microscopical examination of some of these trees shows that they bear a close resemblance to *S. sempervirens.* In a photograph given to me by Dr. Knowlton, of Washington, one sees living conifers of other genera side by side with the lichen-covered and weathered trunks of the fossil Sequoia, contiguous but separated in time by millions of years. From Cretaceous rocks of South Nevada, not very far from the present home of Sequoia, petrified wood has been described possessing the anatomical characters of the mammoth tree. While there is little doubt that Sequoia formerly had its maximum distribution in the northern hemisphere, there is some evidence, though not conclusive, that the genus once existed in Madagascar and in New Zealand.

The Araucaria Family.

Another and even more venerable section of the conifers is represented by the Araucaria family, which includes two genera, Araucaria and Agathis. The best known species of Agathis, or Dammara as it is sometimes called, is the Kauri pine, probably the finest forest tree in New Zealand. The stems reach a height of 160 feet, terminating in tiers of spreading branches bearing thick and narrow leaves 2 to 3 inches long. The almost spherical cones consist of a central axis bearing overlapping, broadly triangular scales, each of which carries a single winged seed. Other species of Agathis occur in the Malay Archipelago, the Philippines, Queensland, and elsewhere. The genus Araucaria, with the exception of the familiar Monkey Puzzle (*Araucaria imbricata*) and a Brazilian species, is confined within the geographical area occupied by Agathis. In addition to the Monkey Puzzle, introduced into England in 1796 from Chile, the Norfolk Island pine (*A. excelsa*) is a commonly cultivated pot-plant in this country; it was introduced to Kew in 1793 by Sir Joseph Banks soon after its discovery by Captain Cook.

Before we consider the past history of the Araucaria family, a word must be added in regard to the characters which enable us to recognise Araucaria and Agathis in a fossil state. The wood of these two genera differs in certain minute structural features from that of other conifers; the examination of a radial longitudinal section of a branch of one of the Araucarias under a microscope shows on the walls of the elongated tubular elements of which the wood consists small polygonal areas technically known as bordered pits; these occur in one or more rows, and may be described as circles converted into polygons by mutual pressure. In pines and other conifers these bordered pits are circular or oval in form, and not, as a rule, contiguous. The foliage shoots of Araucaria, though fairly distinctive in the form and arrangement of the leaves, may be confused with branches of other genera, and are in themselves of secondary importance for diagnostic purposes. On the other hand, the seed-bearing scales of the large cones afford much more trustworthy means of identification; each scale bears a single seed either immersed in the scale or lying in the middle of its upper face. In other conifers two or more seeds occur on each scale. It is not possible as yet to give a definite answer to the question: How far into the past can we trace the direct ancestors of existing species of Araucaria and Agathis?

From Permian and Upper Carboniferous rocks foliage shoots have been obtained almost identical in form with those of the Norfolk Island pine, and there is other evidence of a more satisfactory kind pointing to the probable existence in Palæozoic floras of trees closely akin to Araucaria. Araucarian types are recorded from Triassic strata, but from rocks of Jurassic age Araucarian cones and seed-bearing seeds, together with wood and foliage shoots, have been found in greater abundance. Petrified wood practically identical with that of the living species is recorded from Lower Jurassic rocks at Whitby, and there is reason to believe that some of the Whitby jet owes its origin to Araucarian wood.

A good example of a cone agreeing closely in structure, as in size, with the cones of some species of Araucaria was described in 1866 by Mr. Carruthers from Jurassic rocks at Bruton, in Somersetshire. Cone-scales exhibiting the characteristic features of Araucaria have been found in the Middle Jurassic rocks of Yorkshire, in Jurassic rocks of north-east Scotland, Cape Colony, Australia, India, and in the eastern States of North America. In a collection of Jurassic plants obtained a few years ago by members of a Swedish Antarctic expedition in Graham's Land, Dr. Nathorst has recognised some seed-scales of the Araucarian type. As we ascend the geological series and pass into Cretaceous strata, evidence of the wide distribution of the Araucarieæ is still abundant. Araucarian wood has been discovered in Cretaceous rocks in Egypt, East Africa, Dakota, and elsewhere; and from beds of this age in New Jersey Prof. Jeffrey and Dr. Hollich have recently described several different types of fossils represented by petrified leafy shoots and cone-seeds, some of which are closely allied to Araucaria, while others are nearer to Agathis.

In Tertiary floras undoubted Araucarian species are less common; it is not improbable that some foliage shoots from the plant-beds of Bournemouth, described by Mr. Starkie Gardner as Araucaria, may belong to a species nearly related to the Norfolk Island pine. From the extreme south of South America Araucarian wood and branches have recently been recorded, and, at the other end of the world, Tertiary rocks on the west coast of Greenland have yielded fragments which, with some hesitation, may be classed as Araucarian.

One conclusion, which seems almost unavoidable, is that the species of Araucaria and Agathis which survive in South America and in the islands of the Pacific have in the course of successive ages wandered from the other end of the world. We can only speculate as to the causes which have contributed to the changes in the fortunes of the family; but one thing is certain, namely, that few existing plants are better entitled to veneration as survivors from the past than are the Monkey Puzzle and other species of Araucaria.

The Maiden-hair Tree.

In recent years the maiden-hair tree of China and Japan, introduced into Europe early in the eighteenth century, has become fairly well known in English gardens. There is probably no other existing tree with so strong a claim to be styled a "living fossil," to use one of Darwin's terms. In 1712 the traveller Kaempfer proposed for this plant the generic name Ginkgo, and Linnæus adopted this designation, adding the specific name *biloba* to denote the characteristic bisection of the wedge-shaped lamina of the leaf into two divergent segments. In 1777 the English botanist Sir J. E. Smith expressed his disapproval of what he called the uncouth name Ginkgo by substituting the title *Salisburia adiantifolia*; but the correct botanical name is *Ginkgo biloba*. In its pyramidal habit Ginkgo agrees generally with the larch and other conifers; its leaves, which are shed every year, are similar in form and venation to the large leaflets of some maiden-hair ferns. The seeds, borne on fairly long stalks, are enclosed in a thick green flesh, and in appearance resemble small plums. For many years Ginkgo has been recognised by botanists as an isolated and probably ancient type. It used to be placed near the yew among the conifers; but in 1896 a Japanese botanist, Hirase, made the important discovery that the male reproductive cells of the maiden-hair tree are characterised by the possession of innumerable cilia which enable them to swim in fluid like the male cells of ferns and many other plants. In the true conifers the male cells have entirely lost the power of independent movement. Without going into details, the important point is that Hirase's discovery confirmed suspicions based on other characters, that Ginkgo was not a true member of the conifers, and supplied a cogent reason for promoting it to a class of its own, the Ginkgoales.

Though some travellers in China have spoken of Ginkgo trees in a wild state, the balance of opinion is in favour of regarding the genus as represented at the present day solely by cultivated specimens. China was, no doubt, its last stronghold; in that country, as in Japan, it is regarded as a sacred tree, and planted in the groves of temples, and it would seem that the fact of its being held in veneration by the priests has saved it from extinction.

As in many other cases, so in regard to Ginkgo we cannot speak with certainty as to its first appearance in the world's vegetation. Leaves constructed on a similar plan have been found in Permian, Carboniferous, and Upper Devonian rocks in England, Germany, France, the Arctic regions, South Africa, Kashmir, the Ural Mountains, and elsewhere, but we still lack decisive evidence as to the systematic position of these plants.

It is, however, an undisputed fact that the maiden-hair tree is connected by a long line of ancestors with the earliest phase of the Mesozoic epoch. From many parts of the world large collections of fossil plants have been obtained from strata referred to the Rhætic period or to the upper divisions of the Triassic system. The vegetation in those far-off days, extending from Australia, Cape Colony, and South America to Tonkin, the south of Sweden and North America, was much more uniform in character than is the case with widely separated floras at the present day. One of the most widely spread plants in this vegetation is one known as Baiera, which possessed leaves differing only in the greater number and smaller breadth of their segments from those of the maiden-hair tree. In the later Jurassic rocks of Yorkshire true Ginkgo leaves, as well as those of Baiera, are fairly common, and a few fragments of flowers have also been found. Both genera are recorded from Jurassic rocks of Germany, France, Russia, Bornholm, and elsewhere in Europe; they occur abundantly in Siberia, and are represented in the Jurassic floras of Franz Josef Land, the east coast of Greenland, and Spitsbergen.

The abundance of fossil Ginkgo leaves and seeds in Jurassic strata in East Siberia has led to the suggestion that this region may have been a centre where the Gingkoales reached their maximum development in the Mesozoic period. The occurrence of fossil species in the Jurassic rocks of King Charles Land (78° N.) and in the New Siberian Islands (75° N.), in central China, Japan, Turkestan, California, South Africa, Australia, and Graham's Land, demonstrates the cosmopolitan nature of the group. During the Tertiary period Ginkgo flourished in North America, in Alaska, and in the Mackenzie River district, Greenland, Saghalien Island, and in several European regions. In the Island of Mull beautifully preserved leaves of Ginkgo, indistinguishable from those of the living tree, have been found in sediments deposited on the floor of a lake during a pause in the volcanic activity which in the early days of the Tertiary era produced the thick series of basaltic rocks to which is due the characteristic contour of the Inner Hebrides.

The recent cultivation in Britain of the maiden-hair tree is thus a reintroduction of a plant which formerly flourished in this part of Europe. Where and when this genus first appeared, and why a type once so vigorous has narrowly escaped extinction, are questions which we cannot answer with confidence; we are, however, certain that the maiden-hair tree links the present with a past inconceivably remote; it is a tree "sacred with many a mystery," antedating by millions of years the advent of man and far surpassing the flowering plants in antiquity.

As we search through the fragmentary records scattered through the sediments of former ages, we discover evidence of a shifting of the balance of power among different classes of plants. Plants now insignificant or few in number are found to be descendants of a long line of ancestors stretching back to remote antiquity. Others which flourished in a former period no longer survive. We can only speculate vaguely as to the cause of success or failure. As Darwin said, "We need not marvel at extinction; if we must marvel, let it be at our own presumption in imagining for a moment that we understand the many complex contingencies on which the existence of each species depends."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

GLASGOW.—Dr. J. D. Falconer, late principal officer of the Mineral Survey of Northern Nigeria, and formerly assistant to Prof. James Geikie, has been appointed to the lectureship in geography, vacated by Captain Lyons, F.R.S.

Mr. J. S. Dunkerley has been appointed a university lecturer in zoology, with special reference to protozoology. Dr. Carl H. Browning, hitherto lecturer in bacteriology, has been appointed lecturer in clinical pathology and director of the new clinical laboratory at the Western Infirmary. Dr. A. Maitland Ramsay has been appointed university lecturer in ophthalmology. Principal Sir Donald MacAlister, K.C.B., has been appointed a member of the executive committee of the Carnegie Trust for the Universities of Scotland in succession to Prof. William Stewart, resigned.

His Majesty in Council has approved a new Ordinance, whereby geography is added to the subjects which may be offered in the final examination for the B.Sc. degree.

LONDON.—An appeal has been issued, with the authority of the Senate, for funds to build the Francis Galton Laboratory at an estimated cost of 15,000*l*. As stated in an article in NATURE of March 16, Sir Francis Galton in his will expressed a hope that his bequest for the promotion of eugenics, amounting to about 45,000*l*., would not be used for the provision of buildings, fittings, or library. The income is accordingly being used for the salaries of the professor (Karl Pearson, F.R.S.) and his staff. A site for the proposed laboratory has been allocated by the University at University College, and sketch plans, prepared by Prof. Simpson, are printed with the appeal showing adequate accommodation for lecture-room, museum, research laboratories for eugenics and biometry, together with a room for Galtoniana. The appeal directs attention to the importance of the work to be carried on in the laboratory in relation to future legislation dealing with social problems. "It is essential that the statistical facts on which such legislation may be based shall be analysed in a purely scientific manner by workers who can give time and energy to investigation, quite independently of any ulterior end or party bias." Already the laboratory, in spite of the difficulties due to inadequate accommodation, is carrying out on a considerable scale the founder's wish to "provide information, under appropriate restrictions, to private individuals and to public authorities." Contributions and promises of support will be gratefully received by Sir Edward Busk, chairman of the Galton Laboratory Committee, at the University.

SIX lectures on "The Causes and Economic Effects of Changes in the General Level of Prices" (illustrated from the history of the nineteenth century) are being delivered by Mr. W. T. Layton at University College (University of London) on Tuesdays at 5.30 p.m., the first having been given on October 10 The lectures are open to the public without fee or ticket.

A SPECIAL course of twelve lectures, dealing with illumination, will be delivered at Battersea Polytechnic during the coming session, the first six being delivered on Tuesday evenings, beginning on October 17, and the last six on Fridays, commencing January 12, 1912. The course will be open to students and all interested in the subject. The course will deal with all illuminants, including electric, gas, oil, and acetylene lighting, the effect of light on the eye and the hygienic aspects of illumination, the measurement of light and illumination, &c. Practical problems, such as the lighting of schools, streets, factories, &c., will also be treated. The lecturers will be Prof. J. T. Morris, Mr. J. G. Clark, Mr. E. Scott-Snell, Dr. W. J. Ettles, and Mr J. S. Dow.

ADDITIONAL buildings of the Royal Albert Memorial University College, Exeter, will be formally opened by the Lord-Lieutenant of Devon, the Earl Fortescue, on Friday, October 20. The buildings are the first instalment of an enlargement scheme which was approved by the governors in 1904. The steady development of the college work has necessitated periodical enlargement of the building accommodation. The last extension, in 1899, was formally opened by his Royal Highness the Duke of York (now King George V.), and the previous extension, in 1895, by the late Duke of Devonshire. The present addition has been erected on a site purchased at the rear of the main building of the Royal Albert Memorial at a cost of 8675*l*. for land and about 16,400*l*. for the building. This occupies only about half of the site acquired. The new buildings consist of two blocks, one for the University College and the other for the Day Training College.

THE opening lecture of the course of instruction on "Colloids" was given by Mr. E. Hatschek at the Sir John Cass Technical Institute on Friday, October 6, when the chair was taken by Dr. Rudolf Messel, president of the Society of Chemical Industry. Mr. Hatschek commenced his lecture by referring to the early work of Thomas Graham on colloids, and then dealt with the subsequent development of the subject as a borderland study between physics and chemistry. The characteristics of colloids were then examined, and an account given of laboratory products that have been prepared and of the large number of natural organic products which can be dissolved direct to form colloidal solutions such as starch, gelatine, agar, and the albumins. The importance of the subject in relation to industrial problems was next specified, reference being made to the tanning and dyeing industries, the photographic plate and paper industry, the fermentation industries, and the treatment of effluents and sewage. At the close of the lecture an experimental demonstration of the properties and methods of preparation of some colloidal solutions was given.

AMONG the scientific lectures arranged this term for advanced students, in connection with the University of London, we notice the following. A course of eight lectures on "Principles of Systematic Botany (Flowering Plants)" will be given by Dr. C. E. Moss, curator of the herbarium, University of Cambridge, in the botanical department, University College, on Thursdays, at 5 p.m., beginning on October 19. Informal meetings for the discussion of important contributions to current meteorological literature will be held at the Meteorological Office on alternate Mondays, at 5 p.m., beginning on October 23 and ending on March 25, 1912. Students who wish to attend are requested to communicate with the Reader at the Meteorological Office. A course of eight lectures on "The Manipulation and Theory of the Microscope" is being given by Mr. J. E. Barnard at King's College, on Wednesdays, at 5 p.m. A course of four lectures on "The History of Plague" will be given by Dr. C. Creighton at the University, South Kensington, on Fridays, October 20 and 27, and November 3 and 10, at 4 p.m. In all cases the lectures are addressed to advanced students of the University and to others interested in the subjects, and the admission is free, without ticket.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 2.—M. Armand Gautier in the chair.—The president announced the loss, by death, of Auguste Michel-Lévy and Joseph Louis Troost.—Émile **Picard**: Continuous solutions of integral equations of the third species.—Paul **Appell**: Functions of the fourth degree.—MM. **Esclangon** and **Courty**: Observations of the Quénisset comet and of the Brooks comet made with the large equatorial (38 cm.) of Bordeaux Observatory. Dates are given for September 26, 27, and 28. The Quénisset comet appeared as a circular nebulosity of 4′ to 5′ diameter, with a clear nucleus. The tail of the Brooks comet has been visible to the naked eye since September 17.—M. **Borrelly**: Observations of the Quénisset comet (1911*f*) made at the Marseilles Observatory with the comet finder. Positions of the comet are given for September 27 and 28. It appeared to be nearly circular, about 2′ diameter, with glimpses of a small nucleus of about the twelfth magnitude.—F. **Baldet** and F. **Quénisset**: Observation of the *gegenschein*. Attention is directed to the remarkable intensity now exhibited by the *gegenschein*, or zodiacal counterglow; it is pointed out that there is no satisfactory explanation for this phenomenon.—M. **Giacobini**: Observations of the Quénisset (1911*f*) and Beljawsky (1911*g*) comets made at the Observatory of Paris with the eastern tower equatorial of 40 cm. aperture. Positions are given for September 25, 27, and 30 for the Quénisset comet, which appears as a nebulosity of sensibly elliptical shape 45″ to 50″ in extent. The nucleus is well defined, and is of the eighth magnitude. The positions of the Beljawsky comet are given for September 30 and October 1. This comet is exceptionally bright, and has a nucleus of the third magnitude. The tail is about 15° long.—D. **Pompéiu**: The functions of complex variables.—Et. **Delassus**: Non-linear linkages.—G. **Reboul** and E. Grégoire **de Bollemont**: The transport of metallic particles under the action of heat. Sheets of copper or silver, near which is placed a sheet of porcelain or another metal, give deposits on the latter when heated. The amount of metal deposited is shown to depend to some extent upon the nature of the gas between the two plates.—Auguste **Marie** and L. **MacAuliffe**: The asymmetry of the Neanderthal, Cro-Magnon, and Spy No. 1 skulls. The application of the method proposed by M. Chervin to casts from these three skulls shows that all are asymmetrical. Three diagrams are given showing the deviations observed.—Paul **Marchal** and J. **Feytaud**: A parasite of the eggs of Cochylis and Eudemis.—E. **Roubaud**: New contribution to the biological study of Glossina. Some data on the biology of *G. morsitans* and *G. tachinoides* from the Nigerian Sudan.—L. **Boutan**: Some peculiarities relating to the mode of fixing of the crustacean *Gnathia halidaii.*

NEW SOUTH WALES.

Linnean Society, July 20. — Mr. W. W. Froggatt president, in the chair.—P. **Cameron**: Parasitic Hymenoptera from the Solomon Islands, collected by Mr. W. W. Froggatt. The parasitic Hymenoptera of the Solomon Islands are practically unknown. Mr. Froggatt's collection comprised representatives of seventeen undescribed species—Chalcididæ, 2; Braconidæ, 6; Evaniidæ, 1; and Ichneumonidæ, 8.—R. J. **Tillyard**: Further notes on some rare Australian Corduliinæ, with descriptions of new species. Seven new or rare Australian Corduliinæ are dealt with. Two new genera, Lathrocordulia and Hesperocordulia, are proposed, and four new species described. One of these is the beautiful yellow and black *Hemicordulia superba* from Pallal, New South Wales. From the same locality the female of *H. intermedia*, hitherto unknown, is also described. Two fine new species sent by Mr. G. F. Berthoud, of Waroona, West Australia, viz. *Lathrocordulia metallica* and *Hespercordulia berthoudi*, form the types of two new and interesting genera, which further bridge the gap between the two main groups of the subfamily. The latter species has a bright red and black coloration, unique amongst Corduliinæ. Lastly, a female of a magnificent new Macromia, *M. viridescens*, taken at Cape York, completes the list of new species.—R. J. **Tillyard**: The genus Cordulephya. This peculiar aberrant genus, originally monotypic and far removed from all existing forms, is enlarged by the addition of a new species, *C. montana*, from the Blue Mountains. The two species, *C. pygmaea*, Selys, and *C. montana*, are described and compared, and their full life-histories given. An interesting "theory of the two broods" is offered as a solution of the differentiation between the two, which occur at different seasons of the year.

August 30.—Mr. W. W. Froggatt, president, in the chair.—Dr. T. H. **Johnston** and Dr. J. Burton **Cleland**: The Hæmatozoa of Australian reptiles, No. 2.—A. M. **Lea**: Descriptions of new species of Australian Coleoptera, part ix. The paper contains notes on some of the types of King's and Macleay's Pselaphidæ; notes on *Xylopsocus bispinosus*, Macl., a species of Bostrychidæ, of which the male protects the female during her egg-laying period, and probably for some time afterwards; and descriptions of new species of Staphylinidæ (1), Pselaphidæ (23, including a new genus), Silphidæ (9), Byrrhidæ (1), Scarabæidæ (2), Lymexylonidæ (2), Ptinidæ (7), Tenebrionidæ (2, including a new genus, with one species of blind insects, the first blind beetle to be recorded from Queensland), and Erotylidæ (1).—Dr. R. **Greig-Smith**: Contributions to a knowledge of soil fertility. No. 2. The determination of Rhizobia in the soil. From a perusal of the literature upon the fixation of nitrogen by the bacteria in the soil, one is led to believe that Azotobacter is the most active. It is not known how many of these organisms may be contained in 1 gram of soil; and, from Löhms's work, we imagine that the members of nitrogen-fixing bacteria are small. By making use of a special medium described in the paper, the author has found as many as three millions of nitrogen-fixing Rhizobia in 1 gram of agricultural soil. The foremost place in the work of nitrogen fixation should, therefore, be given to Rhizobium rather than to Azotobacter, until it is found that the latter is at least half as numerous as the former. The numbers of Rhizobia in the soil afford an indication of its comparative fertility.

Cape Town.

Royal Society of South Africa, August 16.—Mr. S. S. Hough, F.R.S., president, in the chair.—L. **Péringuey**: A note on the Heidje Eibib, or stone mound of Namaqualand. The name Heidje Eibib is usually given to artificial mounds of stone occurring in certain places in Namaqualand and elsewhere, the formation of which is ascribed to the Hottentots, who whenever passing the spot add a stone to the cairn, taking great care, however, that in so doing their shadow is not projected on the mound. But so far there was nothing to prove that these cairns were really a kind of sepulture. Lately, however, one such mound was opened, and it was found that the accumulation of stones covered parts of a body; the skull is, to all appearances, that of a Bush. But the Rev. Mr. Kling informs the author that there are two kinds of Heidje Eibib. The one opened is known as Heidje Eibib Garedje, and would be the grave of a Bush witch doctor, erected by his people. But it is not yet proved that the Hottentot's Heidje Eibib is a grave.—E. **Nevill**: The secular acceleration of the orbital motion of the moon. The paper begins with a critical examination of the records of the principal ancient eclipses of the sun mentioned as being total, or very nearly total, by different Assyrian, Babylonian, Grecian, and Chinese records. The exact conditions of each eclipse have been calculated from the best modern theoretical data according to Hansen's method of computation. As a result, it is shown that with our present knowledge it is not possible by any system of data consistent with the modern observations of the sun and moon to bring all the principal eclipses recorded by ancient authorities as having been total into accord with the tables. The second portion of the paper assumes the existence of a secular acceleration in the motion of the earth around the sun, and proceeds to consider what might be the origin, and to what degree the existence of this cause will modify the motion of the different members of the solar system, and how far the deduced consequences are in harmony with observation. It is shown that the case of the terrestrial tidal effect due to the action of the sun and moon does not form a conservative system, and that the principle of conservation of angular momentum does not hold for any non-conservative system of forces. No other origin for a secular acceleration being apparent, the great difficulty in reconciling the consequences of such a secular acceleration with the known motion of the sun and moon render it preferable to look to one of the other permissible causes as a means of reconciling the existing theories of the sun and moon with the records of the ancient eclipses of the sun and moon.—A. **Theiler**: Some observations concerning the transmission of East Coast fever by ticks. In the experiments it has been proved:—(1) That brown tick imago which as larvæ had become infected with East Coast fever, and had transmitted the disease in their nymphal stage, were no longer infective for susceptible cattle. Four batches of ticks proved their infectivity in the nymphal stage on eight animals, but in their adult stage failed to transmit the disease to two susceptible animals. (2) Ticks belonging to the same batches which were feeding on two animals rendered immune to East Coast fever by inoculation, in the nymphal stage, did not transmit the disease in their adult stage to six animals, thus proving that the brown tick which has become infected in one stage cleans itself in the following stage by feeding on an immune or susceptible animal. (3) Ticks which became infected with East Coast fever in their larval stage, and passed their nymphal stage on a rabbit, did not prove to be infective in their adult stage for susceptible cattle. This conclusion bears out that given above (2), showing that a tick loses its infectivity the first time it feeds on an animal susceptible or immune to East Coast fever. (4) Clean or infective ticks feeding on an animal which has recovered from an attack of East Coast fever do not transmit the disease in their next stage. This conclusion is in support of experiments undertaken eight years ago (*vide* Annual Report of the Government Veterinary Bacteriologist, 1904–5). (5) It has been demonstrated that certain batches of ticks collected at the same time, and which fed under similar conditions, did not transmit the disease in their next stage, even when infected in great numbers and on numerous animals. Other batches of ticks reared in exactly the same way and under similar conditions only infected a few animals, whilst again other ticks proved infective in almost every instance, even when a minimum number were used. It is difficult to give an explanation of this fact, but it is quite likely that outside conditions have some influence. The ticks which did not transmit the disease were bred during the coldest time of the year.

DIARY OF SOCIETIES.

TUESDAY, October 17.

Faraday Society, at 8.—*Adjourned discussion*: The "Paragon" Electric Furnace and Recent Developments in Metallurgy: J. Härden.—Progress in the Electrometallurgy of Iron and Steel: Donald F. Campbell.—The Hering "Pinch Effect" Furnace: E. Kilburn Scott.

WEDNESDAY, October 18.

Royal Microscopical Society, at 8.—Structural Details of *Coscinodiscus asteromphalus*: T. W. Butcher.—Abstract of Paper on the Wheat Plant: A. Flatters.—New British Enchytræids: Rev. Hilderic Friend.—Instantaneous Exposure in Photomicrography: Walter Bagshaw.
Entomological Society, at 8.

FRIDAY, October 20.

Institution of Mechanical Engineers, at 8.—The Endurance o[f] Metals; Experiments on Rotating Beams at University College, London: E. M. Eden, W. N. Rose, and F. L. Cunningham.

CONTENTS.

THURSDAY, OCTOBER 19, 1911.

A VOLUME OF KOHLRAUSCH'S COLLECTED PAPERS.

Gesammelte Abhandlungen von Friedrich Kohlrausch. Erster Band, Elastizität, Wärme, Optik, absolute elektrische Messungen und Verschiedenes. Pp. xxxv+1108. (Leipzig: J. A. Barth, 1910.) Price 25 marks.

THE first paper contained in this collection is dated 1863, the last is dated 1909, less than six months before the author's death. Together they fill more than one thousand pages, and each of them has its own value and interest. When it is considered that the present volume contains none of the work on the conductivity of electrolytes and mobility of ions, in connection with which it is probable that the author's name is best known (the papers on these subjects being reserved for a second volume), it must be admitted that here is remarkable evidence of sustained and well-directed labour.

The half-century that was nearly covered by Kohlrausch's scientific activity was, in relation especially to magnetism and electricity, the subjects at which he chiefly worked, a period of systematising and setting in order, rather than, until near the end, of the discovery of new phenomena leading to essentially new conceptions. Even the reconstruction of electrical theory by Maxwell was based, not on new discoveries, but on a revised interpretation of well-known facts. To those whose personal memory of such things goes back to Kohlrausch's student days, the greatest and most far-reaching of the changes they have lived through must seem to be the universal recognition of the principle of the conservation of energy, and, as essential for the definite statement of this principle, the introduction of the conception of "absolute" units of measurement.

At the time of which we speak, these ideas had been formulated, but they were far from familiar, and the instrumental appliances needed for their practical application scarcely existed. Gauss's method of measuring the absolute intensity of the earth's magnetic field was beginning to find a place in German text-books, but it might be sought in vain in English or French books. A tangent-galvanometer of accurately known dimensions was a rarity. "Resistance-boxes" did not exist. Kirchhoff had, as long ago as 1849, published the experiments that are commonly cited as constituting the earliest actual measurement of a resistance in absolute measure, but no concrete embodiment of his results existed. Wilhelm Weber had distributed a certain number of coils of which he had measured the resistance, but very few physicists possessed a coil, or wire of any kind, of which they knew the resistance, otherwise than by comparison with some accidental arbitrary standard. Though the fundamental principles of absolute measurement are due undoubtedly to Gauss and Wilhelm Weber, the general spread of the conception and the introduction of practical methods founded thereon was, in a great degree, promoted by the Committee on Standards of Electrical Resistance first appointed by the British Association in 1861. The committee's first experimental determination of the "B.A. unit," $10^7 \frac{\text{metres}}{\text{second}}$, was published in 1863. At the same time, Maxwell and Jenkin's memorable paper "On the Elementary Relations between Electrical Measurements" appeared. As the first connected and comprehensive statement of the matter, this paper contributed greatly to promote a more general understanding of absolute measurements.

It is significant of the condition of the current teaching of theoretical physics at this time that, when Tyndall published his "Heat as a Mode of Motion" in 1863, he introduced it as an attempt "to bring the rudiments of a new philosophy within the reach of a person of ordinary intelligence and culture," but he and other popular writers so completely neglected to deal with one-half of the new philosophy that Macquorn Rankine felt called upon, in 1867, to publish a paper, "De la nécessité de vulgariser la seconde loi de la thermodynamique." There was no such thing in those days as a physical laboratory in the modern sense of the word. As Kohlrausch says, conditions were "pinched and patriarchal," and it was quite appropriately that the whole instrumental outfit of a university was called the "physical cabinet."

The state of electrical knowledge at the outset of Kohlrausch's career is well brought out by him in speaking of the conditions under which Gustav Wiedemann wrote his magnificent "Lehre vom Galvanismus und Elektromagnetismus," first published from 1861 to 1863:—

"It is only right that we should call to mind some of the inherent difficulties which beset the production of this classical work, difficulties which increased the labour of the exposition to an extent that we can understand only by a distinct effort of the imagination.

"The thermodynamic basis for the connecting links which now bind all together to a coherent whole was then in course of development, and had not by any means become common property; and in the case of electricity especially a consistent system of measurement was still wanting in a practically accessible shape. It is true that Ohm and Kirchhoff had laid down the laws of the strength of currents, and the foundations of a system of measurement for current, tension, and resistance had been settled by Gauss and Weber, but hitherto very few measurements in definite units had been actually carried out. It is hardly too much to say that the subject of absolute electrical measurement was as yet familiar to but few physicists. The Daniell's cell was almost the only standard of measurement that was commonly accessible. Measuring instruments that gave the strength of a current in intelligible units were not introduced till much later. The measurements of resistance then in use were inconvenient and untrustworthy. I remember my own not very successful struggles with file and plane to construct a rheostat. The statements given in published papers in reference to the units of resistance employed were often uncertain to the extent of 50 per cent. or more."

As was befitting in a son of Rudolf Kohlrausch and a pupil of Wilhelm Weber, our author took an effective part in remedying this state of things, and the present volume forms the first part of a record of what he accomplished.

The contents are arranged by the editors in sections, the first of which, extending to nearly 200 pages, is headed "Elasticity and Capillarity," and contains the author's earliest published papers. The two papers on capillarity, however, belong to the years 1906 and 1907. In the first of them, the author reproduces the substance of a paper by Lord Rayleigh, on the formation of drops, because, as he says, it had been treated "etwas stiefmütterlich" by German periodicals, and he directs attention to the value of the "method of dimensions" used by Lord Rayleigh.

The second section, nearly 100 pages, relating to "Heat, Thermoelectricity, and Gaseous Mechanics," contains almost the only exclusively theoretical paper in the volume. In this paper, Kohlrausch starts from the fact that differences of temperature between neighbouring parts of continuous pieces of metal are an essential condition of the action of a thermoelectric couple. He points out that a thermoelectric current is therefore necessarily accompanied by a current of heat, and, assuming a mutual convective action between these two currents—that an electric current conveys heat and that a current of heat conveys electricity—and assuming further that the quantity of electricity conveyed by a given flow of heat depends on the temperature of the conductor, he arrives at the ordinary formula, which represents the electromotive force of a thermoelectric couple as being proportional to the difference of temperature of the junctions multiplied by the difference between their mean temperature and a fixed temperature depending on the nature of the couple.

The third section, fifty pages, devoted to "Optics," deals chiefly with a method of measuring indices of refraction founded on the phenomenon of total reflection.

The fourth section, more than 650 pages, "Electrical and Magnetic (absolute) Measurements and Methods of Measurement," is the most important in the book. We may mention specially a paper on the "Absolute Value of Siemens's Unit of Resistance," which contains an acute and interesting criticism of the experiments of the British Association Committee. Unfortunately, in his own experiments, Kohlrausch adopted, without personally verifying them, the dimensions of a coil that had been wound by Weber, although he carefully determined every other quantity involved, with the consequence that he obtained an erroneous result. A later determination of the "Absolute Resistance of Mercury" led almost exactly to the value now adopted as the most accurate. The same may be said of a determination of the "Electrochemical Equivalent of Silver," which he carried out in conjunction with his brother Wilhelm. These two investigations seem to have been conducted with the utmost care, and they afford striking examples of the multitude of minute precautions that must be observed when great accuracy is aimed at in the determination of a physical constant. These two papers are the most elaborate in the volume, but all go to show the author's love of exact measurement and furnish evidence that he was pre-eminently in his right place when he was appointed president of the Reichsanstalt.

A final section, 100 pages, is headed "Miscellaneous and Books." It contains some interesting addresses and reports and biographical notices, and the preface to the last (eleventh) edition of the author's "Lehrbuch der praktischen Physik," first published in 1870, under the title "Leitfaden der praktischen Physik."

It only remains to add that the volume is excellently printed and very carefully edited.

G. C. F.

A MODERN HISTORY OF CHEMISTRY.

A Concise History of Chemistry. By T. P. Hilditch. Pp. ix+263. (London: Methuen and Co., Ltd., n.d.) Price 2*s.* 6*d.*

IN this book an attempt is made to trace the development of chemistry from the point of view of its present-day position—that is, from the point of view, say, of a traveller who, having reached his goal, seeks to retrace his route, and to survey, as if from an eminence, the devious and dimly indicated wanderings by which he has attained the coign of vantage he has gained. There are, of course, two ways of writing history. The first, which is by far the more difficult, inasmuch as it presupposes profound knowledge and extensive research, combined with imagination and the faculty of detachment, is for the historian to seek to project himself, as it were, into the particular period with which he is dealing at the moment, and to attempt to elucidate it from the contemporary point of view. In this way he becomes a faithful chronicler of the epoch, reflecting its spirit, correcting its errors, supplementing its truths, and making manifest the gradual evolution and enlargement of the special phase of intellectual, moral, social, or political development with which he may be concerned. Or he may, as in the present case, view the whole course retrospectively. This, no doubt, has certain advantages. But when applied to chemistry it is apt to do an injustice to one's predecessors by belittling their successive contributions to the general knowledge: there is apparently so much chaff to be winnowed, and the kernels of good grain would seem to be so few and so small in comparison with the harvest of to-day. It is apt, too, to give false impressions of the course of reasoning—the movement of the time—by which the early speculators were led to formulate their attempts at a chemical system. It is impossible to do full justice to their efforts unless the historian has that complete sympathy with them which comes from trying to put himself in their place, and so appreciating the motives by which they were guided or impelled.

In a volume of some 250 small octavo pages, which seeks to trace, in the broadest possible outline, the growth of chemistry from the earliest times to the present epoch, there is not much room for dwelling on the philosophy of its history. Mr. Hilditch is chiefly concerned more with results than with motives —with the ordering in historical sequence—of the significant facts of the science, and it is quite remarkable what a number of such facts he has contrived to pack within the limited compass of his book. To the busy student who seeks to acquire merely an *aperçu* of the main current in the gradually broadening stream of chemical knowledge, and has but little interest in the personal aspects or human element in the story, the compilation, concise as it is, will be invaluable. Indeed, the author frankly confesses that his book "is designed more especially for those students whose interest in this aspect of the science is stimulated by the inclusion of 'historical chemistry' in the syllabus of examinations which concern them."

The examinee will certainly get a perfect plethora of the facts of chemical history if he steadily works his way through this volume. Even if he is unable to assimilate a moiety of them, he will at least have the satisfaction of knowing that he possesses in Mr. Hilditch's book a trustworthy and fairly comprehensive work of reference, and as such we warmly recommend it to every chemist, whether he be an examinee or not. The book is excellent in plan, and, in spite of its conciseness, eminently readable. Its arrangement readily enables the searcher to discover the origin and date of practically every fact of importance, even without the aid of the synoptical tables and very full index which are appended.

The book differs from all other works of the kind in its modernity. The author is more concerned, apparently, with the chemistry of our own times than with that of any preceding epoch. There are other works which deal more fully with the science of bygone ages, but there is certainly no book in our language which treats of the story of our own age with the same degree of fulness as the volume before us, and we hope that its sale will be such as to encourage the author to maintain it at its pretty high level of completeness.

THE ANOPHELINE MOSQUITOES OF INDIA.

A Monograph of the Anopheline Mosquitoes of India. By Dr. S. P. James and Dr. W. G. Liston. Second edition, rewritten and enlarged. Pp. viii + 128 + xv plates. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co., 1911.) Price 16 rupees net (25*s*. net).

THE second edition of this work has been long looked for, and we now welcome it in much the same guise as before; for, although "enlarged," it has actually fewer pages than the first edition, the enlargement apparently referring to new plates, though the number of coloured plates remains the same as before. These coloured plates are so excellent that it is a pity that their number could not have been increased. In our opinion the outstanding merits of this book are the clearness of the descriptions and figures, and the provision of very good analytical tables.

We are glad in this edition to see Theobald's scale classification adopted as a first step in arranging the Indian anophelines in their proper zoological position. The authors are quite justified in their criticism of a good deal of scale nomenclature and their admirable plates of scales are a welcome addition, but their division of scales into "false" and "true" is hardly a happy one. In our opinion, "striate" and "non-striate" would have been better terms. In their attempts at revision of specific and generic names, the authors are a law unto themselves. It is not merely a question of nice judgment on the evidence for and against such a name, but there are violations of well-understood and accepted rules. We could give numerous examples of this, but one must suffice. Thus a certain African anopheline bears the name *Nyssorhynchus maculipalpis* (Giles). The authors accept Theobald's opinion that the so-called Indian *maculipalpis* is different; they therefore "change" the name of the Indian species to *maculipalpis* (James and Liston). This substitution of their name is, of course, no change at all, but it leaves us with two identical specific names in the same genus. A *new* name for the Indian species is imperative. We would appeal to the authors to consider this question of nomenclature, and to study carefully the laws governing it, and then publish a list of Indian anophelines with their synonyms. It is their duty to acquaint themselves with the matter fully, even down to the correct way of writing a specific name and its author.

We suppose the method advocated (p. 26) for mounting a collection of mosquitoes has advantages, or it would not have been adopted by the Central Malarial Bureau, but it certainly seems cumbersome, and to fasten nine different objects on to a board with *elastic bands* must sooner or later, in India of all places, spell certain disaster, *i.e.* loss of some of the objects.

Although the book contains an index of specific names, yet generic ones are omitted, and the general index of the first edition has disappeared—a distinct loss. We have noted several erroneous references to plates; *e.g.* three out of five on p. 7 are wrong. As is evident from reading the book, much work remains to be done on the male genitalia, larval stigmata, and eggs, and indeed on the whole bionomics of the Indian anophelines, but this will, we hope, now soon be remedied in India. The book has not, then, reached that ideal standard of excellence we had hoped for, but it must in justice be said, and this is a very practical point, that a worker with this book at his disposal will be able to find out with ease which of the some three dozen Indian anophelines his may be, although in several cases he will certainly be giving them erroneous names.

MINERALS OF RHODESIA.

The Mineral Industry of Rhodesia. By J. P. Johnson. Pp. iv + 90. (London: Longmans, Green and Co., 1911.) Price 8*s*. 6*d*. net.

THIS book is specially addressed to the prospector, and gives a good deal of information as to the occurrence of gold and minerals of economic value that have been worked in Rhodesia, the conditions under which they have been found, and mines of importance with their yields. It also gives an account of the occurrence of tin in other mines of South Africa outside Rhodesia, where minerals have been worked which the author thinks might reasonably be expected within the limits of the colony itself.

Gold has proved, up to now, the most important of the metals mined, a value of 2,508,200*l*. having been recovered in 1910. It occurs chiefly as free gold, but alloyed with a varying quantity of silver, and is found disseminated through various rocks, *e.g.* granite syenite, granulite, various schists, ironstone, and quartzite; but quartz veins traversing various rocks are the dominant gold carriers, all situated close to the granite contact. These veins vary greatly in width, and also in yield, the average yield for 1910 being 30*s*. 9*d*. per ton milled.

Nearly all the mines are situated on old native workings, and the quantity of gold taken from these workings, which sometimes attain a depth of over 200 feet, must have been considerable.

The blunders of pioneer mining companies and resultant financial difficulties have furnished a rich harvest for tributers, who have made handsome profits.

In a large number of the reefs a serious falling off in values is encountered at the water level, their payability down to that point apparently being due to secondary enrichment.

The conditions of Rhodesia are not favourable to the formation of extensive alluvial deposits, and very little gold has been derived from that source.

Other metals than gold are coming increasingly into prominence. Chromite has been mined continuously and with a progressive output since 1905 from a hill of the mineral at Selukwe, the output in 1910 being 44,000 tons, of a value of 98,130*l*., most of the mineral being shipped to America.

Wolfram and scheelite have been produced in the Buluwayo and Hartley districts of a total value of 10,930*l*.

Nickel and cobalt have not been found, but the author describes their mode of occurrence and the characters of the minerals at Sudbury and New Caledonia as a guide for prospectors.

Copper ores are very widespread in Rhodesia, and the author describes the Kansanshe, Bwana M'Kubwe, and Umkondo and Alaska deposits, on all of which there have been extensive old workings, those on the Alaska extending in an almost unbroken line for about 1700 feet with an extreme width of 660 feet, and have been proved to go down in some places to a depth of at least 70 feet. The copper so far exposed is mainly in the form of malachite, the sulphide zone not having yet been reached. It is disseminated through a crushed belt of limestone.

Lead and zinc are found as an enormous body in the well-known occurrence at Broken Hill, which is remarkable for the large development of phosphates of lead and zinc within the zone of oxidation. The Penhalonga Gold Mine has yielded lead as a by-product.

Molybdenite occurs on the farm Appingadam. Bismuth and antimony have only as yet been found in Rhodesia with the gold ores rendering them refractory. The output of silver is obtained mainly as a by-product in the treatment of gold ores, and partly from the argentiferous galena of the Penhalonga Mine, but no true silver minerals have as yet been found.

A chapter is also devoted to the non-metalliferous minerals of Rhodesia, which, while interesting, space does not permit us to notice, and the book concludes with a chapter giving hints to prospectors which they will find of interest.

Generally speaking, the book is clearly written, and contains a good deal of information; it should be in the hands of anyone who is devoting his attention to prospecting in Rhodesia.

THE FOUNDATIONS OF SCIENCE.

Die logischen Grundlagen der exakten Wissenschaften. By Prof. Paul Natorp. Pp. xx+416. (Leipzig and Berlin: B. G. Teubner, 1910.) Price 6.60 marks.

Probleme der Wissenschaft. By Federigo Enriques. Uebersetzt von Kurt Grelling. Erster Teil, Wirklichkeit und Logik. Pp. x+258+16. Price 4 marks. Zweiter Teil, Die Grundbegriffe. Pp. vi+259-599. Price 5 marks. (Leipzig and Berlin: B. G. Teubner, 1910.)

THE publication of these works, and, indeed, of the whole series to which they belong, furnishes further evidence for the revival of the interest in the ultimate problems of science, an interest which becomes very much alive so soon as an important branch of investigation reaches the borders of the knowable, and stands in danger of losing itself in unphilosophic disputations. Such an event is at present taking place in physics in connection with the relativity hypothesis, and before we reach the end of the controversy the logical foundations of science will have been thoroughly overhauled.

Prof. Natorp's work is practically a treatise on the fundamental principles of mathematics. It deals with such subjects as infinity and continuity, direction and dimension as determining pure number, time and space as mathematical structures, and the temporal and spatial arrangement of events. The treatment of the problems touched upon is detailed and thorough, and often leads to very decided (and, let us hope, decisive) pronouncements on present-day problems, as when the author declares it to be impossible to decide between the Euclidean or non-Euclidean structure of our space by means of any imaginable physical experiments. A brief summary of the new Principle of Relativity as formulated by Lorentz, Einstein, and Minkowski concludes a very informing and valuable work.

Prof. Enriques's two volumes are more practical and empirical, and will probably appeal to a wider circle of readers than Prof. Natorp's. The style is vigorous, and sometimes distinctly informal, and for that very reason the book is more readable than is the average work on these recondite subjects. His definition of "reality" is interesting. "Our belief in the reality of a thing," he says (p. 85), "supposes a totality of sensations which follow invariably upon certain conditions arbitrarily provided." This, as the author himself perceives, does not eliminate the possibility of a complex hallucination, unless we assume that the will is entirely in abeyance during hallucination. Those who prefer to regard reality as simply the "hallucination" common to the majority of mankind will scarcely be won over by the author's attempt to attain a definition more flattering to our self-esteem. A terse definition of reality as "an invariant in the relation between volition and sensations" (p. 100) expresses very aptly the author's point of view. The chapter on the physiological bases of logic brings out clearly the author's ultra-modern methods, and his treatment of non-Euclidean geometry shows that he is not greatly out of sympathy with Poincaré's demand to regard all postulates, not as fundamental verities, but as mere mutual agreements among philosophers.

The last chapters of the book deal with the root laws of mechanics and physics in a brilliant and entertaining manner, including, of course, the Principle of Relativity. In the treatment of the latter, it is regrettable that the author stopped at the Fitzgerald-Lorentz contraction without going on to Einstein's all-important work. His final *tour de force* is to show that freedom and necessity are not incompatible, inasmuch as there is a necessity for freedom in biological processes. That, at all events, seems the most concise way of putting his argument.

OUR BOOK SHELF.

The Book of Buchan: a Scientific Treatise, in Six Sections, on the Natural History of Buchan, Prehistoric Man in Aberdeenshire, and the History of the North-east in Ancient, Medieval, and Modern Times. By Twenty-nine Contributors. Edited and arranged by J. F. Tocher. Pp. xxi+508. (Peterhead: The Buchan Club, 1910.) Price 10s. 6*d*.

THIS is a compendium of essays, somewhat on the lines of the Victoria County Histories, dealing with the natural history, archæology, and history of a district of north-east Aberdeenshire, known from ancient times by the name of Buchan. The essays, which are published by the local Field Club and edited by its secretary, are of varying degrees of merit. There are excellent essays on the geology of the district by Mr. A. W. Gibb and Dr. T. F. Jamieson. Prof. J. A. Thomson gives an admirable sketch of the fauna of the district and their origin. Prof. Trail deals with the flora in an essay which is chiefly concerned with pointing out the imperfections of the present knowledge of the subject, and urging the local botanists to complete the survey which he himself has so well begun. A valuable essay on "Stone Cists in Aberdeenshire" is contributed by Prof. R. W. Reid, to which are added tables of measurements of the skulls and limbs of the remarkable race which inhabited east Aberdeenshire in the late Neolithic and early Bronze age. Important contributions also bearing on the prehistory of the district at the same epoch are "The Prehistoric Pottery of Buchan," by the Hon. John Abercromby, and "Some Notes on the Stone Circles of Aberdeenshire," by Sir Norman Lockyer. These essays represent the latest views on these interesting archæological questions by acknowledged authorities.

The remainder of the volume deals with the history of Buchan from the beginning of history up to modern times. Some of these contributions show evidence of considerable research and mastery of the subject, notably that on "Life in the Northern Burghs before the Reformation," by Dr. P. Giles, of Cambridge.

Many of the contributions are, however, not up to the above high standard. We have an essay on Gaelic place-names of a type which usually is produced by the Celtic scholar with insufficient knowledge of philology, who relies chiefly on picking out words of similar sounds from a Gaelic dictionary. It is not surprising either that the editor, who writes with an air of great authority on nearly all the various subjects dealt with in the volume, should sometimes be caught tripping. We find him waxing enthusiastic about the maps of Ptolemy, evidently ignorant of the fact that there is no evidence that Ptolemy ever drew any maps, all the so-called maps of Ptolemy having been drawn by modern geographers from Ptolemy's descriptions. He also ascribes the writings of Bede to the seventh instead of to the eighth century.

On the whole, however, the volume is a credit to the science and scholarship of Aberdeenshire.

The Senior Botany. By Prof. F. Cavers. Pp. vii+484. (London: University Tutorial Press, Ltd., 1910.) Price 4*s*. 6*d*.

LIKE the three earlier text-books which Prof. Cavers has prepared for this series, the present work is admirably designed to portray the plant as a living entity, to indicate how structure is subservient to function, and to show that conditions and purpose underlie the manifold variations which plants assume. Much of the earlier chapters has appeared in one or other of the former books; the broad bean plant is selected as the introductory type, and the same satisfactory arrangement of information supplemented by experiment is adopted. Although a chapter is devoted to the microscope and cell structure, evidence requiring microscopic examination is generally avoided.

Photosynthesis is taken as the starting point for explaining metabolism, and the attractive theory, for which, however, further proof is required, of a conversion from light to electrical energy as the crucial operating factor is definitely formulated. Incidentally it is suggested that carbon assimilation is a more suitable expression than photosynthesis, but this depends upon the application of the term assimilation. Here, too, it seems desirable to raise a protest against the use of the word "stomate" on the grounds that "stoma" is more correct, and used generally, if not universally, by the best authorities. Among the various forms of transpiration measuring instruments, the best and simplest is not given; also it is observed that the interesting subject of soil physics is omitted except to advise reference to agricultural books.

There is an extensive chapter on ecology, which, with the chapters on flowers, classification, fruits and seeds, deserve special praise, as they are all explicit, stimulating, and copiously packed with detail; a few minor points of criticism arise, notably the description of monocotyledons as a lower class than the dicotyledons.

It should be understood that the qualification "senior" refers to the local examinations of Oxford and Cambridge. The book is well adapted for its purpose, although there is more information than most pupils in schools could assimilate; in addition, it can be strongly recommended to students in the polytechnics as a sound guide to the study of plant-life.

Praktikum der experimentellen Mineralogie mit Berücksichtigung der kristallographischen und chemischen Grenzgebiete. By Prof. E. Sommerfeldt. Pp. xi+192. (Berlin: Gebrüder Borntraeger, 1911.) Price 4.80 marks.

THIS little book is a veritable *multum in parvo*. It is astonishing how much information Prof. Sommerfeldt has succeeded in compressing into so small a compass; he has covered practically the whole range of physics and chemistry so far as these subjects may be applied to the determination of the characters of minerals. He rightly believes that, while a careful study of the variety of specimens contained in a large mineral collection is most helpful towards acquiring facility in recognising mineral species, yet it is always desirable to be able to confirm a judgment by, or even to base it wholly upon, a few well-chosen tests, and this book is intended to assist students and others who may have occasion to identify mineral specimens in carrying out such tests.

The opening chapter deals with the goniometrical measurement and the perspective drawing of crystals, the calculation of the fundamental morphological data, and the measurement of refractive indices by the method of minimum deviation. In the next chapter the author passes on to the chemical examination by means of the blow-pipe, microchemical reactions, and the quantitative determination of the precious metals, coal, &c. The third chapter is concerned with crystal optics, and the fourth with the special application of these properties to use with the microscope. The last chapter includes the remaining physical characters, such as hardness, specific gravity, pyroelectricity, etching, melting point, and crystallisation, the phenomena presented by mixed crystals being considered at some length. In an appendix the author offers some hints on the kind of apparatus useful for prospectors and generally travellers interested in minerals, and considers the special case of precious stones.

The book has been carefully written, the hints given being evidently based upon the author's own experience, and it will be found to serve well the purpose for which it is intended.

Mikrographie des Holzes der auf Java vorkommenden Baumarten, im Auftrage des Kolonial-Ministeriums, unter Leitung von Prof. J. W. Moll, bearbeitet von H. H. Janssonius. Dritte Lieferung. Pp. 161–540. (Leiden: E. J. Brill, 1911.)

THIS is the third part of an extensive publication, designed to take advantage of a large number of Javanese wood specimens collected by Koorders with a view to the preparation of a forest flora for Buitenzorg. The collection is unique because corresponding herbarium material was gathered at the same time, so that the identity of each specimen can be accurately determined. The herbarium material was critically examined and described in the "Additamenta" noted in the title. The microscopic investigation is being conducted by Mr. H. H. Janssonius in great detail; a "topographical" or general description of the sections which would serve for most purposes is not considered sufficient, but copious details are supplied for each type of cell represented. Figures are only given for one species of each genus, and the scale of 1 : 25 is adopted; it would have expedited reference if a figure had been provided for each species on a scale of 1 : 10, enabling direct comparison to be made with illustrations provided in several standard works. The most valuable feature is the summary of anatomical characters drawn up for the analytical determination of genera and species. Prof. Moll suggested, in a notice of the earlier parts subscribed to the *Botanische Centralblatt* (vol. cxiii.), that it should be possible to determine not only the families but genera, and occasionally species, by the characters of the wood; the full consummation of this scheme is reserved for a final survey.

A book on these lines has long been a desideratum. Some estimation of the magnitude of the work can be formed when it is mentioned that this part completes a second volume of 540 pages, devoted entirely to the Disciflorae represented by 163 species or varieties.

When Should a Child Begin School? An Inquiry into the Relation between the Age of Entry and School Progress. By W. A. Winch. Pp. iii+98. (Baltimore: Warwick and York, Inc., 1911.)

MR. WINCH's book is an admirable example of educational inquiry as it should be pursued. Instead of arguing on *a priori* grounds that children under five are better at home than at school, he shows by careful statistical methods what the actual effect of early entrance upon school courses is. His research shows in a thoroughly convincing way that those who begin school about five years of age do quite as well—often very much better—than those who begin at an earlier age. Stated quite moderately, it is clear that it makes no actual difference to the future school record whether a child begins at three or at five, though incidentally the figures suggest that delay beyond the fifth year is actually disadvantageous—a point in favour of English as opposed to German practice. Of course, many school authorities have already ceased to provide for children so young, not because of Mr. Winch's work, but because the State has withdrawn the grants. Yet it does not follow, of course, that the social value of the babies' classes in the infants' schools is nil. It is something that overworked wives are relieved for a few hours a day of the strain which young children in a small house commonly bring. But it is abundantly clear that formal school lessons of any kind before the fifth year is completed are quite unnecessary. Hygienic surroundings and playful occupations with abundant opportunities for sleep are chiefly wanted. Trained nurses rather than trained teachers, crèches rather than schools, would perhaps meet the situation. J. A. G.

LETTERS TO THE EDITOR.

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

The Orientation of the Great Temple of Amen-Ra at Karnak.

IN 1891 Sir Norman Lockyer made a magnetic survey of the axis of the great Temple of Amen-Ra, at Karnak, with the view of determining an astronomical date for the original building.

Since that time a great deal has been done in excavating and exposing the foundations of the older work along the temple axis, chiefly under the personal supervision of M. Legrain, of the Department of Antiquities, who for sixteen years has been the director of the explorations at Karnak.

On my recent visit to Karnak, where I spent some weeks, M. Legrain gave me the greatest assistance to enable me to make a resurvey of the axis in the light of the many new discoveries, and particularly in pointing out the parts of the original buildings still *in situ*, many of which he had himself uncovered, and all of which I afterwards measured and centred up.

Unfortunately, I arrived at a very unlucky time for carrying out this work, as the place was crowded with Arab workmen hauling out great stones from the excavations, and gangs of boys carrying baskets of earth from the diggings, all making as much noise as possible, that the place was more like a busy ant-hill than the eternal calm which might be expected in an Egyptian temple. In addition to this, the tourist season was at its height, and personally conducted parties were continually passing up and down, and naturally made a highway of the axis where I had set up my instruments. One soon forgets small inconveniences; but the torment of the insects, when both hands were occupied, is brought to mind by a remark made to me by a passing gentleman from the far West when he said, "Mr. Surveyor, I guess you're having a bully time with them flies."

In the end I managed to peg out a line, down as much of the axis as I could get at, 523 feet long, from the columns in front of the sanctuary down to the lower end of the Hypostyle Hall; unfortunately, both the extremities of the line are blocked up. The sanctuary itself is completely filled up with the huge stones of the fallen roof, and the last columns of the Great Hall at the other end are at present built round with stones and bags of sand on account of the repairs being carried out to the neighbouring pylon, while the pylon itself is timbered up to prevent its falling, so that the two important points for a survey of this part of the axis cannot be used at present.

The line at this end of the axis had to be continued by the theodolite alone, as no measures for centring were possible, as it had to be carried through the Rameses Pylon into the Outer Court so far as the standing pillar of Tirhakah in order to get the true bearing of the central line by observations of the Pole Star, that star not being visible from any place on the axis inside the buildings.

The result of the survey in general quite confirms the data used by Sir Norman Lockyer in fixing the date at which the original axis was laid down, viz. about 3700 B.C. —a date which M. Legrain fully accepts on the results of his excavations, as the building of the upper end of the temple has been assigned on archæological grounds to about this period; indeed, two statues have been dug out by him, both now in the Cairo Museum, which give direct evidence as to the date. One is a seated figure of Cheops with his cartouche (of the fourth dynasty), the date of which is given in the lists as B.C. 3733, and the other is a headless figure which has been assigned to the work of the third dynasty. These figures were, of course, dug up long after Sir Norman Lockyer's survey; no older work has been found.

The height of the hills behind which the sun used to set at the summer solstice, to which the temple was oriented, was taken at 2° 30′. From the spot I was able to climb up to on the stones filling the sanctuary, to what I thought was about the height of an altar, I made it a little more; but as I had to see the hills through the timbering of the Rameses Pylon, between the struts, I could only measure the small part which was not covered; if this is the correct height, as I believe it to be, it would make the date of the foundation a little earlier, possibly to the time of the headless statue, which M. Legrain has assigned to B.C. 4000.

There are a great many difficulties just now in carrying out such an accurate survey as is required to arrive at an astronomical date of any value on account of great work that is being carried on. It must be remembered that the temple is about 1200 feet long, and stands on an area about five times that of St. Paul's, and is divided into numerous halls, corridors, and gateways; but all these are connected by the axis which runs through the whole building from east to west. This axis, when originally laid down, pointed to the place on the hill at which the sun disappeared behind it on the longest day, and the difference between the place where the sun set then and where it sets now gives the date of the foundation of the temple, the rate of the sun's change in declination being known.

M. Legrain tells me that in about two years' time he will have cleared out the fallen roof of the sanctuary, and that by that time he hopes the repairs to the Rameses Pylon will be completed and the timbering removed. In that case a unique opportunity will present itself for a survey of the whole of the axis at once from the court behind the opened-out sanctuary right down to the Ptolemaic Pylon at the west; and this Mr. Dowson, the Director-General of the survey in Cairo, has very kindly undertaken to have done by the survey officers so soon as the work is completed.

Howard Payn.

20 Hyde Park Place, W., October 11.

A Possible Relation between Uranium and Actinium.

It is believed fairly generally that actinium has its source in the disintegration of uranium, although it is not a member of the direct line of descent through radium. This belief is based mainly on the fact that actinium and its products have a constant ratio to uranium in minerals, and since this ratio is very small actinium is supposed to be a branch-product.

In *The Philosophical Magazine* for September Mr. G. N. Antonoff describes some experiments in which a new product is obtained, called uranium Y, and gives strong reasons for the view that it is derived, not from uranium X, but directly from uranium. It is always in a small ratio to uranium X. Antonoff has shown that it is probably a branch-product, and a possible origin of the actinium series.

The following considerations may indicate how such a branch-product could be formed. They were not thought worthy of mention until the starting point of a branch-series had been found experimentally. If a single atom of uranium begins to disintegrate, it ordinarily leads to the whole radium series, without disturbance from other atoms. But the molecule of uranium will contain at least two atoms chemically combined, and perhaps a large number. An instability arising in one atom may frequently produce a similar instability in a contiguous atom, or even a projection of one atom into another, so that two atoms may break up together and form new combinations.

The scheduled atomic weight of uranium is 238·5. Two such atoms have a weight 477. If they break up together and form only one substance, it might have a molecular weight equal to that of uranium, or $\frac{1}{2}$, $\frac{1}{3}$, . . . of that of the combined atoms. On the assumption that three atoms of a substance are formed, its atomic or molecular weight is 159.

The experiments of Russ appear to give the most trustworthy value of the atomic weight of actinium emanation. They showed that the thorium emanation is 1·42 times as heavy as that of actinium. If thorium emits two α particles, both helium atoms, its emanation should have an atomic weight about 224. The atomic weight of actinium emanation thus becomes about 156.

On a theory of the constitution of the elements given to the British Association by the writer at Portsmouth, it is more likely that the emanation from thorium has the same atomic weight as that from radium, and that actinium emanation has an atomic weight of 152·5. Russ's experiments would then lead to a value very close to this for actinium emanation. It is, of course, difficult in most cases to obtain satisfactory conclusions from such experiments on diffusion, but there are strong grounds for thinking that in this special case the usual sources of error have been minimised.

If uranium Y be formed in this way, with an atomic weight 159, it may well be the parent of actinium, whether the suggested atomic weight of the emanation be correct or not, and it is not unlikely that at certain stages in the radium series a similar series of branch-products of low atomic weight may be produced. There is evidence of this in the complex product radium C.

J. W. Nicholson.

Trinity College, Cambridge, October 11.

Hot Days in 1911.

Mr. MacDowall's letter in Nature of October 12 (p. 485), in which he directs attention to certain features in the sequence of annual number of hot days at Greenwich, is interesting. Nevertheless, I think he himself will acknowledge that his example, viz. the summer of 1911, is a happy one. What his diagram would lead one to expect if one were making a forecast, and not a retrospect, is that the number of hot days in 1911 would lie between his lower limit of 90 days and an upper limit of about 90+130, or 220 days; the value half-way between the two, *i.e.* 155 days, being the "most probable." Clearly in this case the upper limit, and also the most probable value, may be disregarded, and the lower limit is sufficiently high to be worthy of note.

The fact is that the dot for 1909, the ordinate of which is sought, lies on the lower edge of the boundary of the area of dots, so that in this case the lower limit gives a close approximation to the truth. If a dot happens to lie near the upper edge of the area of dots, the upper limit of its range along the vertical of the diagram becomes a close approximation. But since the difference between the upper and lower limits is no fewer than about 130 days, that is, 53 days more than the average number of hot days per year, it is evident that the method will seldom give results that are useful.

I think the most striking fact brought out by the diagram is that a distinct relationship exists between the total number of hot days in five consecutive years and the difference between that number and the corresponding one for the next five years. I have used the diagram to find the coefficient of correlation between these quantities, and I find that its value is as high as -0.725 ± 0.059.

Five hot years are thus usually followed by five cold years, and *vice versa*. This may be accounted for by supposing that the number of hot days at Greenwich is subject to a regular fluctuation with period not far from 10 years. If the period were exactly 10 years the coefficient of correlation would be nearly -1, and all the dots would practically lie on a straight line passing through the origin of the diagram. The fact that they do not lie on a straight line means either that there is another period or periods superposed, or that 10 years is nearly, but not quite, the true period.

It would be interesting to learn whether the directions of the lines joining successive points (chronologically) on the diagram show any sort of regularity. If they proceed generally in a clockwise direction they indicate that the period is slightly greater than 10 years; if in a counter-clockwise direction the period is less than 10 years. The whole arrangement is similar in some respects to Dr. Schuster's well-known periodogram. R. CORLESS.

October 14.

Insects Feeding on "Slime Flux" of Trees

MY attention has been directed to three elm trees at Ettington, near Stratford-on-Avon, which it is said have been "killed by wasps." It appears that the wasps were attracted by the sweetness of the sap, and attacked the trees in such swarms, and so drained them of sap, that the death of the trees seems imminent, all the leaves having gone yellow long before the usual time.

I should be glad to know if others have noticed similar attacks on elm trees, and whether the averred sweetness of the sap is due to some previous degenerative change in the tissues of the tree, or whether wasps would attack a normal tree if they could get access to the sap.

The elms are all three comparatively young trees, and belong to the common variety. My informant tells me that he has previously noticed the same thing happen with an elm tree in one of his fields, which died the next winter.

JOSEPH A. GILLETT.

Woodgreen, Banbury, October 9.

A SIMILAR phenomenon may be seen at the present time in the collection of elms at Kew. The trunk of a fine specimen of *Ulmus parvifolia* has for some weeks past—but more especially during August and September—been the daily rendezvous of hundreds of wasps and bluebottles. As is the case with the trees at Ettington, the attraction is the sweet sap that exudes from the trunk. It is a mistake, however, to blame the wasps for the damage that is being done to the trees. They do not cause the outflow of sap, but are merely there feeding on it. A piece of bark has been removed from the tree at Kew and microscopically examined. It was found to be suffering from what is commonly known as "slime flux," the bark being saturated with sugary moisture. The primary cause of this somewhat obscure disease appears to be a yeast, which finds its way to the cambium layer by means of a wound. Often, as in the Kew instance, ingress has been facilitated by the borings of an elm beetle. The yeast sets up a decomposition of the cells, and starchy, ultimately sugary, products are formed, which exude from the trunk in solution. It is this which attracts the multitude of wasps, bluebottles, and other insects. It is evident from the odour of the bark that a certain amount of fermentation is going on, and the presence of alcohol is further indicated by the behaviour of the wasps, which, after feeding for some time, become stupid and lethargic.

Although "slime flux" is not an uncommon disease of trees in Britain (it is much more prevalent on the Continent), it is not one of the most troublesome. Still, where it attacks it is nearly always ultimately fatal. The Kew tree is evidently suffering from severe debility. Unfortunately, the disease, as a rule, has become firmly established before there are any outward indications of its existence. When noticed on a branch the part attacked can be removed, but when the trunk is badly affected there seems to be no means of curing it. W. J. B.

Meteor Showers.

THE following meteor showers become due about the time when the Orionids may be expected to put in an appearance:—

Epoch October 18 22h. (G.M.T.), approximately twenty-ninth order of magnitude. Principal maximum, October 20 12h. 45m.; secondary maxima, October 20 11h. 15m. and October 22 8h. 10m.

Epoch October 20 9h. 30m., approximately fifth order of magnitude. Principal maximum, October 21 11h. 15m.; secondary maxima, October 20 9h. 30m. and October 22 10h. 35m.

From the foregoing it may be seen that there is likely to be a considerable amount of meteoric activity on the nights of October 20–22. These three nights seem well favoured as regards maxima, which occur at times very suitable for observations.

Other radiants besides that in Orion may be found active on the nights mentioned, but Orionids ought to prove most numerous on the night of October 20, as it is on this night that the general Orionid maximum becomes due. JOHN R. HENRY.

October 16.

The Possible Identity of the Kiess Comet.

IT is well known that the aphelia of many comets are grouped at distances which are nearly the same as those of the larger planets, and astronomers have sometimes attempted to use this fact to demonstrate the existence of a planet beyond Neptune. M. Flammarion mentions two cases—a comet which appeared in 1532 and 1661, and Tuttle's 1862 comet, which is related to the Perseid meteors, and has a period of $121\frac{1}{2}$ years. These are taken as indications of a planet at a mean distance of about 48 astronomical units. The evidence is obviously insufficient; and special interest therefore attaches to the statement that the Kiess comet (1911*b*) is possibly the same as 1790 I. If the identity can be established, this comet must belong to the same group as the other two, and may be regarded as strengthening their evidence as to the hypothetical planet. P. H. LING.

7 Chandos Road, Redland, Bristol, October 2.

Standard Time in New Zealand.

I NOTE that in NATURE of March 16, in an article headed "Standard Time in France," it is stated on the authority of "Hazell's Annual" that the standard time adopted in New Zealand is 11 hours fast on Greenwich.

This is not correct. New Zealand standard time is the time of the meridian $172\frac{1}{2}°$ E., that is, $11\frac{1}{2}$ hours in advance of Greenwich civil time. This is correctly stated in "Whitaker's Almanac," 1911, p. 89.

G. HOGBEN.

Seismological Observatory, Wellington, New Zealand, September 4.

Habits of Dogs.

MR. VENABLES's reference to formic acid (NATURE, September 21, p. 382) reminds me that once, in the pine-woods at Potsdam, I came upon a forester performing some curious evolutions, apparently patting something on the ground and then holding his hands to his face. He explained that it was an ant-hill, and the smell was "very good for the nerves." A. EVERETT.

ARCHÆOLOGY IN EGYPT AND GREECE.

NO great discovery has marked the progress of archæological excavation in the Near East during the past season. The fierce heat of summer has now, at the time of writing (August), stopped all excavation by us northerners in the lands of the eastern Mediterranean, and probably only the Cretan archæologists at Tylissos (and possibly the Italians, also in Crete) are still in the field. The work of winter and spring is over, and we may now sum up the more important results of it.

In the Nile-basin the most sensational find has been that of Profs. Garstang and Sayce, working for the Sudan Excavations Committee of the University of Liverpool, at Meroë, in the Sudan, the ancient seat of the kingdom of the Kandake queens. The splendid bronze head (Fig. 1) of an imperial Roman of the first century A.D. (no doubt Augustus himself), which was on view in June in the rooms of the Society of Antiquaries at Burlington House, and has now been acquired by the British Museum, was alone sufficient to "make the fortune" of any excavator; while the nuggets and cakes of gold which a lucky chance revealed to Prof. Garstang's spade are no doubt a very unusual sensation in archæology. To the Sudani, and not less to the Egyptian and the Nilote Greek, it must have seemed that one antîka-hunter, at any rate, had at last obtained what all must really be seeking—gold.

Gold, far more than iron nowadays, "doth of itself attract a man"; and for its gold alone the Meroë excavation would be remarkable to the vulgar, while the head of Augustus renders it remarkable to the *cognoscenti*. But we cannot dignify either the finding of a heap of ancient dross, though intrinsically valuable and useful on account of its value, or that of a fine Roman bronze head, as a great discovery. The great discovery was made last year, when the Meroë of the Kandakes was found, and the temple of Amen mentioned by Herodotus was identified. The smaller finds this year are less interesting than those of last year. There is more of the remarkable African-looking, hand-made pottery which to our eyes unmistakably stamps the Meroïtes as pure negroes of central Africa, Nilotes perhaps, but certainly negroes; as, indeed, we see in their rude pseudo-Egyptian representations of themselves and of the Egyptian gods whose worship they caricatured.

Of the history of the Roman head and how it got to Meroë, we can only conjecture that in some raid northwards into Upper Egypt the head of an imperial statue of heroic size, set up possibly at Syene, was struck off and carried by the barbarians back to Meroë. Though in the reign of Augustus the Roman general Petronius took Napata (Gebel Barkal) from one of the Kandakes (in punishment for just such an incursion as has been postulated), the place was not retained, and there is no likely place for a big public statue of an emperor anywhere south of Syene: it is not at all probable that so fine a figure as this must have been would be set up at the southern frontier station of Primis (Ibrîm). From Syene then we must suppose that the head originally came, and it is most like a young Augustus, of all the imperial family: perhaps one may almost call it an Octavian. Germanicus it certainly is not, nor is a statue of Germanicus in Egypt in any way probable, or even possible, in spite of the honour with which he was received: he was there illegally, in violation of the law of Augustus which forbade those of senatorial rank to visit that country. The head has now been placed in the British Museum through the generosity of the Sudan Excavations Committee, in consideration of a gift of a thousand guineas towards the committee's further excavations by the National Art Collections Fund. The photograph here shown was kindly lent by Prof. Bosanquet.

As for the gold, one might well wish that it could be coined into sovereigns, each with the word Meroë stamped upon it in the manner of the Vigo money, coined of the silver captured out of Spanish galleons at Vigo, of Queen Anne. But it is to be feared that the "Meroë" sovereigns would as soon pass out of circulation as did those of President Kruger!

Generally speaking, the Liverpool excavations have been of great interest as showing us more of the life of this curious Egyptianised negro kingdom of Meroë, whose Queen Kandake sent the eunuch to Jerusalem who was converted to Christianity and baptised by St. Philip on the way to Gaza (Acts viii. 27). There is no proof that he perpetuated his new religion at Meroë, though long afterwards the Ethio-

FIG. 1.—The Meroë Head of Augustus.

pians were strong Christians and handed their faith on to the non-negro Abyssinians, who (absurdly) like to call themselves "Ethiopians" to-day.

Passing northward to the modern border of Egypt and the Sudan, the scene of many an Ethiopian foray in old Roman days and many an Egyptian razzia in days then ancient, we find that at Farrâs, north of Wadi Halfa and just on Sudanese territory, Mr. F. Ll. Griffith, reader of Egyptology in the University of Oxford, has, assisted by Mr. Blackman, excavated a large number of tombs of late period, ranging from Ptolemaic to Christian days. Very interesting pottery has been found, linking up that of Meroë with that of Nubia exemplified by Mr. Randall-MacIver's finds at Areika (see NATURE, April 28, 1910), but at the same time presenting constant points of difference and originality. Additions have also been made to our store of inscriptions in the

"Meroitic" demotic script, of which Mr. Griffith is the first to begin the decipherment.

One cannot describe in detail all the various excavations, some regular, others ephemeral, that are set on foot every year in Egypt. The season has not been remarkable for discoveries. The Egypt Exploration Fund, premier and pioneer of modern scientific excavation-societies in Egypt, has dug with success at Atfih in Middle Egypt (this work was carried out by Mr. de M. Johnson), and has steadily gone on with the thorough exploration of Abydos which it resumed two years ago. The Fund's expedition at Abydos was directed by Prof. Naville, assisted by Mr. T. E. Peet and Mr. James Dixon. The work of supplementing Prof. Petrie's former excavations of the royal tombs of the first dynasty at Umm el-Qa'ab by further investigations has been brought, at any rate temporarily, to a conclusion, the previously unexplored portion of the Mound having been thoroughly excavated. Last year interesting discoveries had been made, including a fragment of a crystal bowl with the name of an early king (well known from the former discoveries of Amélineau on the same site), which has been the subject of scientific discussion and is now in the British Museum.

The results of this year's work from the tombs explored in the necropolis of Abydos (not Umm el-Qa'ab) have been exhibited, not in England, but at Boston. The Egypt Exploration Fund is an Anglo-American society, and it is fitting that the yearly exhibition should occasionally, at least, be held in the United States.

Next year Prof. Naville proposes to proceed to the complete exploration of the "Osireion," an extraordinary subterranean (or apparently subterranean) sanctuary of Osiris, close to the great temple of Seti I. This Osireion has already been attacked by the Egyptian Research Account, several years ago, and the results of this work were published by Miss M. A. Murray. But various reasons did not allow of the heavy work of emptying this tunnel being concluded, and it now remains for the excavators of the Exploration Fund, directed by a veteran whose speciality has always been precisely this kind of work, to discover the hidden secrets of the Osireion. But for a big work of this kind money is necessary. Subscriptions for the Fund are urgently required, and the office of the secretary is 37 Great Russell Street, W.C. Among recent subscribers to this work may be mentioned, as an instance of Japanese interest in all branches of science, the University of Kyoto, which has already received from the Fund many interesting relics of ancient Egypt to be studied by the youth of new Japan.

The other British society at work in Egypt, the Egyptian Research Account, has, under the direction of Prof. Flinders Petrie, continued its work at Memphis and elsewhere. An interesting series of Græco-Roman portraits from Hawara, similar to those discovered by Prof. Petrie at the same place many years ago, has been exhibited at University College, Gower Street, this summer, together with sculptures from the Egyptian Labyrinth and from Memphis, and prehistoric vases and flints from a site explored during the season's work.

Turning to Crete, we find a sterility of results this year comparable to that in Egypt. Sir Arthur Evans (whom we congratulate most heartily on his richly deserved knighthood) has not put spade to earth at Knossos this year, or continued the works of conservation which he carried out in the "Queen's Megaron" last year. Nor has Mr. Seager dug in the country round the Isthmus of Hierapetra, which he has earmarked as his own special hunting-ground. But he has located, and reserved for future excavation, possibly next year, an extraordinary village-site of the Geometric period, on a ledge, almost inaccessible to all but Cretans and Mr. Seager, high up on the vertical side of the great cleft in the mountains above the village of Monasteraki, near Kavousi (Fig. 2). This ledge, at first barely three feet wide, turns the corner of the cleft, and there, well within the gorge, broadens into a platform some ten feet across, on which people of the Geometrical period had found a hidden and secure refuge from the attacks of the Ægean pirates of their degenerate and barbarous times. The cliff rises sheer above, and falls sheer below for hundreds of feet to the untrodden floor of the gorge. Another work reserved by Mr. Seager until next year is the continued exploration of the hill-village of Vrokastro, begun last year by Miss Edith Hall, which yielded interesting antiquities of the transition period from Geometric to classical times.

FIG. 2.—The great Cleft of Kavousi.

The Italian work of recent years has resulted in the addition of a pillared "agora" to the palace of Agia Triada (Fig. 3): the results of this year's explorations, which were not yet begun when the writer visited Phaistos and Agia Triada in May, have not yet come to hand.

An interesting feature of Cretan work is now the participation in it of the Cretans themselves, who are keenly interested in the antiquities and past history of their splendid but sorely tried and oppressed island. In Drs. Hatzidakis and Xanthoudidis, Crete possesses archæologists of whom England, France, Germany, or any other country might be proud. Dr. Xanthoudidis has for several years past made important discoveries, and now Dr. Hatzidakis has discovered and is excavating an important Minoan palace at Tylissos, not far from Knossos, at the base of Ida. Great brazen bowls, the largest vase of obsidian (a single piece twelve inches high) yet discovered, and a remarkably bold and fine bronze statuette of a man in the Minoan saluting attitude of adoration, are only a few of the fine trophies that have come from Tylissos to the shelves of the really magnificent museum of Candia. The work at Tylissos continues under the direction of Dr. Hatzidakis.

The Museum of Candia may be described as the Mecca of students of the Greek Bronze age, though the Ashmolean at Oxford, thanks to the unremitting care of Sir Arthur Evans, is a very good second to it, so far as Cretan antiquities are concerned, and the first vase room at the British Museum now contains a "Mycenæan" collection which, thanks chiefly to the results of past excavations of Minoan tombs in Cyprus, makes the British Museum by no means a bad third, while its Cretan collection also has now become quite important. The Museum of Athens proudly exhibits its trophies from "golden" Mycenæ and elsewhere in Greece, but of Cretan and Cypriote antiquities it has none.

FIG. 3.—Agia Triada: the new Agora.

The British School at Athens has again turned its attention to a Mycenæan site this year, having resumed its interrupted excavations at Phylakopi in the island of Melos. Interesting discoveries, especially of pottery, have been made. The German work at Tiryns last year produced most important results, especially remarkable being the remains of a fresco depicting a boar-hunt, in which figure two women (or, more probably, in the writer's view, noble youths) riding to the hunt in a chariot. A fine representation of a woman in splendid robes has also been found. Reproductions of this fresco, from the accomplished hand of M. Gilliéron, junr., will soon be given to the world.

Elsewhere in Greece, though interesting results have been obtained by the French at Delos, the most remarkable discovery has been made this year at Corfu, where the Greek Archæological Society has discovered an archaic temple, with sculptures resembling the metopes of Selinus in Sicily. In view of the fact that ancient Kerkyra was a colony of Corinth, and Selinus of the neighbouring Megara, this resemblance is interesting. At the time of the discovery the German Emperor was in residence at his Corfiote palace of the Achilleion, and, thanks to his active interest in it, the excavation is to be continued under the distinguished direction of the leader of German archæology in the Levant, Prof. Dörpfeld (see NATURE, vol. lxxxvii., p. 149).

I bring this account to an end with a mention of the explorations of Messrs. Wace and Thompson for the English Macedonian Exploration Fund in the Elassona district of Turkish Thessaly, which will no doubt add much to our knowledge of the remarkable Neolithic culture of northern Greece, which has upset so many preconceived notions of the early history of Greek civilisation. It may be noted, in this connection, that Mr. F. W. Hasluck has just discovered a Minoan "bee-hive" tomb at Kirk-kilisse in the vilayet of Adrianople.

H. R. HALL.

PROGRESS IN ELECTRIC LIGHTING, HEATING AND COOKING.

ELECTRICAL engineers are claiming—and are claiming with justice—that great advances from the industrial and commercial point of view have been made during the last year or two in electric lighting, heating and cooking; but the average man of science, who probably concerns himself more with general principles than with the detailed applications of physics, may wonder in what these great advantages really consist. He will remember that the employment of tungsten in place of carbon for the filaments of incandescent lamps, and the consequent improvement in efficiency from 4 to $1\frac{1}{4}$ watts per candle-power, dates back to five years ago, and will point out that in the present form of this lamp a tungsten filament is still used, heated to the same temperature, and consequently having the same light efficiency. As to electric heating, he may even be still more sceptical, for, when at school or college, he may have learnt that the energy of an electric current flowing continuously through a resistance is transformed into heat, and that no invention can make the heat generated greater than is represented by the square of the current multiplied by the resistance of the wire. It will, therefore, not be out of place to pass in review the actual improvements in detail which enable the electrical engineer to substantiate his claim that great progress has been made.

Taking the case of electric lighting first. The efficiency of the incandescent lamp depends entirely upon the temperature of the filament, if we neglect for our present purpose the hypothesis of selective emissivity of certain substances, which, although advanced from time to time, has never been completely established, and in any case would only slightly affect the accuracy of the above general statement. Tungsten, being more refractory than carbon, can be kept continuously at a higher temperature without volatilising, and a tungsten filament would give three times the light of a carbon filament for the same consumption of power and the same life. But as the specific resistance of tungsten is lower than that of carbon it was necessary to produce a finer filament than the carbon one, and to find a means of supporting a greater length of this fine filament in the lamp. These difficulties were at first only partly overcome. The filament of a 25-c.p. 220-volt carbon lamp has a diameter of about 0·16 mm., and a length of about 350 mm., while the filament of a tungsten lamp of the same candle-power and voltage is about 0·02 mm. in diameter and 830 mm. long.

To produce pure tungsten in the form of a rod with a diameter in the order of a few hundredths of a mm. it was necessary to mix it with other materials, to press or "squirt" a filament of the required diameter, and to eliminate the foreign substances by various processes, at the same time "forming" and strengthening the pure tungsten filament which was left. This resultant filament was exceedingly brittle, especially when cold, and it could only be made in short lengths, so that several separate loops had to be independently supported and joined in series in each lamp; obviously a delicate operation in view of the fragility of the filament and the difficulty of welding tungsten to other metals.

At first, therefore, the filament could only be made of small enough diameter and high enough resistance for comparatively high candle-powers, and for voltages not greater than 110 volts; and, in fact, when the first tungsten lamps were put on the market as articles of commerce only one diameter of filament was used, and the length varied according to the voltage, so that the buyer had to be satisfied with one particular candle-power of lamp suited to his voltage. Month by month and year by year, however, the manufacturing processes were improved, the filaments were made stronger, finer filaments were pressed and formed, and the methods of mounting them were bettered. The range of sizes and voltages was gradually increased, and during the first half of 1909 16-c.p. 100-volt lamps and 32-c.p. 200-volt lamps with tungsten filaments were placed on the market, followed in the autumn of that year by a 25-c.p. 200-volt 32-watt lamp.

With this, the limiting size of a squirted filament seemed to have been reached, but in the meantime painstaking research work had been carried on in the laboratories of the chief lamp manufacturers, with the object of finding a process for actually drawing tungsten in the form of a wire. This has now been finally accomplished on a commercial scale, and during the last two months three of the leading incandescent lamp manufacturers in this country have already practically "scrapped" their comparatively new filament presses used for the squirting process, and are making their lamps with filaments of tungsten wires. The new wire filament has an enormously greater strength, and as in addition it can be used in the lamps in one continuous length without joints, the robustness of the lamp has been so improved that it is as great as that of one with an ordinary carbon filament. Finally, it has been already found possible to produce finer filaments of drawn wire than by the squirting process, and, as has already been announced in our columns (September 28, p. 420), at the opening of the Electrical Exhibition at Olympia on September 23, a 16-c.p. 220-volt 20-watt Osram lamp was shown, as an article of commerce, with a filament only about 0·015 mm. in diameter.

During the various stages of the introduction of the metal filament lamp, the electrical engineer set himself the task of making the utmost use of the economy which it occasioned in the consumption of electrical energy. For equal light, one-third of the energy was being consumed as with the carbon filament lamp, and the consequent cheapening of electric light opened a much wider field, and brought it within reach of the smaller householder. There were, however, two obstacles to overcome: first, the fact that the metal filament lamps for the usual town-lighting voltages were only to be obtained in comparatively large sizes, so that although the consumer obtained three times the light at the same cost, he could not light a small room at one-third of the cost; and, secondly, the expense of wiring a house for electric light acted as a deterrent to the small householder.

The first of these difficulties was overcome, in alternating-current systems, by the interposition of a small transformer or "auto-transformer" between the consumer's main switch and his lamps. A voltage of 25 or 50 could thus be obtained, for which pressures metal filament lamps down to the smallest candle-powers have been obtainable during the past four years. A wastage of electrical energy is, however, liable to occur when no lamps are on, unless the consumer then turns off the supply at his main switch, for otherwise magnetising current is passing through the primary of the transformer all day long, whether lamps are switched on or not. To prevent this waste automatic switches have sometimes been employed to disconnect the transformer when all lamps are extinguished, and to reconnect it as soon as a lamp is turned on.

One of the latest types of these (made by Messrs. Muirhead and Co.) is shown in Figs. 1 and 2. In this case an auto-transformer is employed; that is to say, a coil connected across the mains with a tapping at a point corresponding to the pressure required for the secondary circuit. The construction of the switch is clear from the general view and diagram. When no lights are on, the main circuit of the auto-transformer is open at the mercury cup 1. As soon as one lamp is switched on, a circuit is established through the coil marked starting coil, and the "auxiliary" coil and "main" coil in series, and the core seen in the two illustrations is sucked into the coil, making contacts 1 and 2. This connects the auto-transformer to the mains at contact 1, and also short-circuits the starting coil at contact 2. When a few more lamps are in circuit, bringing the current up to 2·2 amperes, the core has been sucked in further, and contact 3 is made, short-circuiting the "auxiliary" coil and leaving the main or retaining coil only in circuit. The object of successively short-circuiting the first two coils is to diminish the voltage drop. On the lamps all being switched off, the arm falls by gravity, and the auto-transformer is out of circuit.

One of the largest items in the wiring of houses is the cost of fixing the steel tubing or wooden casing in which the wires are placed. In those houses where surface work is not objected to, use is now frequently made of metal-encased wires, which are simply fixed on the walls by metal saddles. The metal casing is in the form of a tube of thin tinned copper or a lead alloy pressed round the insulated wire, and forming an integral part of it. When low-voltage wiring is supplied through a double-wound transformer, the outer metal sheathing of the wire is used as a return conductor; in the case of the lead-covered wire there is a thin copper tape under the lead to improve the conductance. For continuous current and houses supplied through an auto-transformer, a twin wire is usually employed, the two wires being under one sheath. In both cases it is essential that the outer sheath shall be mechanically continuous; in the concentric system this is obvious, and in the twin system the continuity of the casing, which is then earthed at one end, is necessary to secure immunity from shock or fire in case of leakage. The necessary "bonding" of the sheathing, therefore, forms part of the "system," and various simple arrangements are used for connecting the wires to the fittings, which effectually prevent this bonding from being omitted.

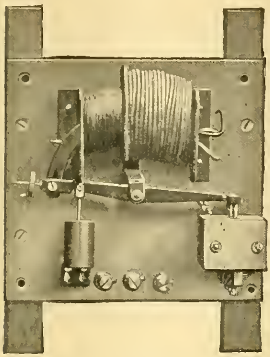


FIG. 1.—Automatic Transformer Switch (cover removed).

In comparison with the triumphs that have been accomplished in the laboratory and works in connection with lamp manufacture, the improvements in heating and cooking apparatus will appear slight. They are largely pure improvements in constructional details. The success of electric cooking has been almost entirely due to the possibility of bringing the actual heating element in the closest possible proximity to the object to be heated, so as to heat nothing else than the actual surfaces required for the cooking operation; this is, of course, not possible to such a degree either with coal or gas cooking. To illustrate this two of the simplest examples may be taken. Fig. 3 is a "table toaster" shown open. The heating element is a ribbon of high-resistance alloy wound spirally on strips of mica. This glows with a dull-red heat when current is turned on. The bread is placed in the removable sides (one only is seen in the illustration), a piece on either side of the heater, and these are closed up so that the bread is held vertically, and parallel to the surface of the heater, with only a very short space between. As a result the bread is toasted absolutely evenly, and with no loss of heat at all. Fig. 4 is a section of the lower part of an electric kettle, and it is seen that the heating element projects into the bottom of the kettle, and is practically surrounded by the water.

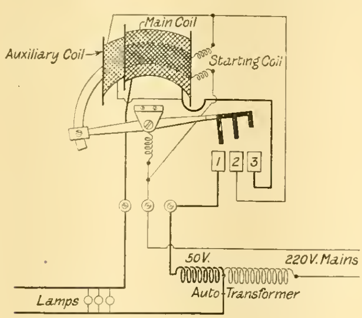


FIG. 2.—Diagram of Automatic Transformer Switch

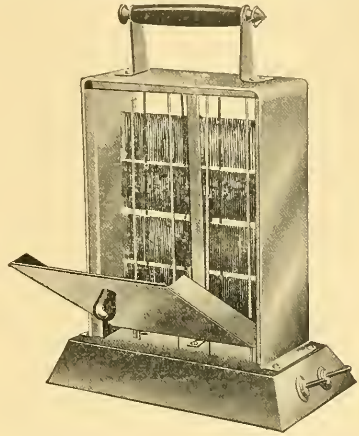


FIG. 3.—Electric "Table Toaster." (Simplex Conduits, Ltd.)

In the larger cooking apparatus similar means are taken to bring the heating elements exactly where they are wanted, and to reduce the amount of heat lost by radiation and convection to a minimum. For instance, in most forms of electric oven at least three of the sides contain heating elements quite close to the interior surface; in nearly all makes the lagging is very thoroughly carried out, while others rely to some extent on giving the outside of the apparatus a bright surface to reduce radiation. It has also been proved by experiment that in roasting a joint in an electric oven, owing to the more even distribution of the heat there is less shrinkage of the meat, so that it retains its gravy; it appears that the smallest possible diminution of weight in a joint during cooking is an object aimed at by cooks and housewives, and that in this respect the electric oven has the same superiority over the gas oven as the gas oven has over the ordinary coal-fired kitchen range. The precision with which the heat can be regulated by switching on or off the heating elements as required is also a great advantage both as regards good cooking and absence of waste, and several makers adopt a series-parallel arrangement of connections and switching, so that all the elements are utilised, whether at full, half, or quarter heat, and there is absolute uniformity of temperature over the whole of the heating surface.

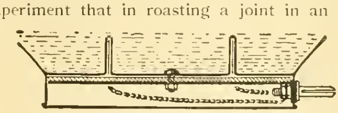
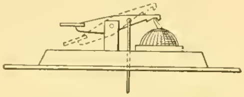


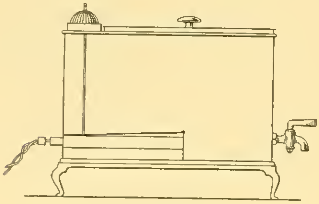
FIG. 4.—Arrangements of heating elements in Kettle. (Simplex Conduits, Ltd.)

Great improvements have also been effected in the heating elements themselves. In the earlier apparatus it was customary to use coils of wire coated with or embedded in enamel, but trouble was experienced owing to the different coefficients of expansion of the wire and the enamel, and consequent cracking and gradual disintegration of the latter, due to unequal expansion. Enamel insulation has been considerably improved in this respect now, and some makers employ it with success, but the favourite method is to wind the high-resistance metal in the form of ribbon on mica strips, or to use flat strips of metal wound edgewise and separated by mica. One maker employs spirals of wire in quartz tubes, and another has for long been particularly successful with strips of mica upon which very thin films of metal have been deposited.

An interesting attachment to a water-boiler (made by the Bastian Electric Heating Syndicate) is shown diagrammatically in Fig. 5. Above the chamber containing the heater is a light, hinged metal flap, upon which bears the end of a rod connected to a catch lever holding the switch in the "on" position. The bubbling of the water when boiling causes the flap to rise, releasing the switch and thus turning off the current.



Details of Switch Release.



Sectional Elevation.

FIG. 5.—Water Heater with Automatic Switch.

MANKIND—FROM THE PLIOCENE TO THE PRESENT.[1]

DURING the last forty years the opening period of mankind has receded further and further into the past. At first we were content to count the years in thousands, then in tens of thousands, and now nothing less than hundreds of thousands is regarded as sufficient to cover the known period of man's existence on the earth.

The three works noticed here cover the whole of the human period so far as it is yet known. Dr. H. v. Buttel-Reepen deals with the Europeans of the Pleistocene or Glacial period, to which, following the teaching of Dr. A. Penck, he assigns a round half-million of years. Dr. Franz Schwerz takes up the story where Dr. H. v. Buttel-Reepen leaves off, and describes the various races which have inhabited his native canton of Schaffhausen since the Neolithic period began—one which he regards as commencing about 25,000 years ago. The third work, by Prof. Niederle, of the University (Tchéque) of Prague, is concerned with events which lie within the Christian period—the expansion and fate of the Slavonic race into south and central Europe and into Asia.

The three works are very different in nature; Dr. v. Buttel-Reepen's small monograph is a concise and excellent summary of the facts and theories relating to mankind in Europe during the Glacial period; it is the best of the many books that have lately appeared in Germany to supply a popular demand for information concerning early man, and is richly illustrated. Dr. Scherwz's monograph represents the results of personal research, and reflects the exact, elaborate, and painstaking methods of the Zurich school of anthropologists. Prof. Niederle's book is a stock-taking of the Slavonic race; he estimates that there were 139,000,000 Slavs at the commencement of the present century, more than 20,000,000 of whom occupy territories outside Russia, and are a continual cause of political unrest in central and eastern Europe.

It is the anthropological rather than the political data of Prof. Niederle's writings which interest us here. He appears to supply the answer to a problem which has puzzled Dr. Schwerz and has been an enigma to anthropologists in every country, especially in England. The problem concerns the source and supply of the brachycephalic races of central Europe and their sporadic appearance in Britain. The oldest human remains yet found in Schaffhausen—a canton almost surrounded by German territory—are those of Schweizersbild—remains which supplied Prof. Kollman, of Basle, with the basis for his famous theory of a pygmy prehistoric race in Europe. There can be absolutely no doubt that the Schweizersbild Neolithic men are identical with the Neolithic English described by Huxley as the "river-bed type"—people of rather low stature and with small heads, somewhat compressed from side to side and falling in the dolichocephalic group. The inhabitants of Schaffhausen soon after the beginning of the Christian era were also a long-headed people, which Dr. Schwerz associates with the Reihengräber of south Germany. The modern inhabitants of Schaffhausen are eminently short-headed, but as to how and when the short-headed people replaced the long-headed Dr. Schwerz can give no answer.

The change in head form in Schaffhausen is most probably due to a Slavonic permeation. In colouring and head-form the modern inhabitants of Schaffhausen are Slavonic. As far back as history and tradition can take us Russia has been the home of the greatest and most homogeneous mass of brachycephalic humanity. Prof. Niederle paints a picture of the exodus of the Bulgarians, Servians, Slovenes, Slovoques, Tschéques, Lusaciens, and Poles, from the parent stock in Russia, and their absorption in the German-speaking peoples.

We may be certain that what has taken place in historical times—a continuous exodus and absorption of the round-headed Slavonic stock—had been at work during the greater part of the Neolithic period, if not earlier. A round-headed race is not known to occur in western Europe until the latter part of the Palcolithic period. There is every reason to regard the short-headed races of mankind as comparatively recent products of evolution; every known example of Glacial and early post-Glacial man, with the possible exception of some Krapina people, is of the long-headed

[1] "Aus dem Werdegang der Menschheit. Der Urmensch vor und während der Eiszeit in Europa." Von Dr. H. v. Buttel-Reepen. Pp. vi+139+109 figures in text+3 tables. (Jena: Gustav Fischer, 1911.)

"Versuch einer anthropologischen Monographie des Kantons Schaffhausen speziell des Klettgaues." Von Franz Schwerz. Neue Denkschriften der schweizerischen naturforschenden Gesellschaft, Bd. xlv., pp. 83–292+80 figures+1 map+87 tables. (Zürich: Zürcher & Furrer, 1910.)

"La Race Slave, Statistique, Démographie, Anthropologie." Par Prof. Lubos Niederle. Traduit du Tchéque par Louis Léger. Pp. xii+231+1 map. Paris: Félix Alcan, 1911.) Price 2.50 francs type. From the present distribution of the short-headed races we may regard Russia as the most probable cradle of this race. The brachycephalic fair-haired European may be regarded as the latest and perhaps highest product in evolving humanity. Time will show that the brachycephalic peoples of Europe are essentially of Slavonic origin, and that brachycephaly will prove to be a Mendelian dominant in the fusion of long- and short-headed peoples.

Dr. v. Buttel-Reepen adopts Dr. Penck's three intermissions of the Glacial period—a first, second, and third; and in the tentative condition of our knowledge that division is as good as another. To the beginning of this period he assigns *Homo Heidelbergensis*, known from his mandible only and by the Eoliths ascribed to him. A minute study of this mandible leaves no doubt that *Homo Heidelbergensis* must be assigned to the Neanderthal race. Remains of this race are also ascribed to the second interval and the third succeeding Ice age—a period estimated at 200,000 to 400,000 years. If such a period is approximately correct, then it is wonderful that the type remained so constant throughout such a vast interval of time. We know of only nine crania of the race, and the limb bones of only five or six individuals, and in all of them the state of preservation is incomplete.

The rarity of such specimens probably explains the extraordinary sum paid by the Museum für Völkerkunde, in Berlin, for the skeleton discovered by Herr O. Hauser near Le Moustier in 1908—a price, according to Dr. Buttel-Reepen, amounting to 160,000 marks. The skull of this skeleton, like that found at Chapelle-aux-Saints, was so broken that in neither case has an approximately accurate reconstruction been made. Indeed, the only cranium which is nearly complete and intact is that found at Gibraltar so long ago as 1848—nine years before the discovery of the Neanderthal calvaria. This cranium, which Dr. Buttel-Reepen regards as of little scientific value, is, in the opinion of the writer, the most primitive and therefore probably the oldest of all the remains yet found of the remarkable Neanderthal race. It is the only one which shows a cranial capacity decidedly below the average of modern Europeans; the palate, and especially the teeth, are of the most primitive form known in this race. In such a long period of time as that ascribed to the Ice age, there must have been a succession of many races, and in the remains found at Krapina (Croatia), and at Spy (Belgium), we see what is apparently a mixture of older and more recent forms.

In the third interval of the Ice age the Neanderthal race apparently disappeared; his successor at present is supposed to be the type of man found at Gally Hill in Kent, and at Brünn in Moravia—a long- and narrow-headed race, so unlike the Neanderthal that Prof. Klaatch propounded the theory of a multiple simian origin for human races—a theory which Dr. v. Buttel-Reepen says must be taken *cum grano salis*. The remains found in the Grimaldi cave, near Mentone, and the Cro-Magnon race are also assigned to the close of the Glacial period. The Cro-Magnon race, which thus early appeared in Europe, is from a physical point of view, and also as regards the cranial capacity, one of the finest races of mankind ever evolved. The bearing of all recent discoveries of ancient man in Europe, both as regards his physical structure and his culture, is to remove the beginning of humanity into a more remote past—one which reaches into the Pliocene period at least.

Dr. Buttel-Reepen, like of many of his German colleagues, is inclined to assign the skull discovered in Gough's cavern, Cheddar, and described by Mr. H. N. Davies in 1904, to the Palæolithic period. There can be no doubt this is an error, for the cranium in question is an example of the "river-bed" type—the characteristic form in England during the early Neolithic period. The Tilbury skull, and one recently found in a Derbyshire cave by the Rev. E. H. Mullins, are also of this type.

A. KEITH.

COAL DISCOVERIES IN BRITISH COLUMBIA.

THE announcement, made in a special article in *The Times* of October 14, on "Coal in British Columbia," that an "immense body of anthracite coal exists at the head-waters of the Skeena . . ." to quote the words used in the telegram from the Minister of Mines of that province, need cause no surprise when it is considered how little is yet known about the mineral resources of the vast territories comprised within the Dominion of Canada. If the figures given by Reuter may be taken as trustworthy, 2100 square miles and 43,000,000 tons per square mile, the estimated coal resources of the province leap up in a single bound from 40,225,000,000 tons, as estimated in 1910, to 130,525,000,000 tons, the addition amounting to about three times the quantity estimated to be contained in our own South Wales coalfield.

Very little information appears to have been allowed to leak out regarding this immense coalfield almost up to the moment when publicity was given to the foregoing statements. All that is said about it in the annual report of the Minister of Mines for the year ending December 31, 1910, is that "the anthracite district around the head-waters of the Skeena continues to attract attention" (p. K88). Again, on p. K176 of the same document a summary is given in the form of a table of the estimated coal-content of the various known coal areas in British Columbia, extracted from a paper read by Mr. D. W. Dowling, of the Geological Survey, before the Canadian Mining Institute at the Quebec meeting in March, 1911, in which the Skeena River is credited with sixteen square miles and 61,000,000 tons of anthracite. Lastly, when the present writer had the pleasure of meeting Mr. McEvoy (mentioned in the telegram of the Minister of Mines) in Toronto on March 7 last, nothing that he can recollect was said to give him any clue to the vastness of the coalfield which Mr. McEvoy was then about to re-visit.

In the table referred to above the names of twelve separate coalfields are given, probably all of Cretaceous age, containing 39,674 million tons of bituminous coal; three, probably of Tertiary age, containing 490 million tons of lignite; and one, the Skeena River coalfield, the geological age of which is not mentioned, containing sixty-one million tons of anthracite. The largest areas are those of Comox, 300 squares miles; Nanaimo, 350; Elk River, 230; Elk River north, 140; Graham Island, 60, all containing bituminous coal; and Graham Island, 100, lignite. Although the areas of Comox and Nanaimo fields are the greatest, the assumed thickness of coal in each, namely, six feet, puts their estimated reserves far behind those of the two Elk River fields, each with 100 feet of coal distributed in a number of separate seams. As stated in the article in *The Times*, the two first are in Vancouver Island. The seams of coal, Douglas and Wellington, with a rider from two to three feet thick under the first, and a similar rider from two to four feet thick above the second, crop out at a greater or less distance from the shore, not exceeding six or seven miles perhaps at most, and dip under the sea in the Strait of Georgia and under the small islands near the shore. The two last, Elk River and Elk River north, are cut through by the defiles in, and not far from, the watershed of the Rocky Mountains, and consequently many of the seams of coal are accessible by means of day-levels. The present writer would have thought that a greater thickness than six feet of coal could have been attributed, at any rate to the seams in the Nanaimo coalfield, as the Douglas seam occurs in the form of lenticular masses, the maximum thickness of which attains as much as twenty-six and twenty-eight feet at some points, and as the Wellington seam, which underlies it at a depth of seven hundred to one thousand feet, is from three to six feet thick.

The following analyses will serve to show the character of the bituminous coals referred to above :—

	Comox per cent.	Nanaimo per cent.	Elk River per cent.
Moisture	1·47	4·60	0·87
Volatile combustible matter	28·19	33·70	23·11
Fixed carbon	64·05	54·70	70·70
Ash	6·29	7·00	5·32

The proportions of all these constituents vary in each of the coalfields, the moisture attaining in some cases as much as 7 per cent., volatile combustible matter more than 40 per cent., and ash 10 per cent. and more. Some of the seams make good coke, when the proportion of moisture is low enough (not exceeding 2 per cent.).

The produce of the Vancouver Island Collieries is in demand along the western coast of America; that of the Elk River Collieries supplies smelting works in the United States, railways, and so on.

The produce of the Skeena River Collieries will have about 180 miles to travel to the coast at Prince Rupert, and will thereafter have to compete with the bituminous coals of Vancouver and some of the other islands along the coast, which can ship their coal directly into the holds of the ships which use it.

It is to be hoped that in the great field the existence of which has been foreshadowed, some of the supposed anthracite will be found to contain at least 12 per cent. volatile combustible matter, as "drier" coals and true anthracites, containing from 3 per cent. to 6 per cent., are not considered suitable for steam-raising purposes in European countries, on account of their slow rate of combustion, although Pennsylvanian anthracite seems to be quite acceptable in some parts of the United States.

DR. HUGHLINGS JACKSON, F.R.S.

THE recent death of Dr. Hughlings Jackson has called forth that widespread recognition amongst men of science which his modesty and retiring nature rendered impossible during his lifetime. To many, and particularly to workers in scientific fields remote from medicine, his name is unknown, and yet, although he never performed an experiment, no one man has so profoundly influenced the growth of our knowledge of the functions of the nervous system.

John Hughlings Jackson was born in 1835, at Green Hamerton, in Yorkshire, and began the study of medicine at York. After a short period as a student at St. Bartholomew's Hospital, he became qualified to practise medicine in 1856, and then returned to York for two years as house-surgeon to the dispensary. In 1862 he was appointed assistant physician to the National Hospital for the Paralysed and Epileptic, and in 1863 he became assistant physician to the London Hospital. These are the material facts in Dr. Jackson's outwardly uneventful life.

At the National Hospital he came in contact with two men who influenced the direction of his thoughts. Brown-Séquard, from whom he acquired a knowledge of the recent work of French physiologists, and Lockhart Clarke, whose beautiful microscopic preparations taught him the minute anatomy of the nervous system. But in his early lectures, delivered between 1864 and 1868, he showed how quickly he had found that path which was to lead him by consecutive steps to his greatest generalisations. In 1864 he had already shown that paralysis of the right half of the body was associated, in most cases, with loss of speech, and characteristically gave the whole credit to Broca, whose work had appeared shortly before his lecture. Broca's observations were essentially anatomical, and are still the subject of dispute, but Jackson described forms of disturbed speech associated with hemiplegia, which stand untouched to-day. In 1866, he formulated the condition now known as apraxia, and repeatedly demonstrated cases of this disturbance to his pupils in the wards of the hospital. But he was forty years before his time, and apraxia was not generally recognised until its rediscovery by Continental observers.

At that time all work on the functions of the nervous system was dominated by the brilliant discoveries of the French School of Physiology, and Jackson's idea that convulsions arose from some change in the cerebrum and usually from a focus within the territory of the Sylvian artery was passed over in contemptuous silence. But when Hitzig and Fritsch showed, in 1870, that stimulation of the cortex could produce movements, Jackson's views came to the front, and local convulsions are now called by his name.

Step by step we can watch the growth of his great generalisation put forward in the Croonian lectures of 1884 on "Evolution and Dissolution of the Nervous System." He showed that in hemiplegia movements and not muscles were affected, for the brain is not dealing with tools but with functions. Thence he passed to the idea of "levels" in the nervous system, each of which represented a higher evolution; passage from one level to that above it was always from the general to the special in function, and from the simple to the complex in structure. Dissolution produced by disease or by experiment occurred in the inverse order, and the removal of the highest level set free the activities of those below. To this view Jackson gave the widest application, and explained the rigidity of limbs paralysed from cerebral disease by the over-action of uncontrolled centres in the cerebellum and spinal cord. So far back as 1877, he laid down that "the cerebellum is the centre for continuous movements and the cerebrum for changing movements," and so formulated the modern doctrine of the tonic nature of cerebellar activity.

These wide-reaching generalisations have not yet received their full application, but they permeate modern neurology; and the position of the English School is due largely to Dr. Jackson's stimulating influence and generous self-effacement. H. H.

AUGUSTE MICHEL LÉVY.

ON September 25, Auguste Michel Lévy, director of the Geological Survey of France, and Inspector-General of Mines, died in his sixty-eighth year. His work, which has had so wide an influence, covered the whole period of the rise of modern petrology. The systematic grouping of rocks was largely a French study at the opening of the nineteenth century; Michel Lévy carried on the tradition into far broader fields by concerning himself with their natural relationships and modes of origin. The great memoir entitled "Minéralogie micrographique; Roches éruptives françaises," in which he was associated with his master Fouqué, appeared in 1879, and showed how the methods of Sorby had been appreciated in

France, simultaneously with their development by Vogelsang, von Lasaulx, and Rosenbusch in Germany. A dual nomenclature, indeed, grew up, for certain structures in igneous rocks, of which traces are still clear when we compare works produced on opposite banks of that great factor in literature, the Rhine.

Lévy, in his desire to understand, and not merely to describe, set himself to construct igneous rocks by fusion in the laboratory, as Ste.-Claire Deville and others had constructed rock-forming minerals. In the domain of lavas the results, produced in collaboration with A. Lacroix, were especially successful, and surpassed the expectations of petrologists, who had previously been content with glassy slags. Carrying the study of the optical properties of minerals in thin sections to a high degree of refinement, Lévy and Lacroix issued their book on "Les Minéraux des Roches" in 1888, and the details there given have formed the basis for a long series of researches by their followers in many lands.

The separation of the members of the felspar family, those halting-points in the continuous series indicated, on chemical grounds, by Tschermak, received special attention in Lévy's memoir on the "Détermination des Feldspaths" in 1894. But those who have watched the development of the French Geological Survey will also recognise how much is due to Lévy as an organiser in the field. The gneisses of the Morvan occupied his attention twenty-four years ago, and in 1887, in a modest paper entitled "Sur l'origine des Terrains cristallins primitifs," published by the Socété géologique de France, he set forth his belief that dynamic metamorphism had been overrated as a cause of the crystallisation of minerals in schists. His official memoir on the "Granite de Flamanville" (1893) shows how far he was prepared to go in urging the potency of contact metamorphism and mutual absorption in the production of types of crystalline rock; and his views, associated as they were with the parallel work of Barrois, laid the foundation for many later observations, such as those of Lacroix, Sederholm, and Daly.

Lévy's official work extended to an investigation of the water supply of his country, a research of immense public importance, which is still in progress. His secure position as one of the foremost of scientific men earned him his election as a member of the Institute of France. For those who wish to have before them, and for future generations of their students, the record of the firm and noble features of Lévy as he lived, it may be well to mention the fine photogravure portrait now included in the series by Eckstein, of Berlin.

DR. F. AMEGHINO.

A CIRCULAR letter recently received at the British Museum (Natural History) from the president of the Sociedad Cientifica Argentina, Buenos Aires, announces the death of Dr. Florentino Ameghino, the well-known palæontologist, as having taken place at La Plata, on August 6. We believe that the cause of death was neglect of a limb that had been wounded in an accident, the deceased refusing to call in medical assistance. For many years Dr. Ameghino kept a small stationer's shop in La Plata, and it was there that much of his palæontological work was carried on. When and how his attention was first directed to this subject we have no information, but it must evidently have been during the 'seventies, as he published a paper entitled "L'homme préhistorique dans la Plata" in the second volume of the *Revue d'Anthropologie*, 1879. This was followed by a number of papers in various local journals on the Tertiary mammals of Patagonia, the materials of which were collected by his brother, Carlos Ameghino, who for many years afterwards continued to make collecting journeys to that country; but whether on his own account or at the instance of others we are unaware.

Figures and fuller descriptions of the, frequently fragmentary, specimens upon which scores of species and genera were founded in these preliminary papers were given in a quarto two-volume work, published at Buenos Aires in 1889, under the title of "Contribucion al conocimento de los Mamiferos fosiles de la República Argentina." This was followed by a perfect stream of memoirs and papers on the fossil mammals and birds of Patagonia and other parts of the Argentine Republic, in all of which the author insisted that the Santa Cruz beds are Lower Eocene, and some of the other mammaliferous horizons of Patagonia Cretaceous, whereas most palæontologists consider them to be not older than Oligocene.

In 1895 Dr. Ameghino published in Buenos Aires an important memoir entitled "Sur les Oiseaux fossiles de Patagonie," in which appeared a full account of the gigantic seriema-like Phororhachis. The discovery and description of this wonderful bird were alone quite sufficient to have made Ameghino's name celebrated in palæontological annals; another great discovery being that of the development of a monodactyle type of foot in an animal far below the grade of the horse. That Ameghino, out of the redundance of his material, should have been profuse in naming species and genera, is, although a matter for regret, scarcely to be wondered at, and must not be allowed to obscure our view of the value of his work in bringing to notice the marvels of the ancient fauna of Patagonia.

On the death of Dr. Carlos Berg, Dr. Ameghino was appointed director of the Museum at Buenos Aires, a post he held until his death.

NOTES.

Reuter's agency states that the British Government is sending out a further commission to Central Africa in connection with sleeping sickness. This will be in charge of Colonel Sir David Bruce, who will be accompanied by Lady Bruce, and assisted by Captain Hamerton, R.A.M.C., Prof. Newstead, of the Liverpool School of Tropical Medicine, Major Harvey, R.A.M.C., Staff-Sergeant Gibbons, and Mr. James Wilson. The work of the commission will on this occasion be confined to Nyasaland, where more than forty cases of sleeping sickness have occurred since 1909. The commission, which is also under the auspices of the Royal Society, is expected to be absent from England for three years. Sir David and Lady Bruce will leave Marseilles on November 10, and will proceed up the Zambezi and the Shire Rivers to Blantyre and Zomba, the capital of Nyasaland. One of the principal objects of the commission is to endeavour to ascertain whether the existence of the fly supposed to be responsible for sleeping sickness in Nyasaland depends upon the presence of big game.

All artists and chemists will learn with regret that Sir Arthur Church has decided to retire from his position as professor of chemistry to the Royal Academy, where he has for so many years not only acted as guide to the young art student through the intricate subject of chemistry as applied to the painting of pictures, but has also performed invaluable services both in advising and assisting artists in their work, and on many occasions helping the Government in the preservation of works of art. His careful investigations and restorations of the frescoes in the Houses of Parliament, and his invaluable work in the preservation of ancient stone buildings, such as Westminster Abbey, are well known to all who are acquainted with these subjects. While on one hand Sir Arthur Church was for many years professor of chemistry at the Royal Agricultural College at Cirencester, and has done invaluable work in connection with the application of chemistry to agriculture, on the other hand he may be said to be one of the few living chemists who have applied their scientific knowledge to the problems connected with the applied arts; and he has done this not only in the department of chemistry, but also in the scientific theory of colour as applied to decoration. He is also known as an authority on precious stones, porcelain, and earthenware, and has shown all his life that interesting combination of the scientific and artistic temperament which is rarely found. It is to be hoped that his retirement from the professorship will mean merely that he will have greater leisure to continue his many researches on the application of chemistry to painting, researches upon which the permanency of some of our greatest works of art must ultimately depend.

REUTER reports that a slight earthquake shock was felt at Catania on October 15. The shock was more severe at Giarre, Macchia, Guardia, Rondinella, and Santa Venerina.

THE South African Branch of the Royal Sanitary Institute is arranging to hold a congress in Cape Town on November 9–11. This is the first sanitary congress to be held in British South Africa.

THE death is announced, on October 10, of Dr. W. R. Huggard, the British Consul at Davos, Switzerland. Dr. Huggard was an authority on mental diseases and tuberculosis. He was not a prolific writer, but was known as the author of a "Handbook of Climatic Treatment, including Balneology," and a few papers in medical periodicals. Dr. Huggard had been a resident at Davos for twenty-five years.

THE death is announced of the Rev. Mariam Balcells, S.J., professor of mathematics at Boston College, Mass. A native of Tarragona, he was for a time connected with the Spanish Geological Survey. He became director of the Ebro Observatory of Cosmical Physics, which he had himself built during his earlier career as an engineer. He introduced into Spain the study of the solar chromosphere by means of the spectroheliograph, and in collaboration with Father Cirera, now the director of the observatory, made various investigations of the relation between solar activity and terrestrial magnetism.

FROM the Abor expedition, which is about to start, we have a good prospect of learning more about this little-known region. Besides the surveying work which is always carried out on such mountain expeditions, the Government of India has arranged for as much scientific investigation to be carried out as the circumstances will admit. According to *The Morning Post*, Mr. J. H. Burkill will be the botanist, and Mr. S. Kamps and Mr. R. Hodgirt will take charge of zoology and anthropology respectively. A geologist will accompany the expedition, but the definite appointment has not been announced. Captain Trenchard and Lieut. Oakes are in charge of the survey operations. An interesting experiment is being made with various forms of rations, and especially with compressed tea, which has been made up into small cases of 45 lb. each for handy transport.

AT the present time Mr. Chas. Urban, who has done so much to correct our geographical impressions, is exhibiting at the Scala Theatre a "kinemacolor" representation of the recent eruption of Etna. It is not an exciting show, though possibly the photographer got uncomfortably hot, for the most interesting feature of the film is the portion depicting the slowly advancing front of a lava stream. This is well worth seeing by any geologist who has not actually witnessed this type of flow. There is a peculiar fascination in watching the deliberate fragmentation of the cooling lava-crust, with the continuous detachment of solidified blocks, each with its attendant puff of white steam. Sitting in the comfortable seats of the Scala, the visitor would like more of this portion; but no doubt there were difficulties.

THE eighteenth International Congress of Americanists is to be held in London from May 27 to June 1, 1912. This will be the first time the congress will have visited Great Britain. The main subjects to be considered at next year's meeting are:—(*a*) the aboriginal races of America, their origin, distribution, history, physical characteristics, languages, customs, and religions; (*b*) the monuments and archæology of America; and (*c*) the history of the discovery and occupation of the New World. H.R.H. the Duke of Connaught is the patron and Sir Clements Markham president. The organising committee includes Sir Richard Martin, Sir T. Holland, Dr. C. H. Read, Profs. Gowland and J. L. Myres, Mr. H. Balfour, and others, with Mr. Alfred Maudslay as chairman. Titles of papers to be presented at the meeting of the congress should be sent immediately to the secretary, c/o the Royal Anthropological Institute, 50 Great Russell Street, London, W.C.; and it is further requested that synopses of the papers may be sent in by March 31, 1912. Communications may be oral or written, and the languages admitted are English, German, French, Italian, and Spanish.

MR. E. A. GAIT, Census Commissioner for India, has collected into a single volume the detailed instructions issued to the provincial superintendents describing the subjects on which it is desired that information should be collected and embodied in their reports now in course of preparation. Of particular interest are the inquiries into the internal working of the caste system and the extent to which the rulers of independent States exercise their traditional prerogative of interfering in such matters; the investigation whether the existence of the Mendelian law can be traced in the crosses between different races; birth and marriage customs; and numerous other subjects which have been discussed only in a summary way during the last and previous enumerations of the people. If the provincial superintendents, in addition to the task of compiling and explaining the statistics, can find time and opportunity for undertaking this investigation, the forthcoming reports of the census of 1911 are sure to furnish materials of much interest to students of anthropology and sociology.

THE committee appointed to investigate ancient earthworks and fortified enclosures has prepared a report for presentation to the Congress of Archæological Societies. The committee reports steady progress in the investigation of these monuments, in particular in Hampshire, where Dr. J. P. Williams is engaged in cataloguing the barrows of that county after the completion of his list of earthworks. Measures of preservation have been adopted in the case of the Stokeleigh Camp in Somerset, the Scambridge Dykes in Yorkshire, and at Skipsea in the same county. The committee regrets to announce grievous destruction at the earthworks of Willington in Bedfordshire, Penmaenmawr in Carnarvonshire, Uley Bury in Gloucestershire, Stainton in Westmorland, and of the ditch round the top of Windmill Hill at Avebury, in Wilts. Excavations have been carried out on several sites, the most important being those at Avebury under the control of Mr. St. George Gray, and some preliminary investigations of Stokeleigh Camp, in Somersetshire, by Prof. C. Lloyd Morgan and Mr. A. E. Hudd, but nothing was found to throw further light on the origin and construction of the camp. At Old Sarum the work of the Society of Antiquaries was practically confined to the uncovering of masonry structures.

IN 1878 ("Cat. Chiroptera Brit. Mus.") Dr. Dobson gave the name *Kerivoula brunnea* to a bat collected by Sir Andrew Smith years previously, leaving it open whether the habitat was South Africa or Madras. Until a short time ago that specimen remained the only known representative of the species; but it is announced in the Annals of the Transvaal Museum for April that a second example has been obtained in Portuguese East Africa, thus fixing the habitat.

IN an article on a new species of Hipparion (*H. proboscideum*) from the Upper Tertiary of Samos, published in *Verh. Deutsch. Zool. Ges.*, 1910–11, p. 192, Prof. Studer expresses the opinion that the preorbital depression or pit found in the skull of many members of the horse group is not for the reception of a lacrymal gland, but is for the purpose of muscular attachment, and attains its maximum development in species like Onohippidium and *Hipparion proboscideum*, which were probably furnished with a proboscis. The position of the pit, it is stated, differs somewhat from that of a true larmier, and the inframaxillary foramen is always some distance from the pit. This accords, in some degree, with the views of Mr. R. I. Pocock, who has pointed out that in Onohippidium the pit is divided into two moieties, one of which may have contained a gland, and that the pit in Hipparion is probably also glandular. From the fact that a preorbital pit occurs in Merychippus, as well as in the above-mentioned genera, Dr. Studer is inclined to think that a proboscis may have been developed in most or all of the forerunners of the horse group.

A THIRD part of the publication "Illustrations of New South Wales Plants," for which Mr. J. H. Maiden is responsible, contains descriptions of seven species of Callistemon, the bottle-brushes, and four species of Swainsona; all except *Callistemon lanceolatus* are illustrated. A key to the species of Callistemon, prepared by Mr. E. Cheel, separates a large section having anthers with free filaments from a small section displaying coherent filaments. Certain species are cultivated, notably *C. rigidus* and *C. pinifolius*, here described. Swainsona, belonging to the Papilionatæ, includes some fodder plants and a few that are poisonous to stock.

A PUZZLING fossil organism, named Traquairia by Mr. Carruthers, forms the subject of a short article contributed by Mrs. D. H. Scott to the *Annals of Botany* (April), a separate copy of which has just reached us. The chief feature in the organism is the complicated structure of the outer envelope, with an elaborate system of anastomosing tubes connected with prominent spines. It was originally referred by Mr. Carruthers to the radiolarians, but subsequent botanical investigators have regarded it as a possible reproductive organ of a cryptogamic plant. Without expressing a definite opinion, the author inclines towards the original suggestion. The chief object of the paper is to identify and describe four species that differ primarily in the nature of the spines.

ARISING out of an investigation into the sources of the Ignatius beans of commerce, furnished by species of Strychnos, Mr. A. W. Hill has prepared a revision of East Indian and Philippine species of the genus, and it is published in *The Kew Bulletin* (No. 7). The section, characterised by long corolla tubes and large fruits containing strychnine, forms a very natural group, ranging in distribution throughout the area, although the individual species conform to the general rule of localised distribution. Types of seven new species are described. Another systematic article is provided by the list of new African plants, which includes two new genera, Discoglypremna and Sclerodactylon. Also a new genus, Dipentodon, showing unique floral characters, is discussed by Mr. S. T. Dunn, who places it provisionally in the Celastraceæ.

THE United States Geological Survey has published ten bulletins (Nos. 457–464, 469, 472, 473) dealing with the results of spirit-levelling during the last ten or fifteen years in various parts of the country. A plate showing the form of bench-mark used is now included to facilitate recognition of the bronze or aluminium plate on which the altitude to the nearest foot, before the final corrections are applied in the office, is stamped.

THE Canadian Department of Mines has published a summary of the triangulation and spirit-levelling carried out in Vancouver Island, B.C., in 1909. Descriptions of the stations are given, and the azimuths, back-azimuths, and distances of points observed from each station are tabulated; but the method of observing is not stated, nor is the accuracy attained anywhere indicated. An 8-inch theodolite, with two micrometer microscopes reading to two seconds, was used. The levelling was carried out with a 14-inch Dampy level, each line being run at least twice; altitudes are tabulated to 0·001 foot, but here again there is no indication of the precision aimed at or attained.

THE mining town of Burketown is in the north-western corner of Queensland. Its ore deposits were first discovered by Mr. F. H. Hann in 1887, but mining was only begun in 1897; since then several of the ore deposits have been worked, and concentrates carted to the coast at Burketown, one hundred miles distant. The leading mining company of the district, the Queensland Silver Lead Mines, Ltd., recently arranged for an inspection of the field by one of the officers of the Queensland Geological Survey. The work was entrusted to Mr. Lionel C. Ball, whose report, illustrated by five maps, twenty-three plates, and forty plans, has now been issued by the Geological Survey of Queensland (Publication No. 232). Mr. Ball is impressed by the widespread distribution of the ores; but the quantity of high grade is small, and the success of the field will depend upon the large low-grade ore bodies. The ore deposits are mainly brecciated lodes in a series of silicified sandstones and indurated shales. The report contains not only a precise account of the chief mineral deposits, but includes some important contributions to the geology of north-western Queensland.

THE U.S. Weather Bureau has issued a special bulletin relating to the destructive hurricane which visited the South Carolina-Georgia coast on August 27–28. Synoptic weather charts are drawn for the Atlantic Ocean for August 25–28, giving the position of the hurricane; reports from vessels show that the storm was in process of formation on August 23 in about latitude 24° and longitude 67° 30′. Its course was far north of the normal path of tropical disturbances at this season of the year, and its influence was not felt at any stations in the West Indies; the first signs of its approach were felt at the land stations that suffered most, viz. Charleston and Savannah, on the morning of August 27, and warnings of its approach were fortunately sent by the Central Bureau to both those stations and to shipping at various ports, thus minimising the danger so far as possible. The centre of the hurricane reached the coast near Savannah at 8h. a.m. of August 28, passed through eastern Georgia, recurved over North Carolina to E.N.E., and passed to sea off the New Jersey coast. Immense damage was wrought, both to houses and shipping, the velocity of the wind at places exceeding 100 miles an hour (factor 3?). Prof. Moore remarks that, had wireless reports been at hand, it would have been possible to give warning of the approach of the storm several days previously; but this would not have saved the hundreds of houses unroofed, the destruction of telegraph wires, and the like.

As stated in NATURE of September 28 (p. 417), at the Turin meeting of the International Electrochemical Commission the committee on international symbols agreed provisionally to the proposals made at the Brussels meeting. These were to represent mass, length, and time by M*m*, L*l*, and T*t*; electric current, electromotive force, and resistance by I, E, and R; quantity of electricity by Q*q*; magnetic field and induction by H and B; inductance by L; the last three symbols to be printed in special type not yet settled. The maximum value of any quantity to be indicated by the subscript *m*.

THE *Verhandlungen* of the German Physical Society for September 15 contains a paper by Dr. A. R. Meyer, of the University of Greifswald, on the change of the electrical resistivity of pure iron from 0° to 1000° C. The iron is in the form of a wire, and is enclosed in an evacuated glass bulb. Its resistance is measured by the fall of potential down the central portion of it, due to the passage of the heating current. Its temperature is measured thermoelectrically by means of a fine platinum platinum-rhodium junction in contact with it, or by means of a radiation pyrometer. For each of three specimens of iron the resistance increases more rapidly with temperature as the temperature rises until 700° C. is reached. Above this temperature the rate of increase is smaller and more nearly uniform. Up to 700° C. the watts spent in the wire, the current through it, the electromotive force at its ends, and its resistance are all proportional to powers of the absolute temperature.

THE September issue of the Journal of the Chemical Society contains obituary notices of Profs. Beilstein, Erlenmeyer, Fittig, Landolt, and Menschutkin. In addition to the biographic and scientific narrative, an admirable series of portraits is given. In the case of Prof. Beilstein, the notice is signed by Prof. Otto N. Witt.

THE forty-second volume of the *Sitzungsberichte* of the Physikalisch-medizinischen Sozietät in Erlangen has recently come to hand. In addition to five papers by Prof. E. Wiedemann on the history of science, the volume includes chemical papers on the halogenaurates of ethylene- and propylene-diammonium, by A. Gutbier and C. J. Obermaier on the copper salts of ferro- and ferri-cyanic acid, and by D. Hovermann on the atomic weight of iridium. The values deduced for this atomic weight by four different methods from the analysis of the salt K_2IrCl_6, were 192·942, 192·881, 192·956, and 193·116, whilst the analysis of the salt $(NH_4)_2IrCl_6$ gave the value 193·403.

The Scientific American of September 16 is devoted specially to industrial chemistry. It contains articles on "How Electricity is Aiding the Chemist," by Prof. W. H. Walker, of Massachusetts; on "Artificial Rubber," by Prof. Ira Remsen; on "Testing before Buying," by Dr. C. F. McKenna; on "Catalysis," by A. J. Lotka; on "The Industrial Chemist," by Prof. R. K. Duncan; and on "The Technically Trained Foreman," by Dr. Allen Rogers. The magazine is attractively produced, and contains a number of interesting and unfamiliar illustrations, but suffers from the disagreeable characteristic of American journalism whereby each article is interrupted at the conclusion of its first or second page and continued in fragments amongst the advertisements.

DEALING with the destruction of the Austin dam, Pennsylvania, *The Engineer* for October 13 states that, shortly before the actual disaster, the condition of the structure had aroused fears among the residents of the towns below, and that these, being expressed, had the effect of inducing the owners to undertake certain minor protective measures. It is questionable whether anything short of complete reconstruction could have saved the dam. Owing to the upward overturning pressures caused by leakages below the foundations, the alignment of the upper edge had last summer already become a slight arc. That this was the real cause of the disaster is the opinion of the engineer who designed the dam, and reported on the defects discovered in January, 1910. He and another engineer reported the dam to be safe, notwithstanding these defects, but made certain recommendations for the repair and reinforcement of the structure. These, however, he was not engaged to supervise, and he has no knowledge that they were ever carried out. That Austin will be rebuilt, or the lumber industry of the district survive the calamity, seem improbable. The local timber supply was rapidly nearing exhaustion, and at the best could have held out but five years longer. To these circumstances, perhaps, in some degree, may be attributed the comparatively few and ineffectual measures taken to safeguard public interests.

Engineering for October 13 contains an account of the demolition of the Bridlington railway bridge on the North-Eastern Railway, an operation which was carried out by the Ammonal Explosives, Ltd., of London. The bridge was composed of five arches, each arch having a span of 18 feet, with a width of 37½ feet. The arches were built of four courses of hard ringing bricks set in cement, forming a hard, tenacious mass of masonry requiring to be pulverised completely and instantaneously. To facilitate the operation, the surface of the bridge had been stripped, leaving simply the crowns of the arches and the buttresses to be blown down. As the bridge was separated from the station and buildings by only about 8 or 10 feet, the crowns of the arches only were blown down at the first operation. The total quantity of ammonal No. 5 explosive used was 39·5 lb., distributed in 139 holes. A feature of the operation rendering it more than usually interesting was the employment, for the first time in England, of an entirely new kind of detonating fuse, called Bickford's toluene fuse or "Cordeau" detonant. With this fuse, detonators in each cartridge are dispensed with. The fuse may be either laid alongside or simply inserted into each cartridge, and one detonator, attached to the firing end of the fuse, alone is necessary to cause the instantaneous detonation of the whole mined structure. The whole operation was conducted in a most successful manner.

MESSRS. H. F. ANGUS AND CO., of Wigmore Street, London, W., have issued their second catalogue of second-hand scientific apparatus and accessories. All the instruments listed have been tested, adjusted where necessary, and, unless otherwise stated, are capable of work of equal precision as when new. The catalogue gives particulars of microscopes and accessories, various other optical instruments, and sundry apparatus.

THE second part of vol. iv. of the Proceedings of the University of Durham Philosophical Society can now be obtained from Messrs. A. Reid and Co., Ltd., of Newcastle-upon-Tyne. It includes a selection of the papers read to the society between December 8, 1910, and May 11, 1911. These papers include a description of a new steam trap, by Mr. E. M. Eden; one by Prof. Henry Louis on the mutual development of metallurgy and engineering; and others by Dr. T. H. Havelock, on the displacement of the particles in a case of fluid motion; by Dr. J. A. Smythe, on benzylorthothioformate; and by Dr. A. A. Hall, on the relationship between the chemical composition and the position of some North Country clays. In addition there is a report of the Boulders Committee on the boulders and pebbles collected or determined since the last report of the committee.

ERRATUM.—In line 9 of Mr. Rollo Appleyard's letter in NATURE of October 12, for $A=e$ read $A=e^{U}$. The expression was correctly given by Mr. Appleyard in his letter, and the ^{U} was in place in the page passed for press, but it fell out in the course of printing last week's issue.

OUR ASTRONOMICAL COLUMN.

CHANGES ON MARS.—An observation made by M. Jarry Desloges at the Massegros Observatory, and published in Circular No. 133 from the Kiel Centralstelle, records a change on the Martian feature Libya. Previous observations had shown this area to be of a dull greyish hue, but on October 12 it was seen to be very bright; changes in the intensity of these white areas are by no means uncommon, and Libya, for example, was recorded as intensely white by the Rev. T. E. R. Phillips on May 22, 1903.

COLOUR PHOTOGRAPHY OF MARS.—In No. 42 of the *Mitteilungen der Nikolai-Hauptsternwarte zu Pulkowo* M. Tikhoff describes some results he has secured by taking photographs of Mars through coloured screens. These screens transmitted light of wave-lengths 690–655 $\mu\mu$ (red), 680–600 $\mu\mu$ (red and orange), 620–545 $\mu\mu$ (orange and yellow) and 550–495 $\mu\mu$ (green), respectively, and were used in conjunction with the 30-inch equatorial telescope. Taken at the focus, the images of Mars were about 1·5 mm. diameter.

Excellent photographs of Mars were secured, and a comparison of those taken with the red and with the green filters shows some remarkable differences. For example, on the "red" photographs the "continents" (Hellas, Elysium, Ausonia, &c.) are very bright, much brighter than the south polar cap; the latter is the most intense feature on the "green" photographs.

The seas are very dark on the "red" plates and greyish on the "green"; the canals (such as Xanthus, Scamander, Cerberus, &c.) are best seen on the "red" and "orange-red" photographs, their colour apparently resembling that of the seas.

The study of the polar cap led to the conclusion that it was of a greenish colour rather than white, and this suggested ice rather than snow, so experiments on the absorption spectrum of ice were carried out. These, and photographic experiments on sand, snow, and ice made by M. Kalitine, confirmed the conclusion that during August 4–30, 1909, the south polar cap of Mars exhibited the optical properties of ice rather than of snow.

BROOKS'S COMET, 1911c.—Below we give a further extract from the ephemeris for comet 1911c, published by Dr. Ebell in No. 4528 of the *Astronomische Nachrichten*. The cloudy and hazy skies of the past week have rendered observations difficult, and, apart from these local conditions, the difficulty will now increase owing to the decreasing northerly declination and magnitude.

Ephemeris 12h. M.T. Berlin.

1911	α (true) h. m.	δ (true) ° ′	log r	log Δ	mag.
Oct. 19	12 43·9	+18 15·5	9·7241	9·8498	2·8
,, 21	12 39·7	+15 13·1			
,, 23	12 36·5	+12 10·4	9·7000	9·8850	2·9
,, 25	12 34·4	+ 9 8·8			
,, 27	12 33·3	+ 6 9·6	9·6904	9·9219	3·0
,, 29	12 33·2	+ 3 14·3			
,, 31	12 33·9	+ 0 24·0	9·6978	9·9587	3·2
Nov. 2	12 35·5	− 2 20·0			

This path lies nearly due south through Coma and Virgo, and the comet will be quite near to γ Virginis on November 1.

THE SOLAR ECLIPSE OF APRIL 17, 1912.—From the *Gazette Astronomique* (Nos. 45–46) we learn that preparations are to be made by the Uccle Observatory to organise two stations for the observation of the solar eclipse of April next. According to the *Connaissance des Temps* data, the eclipse should be total for six seconds in Spain, for two seconds in the neighbourhood north of Paris, and should cease to be total in Belgium. But the Nautical Almanac data would make it not a total eclipse anywhere in Europe, although the greatest duration of annular eclipse, six seconds, would then take place in Belgium.

AN ENORMOUS BOLIDE.—On April 10 a great noise was heard at Catania following, by about three minutes, a brilliant flash of bluish-green light; the microseismograph also registered slight movements. These phenomena and their relation to a bolide are discussed very fully by Prof. Ricco in No. 7, vol. xl., of the *Memorie di Astrofisica ed Astronomia*, who finds that the meteor probably exploded at a height of 30 km. above a point some 52 km. N.N.E. of Catania. A careful search in the indicated region has, however, revealed no traces of the fragments as yet. From the tabulated summary of communicated observations it would appear that a most extraordinary phenomenon was very generally observed.

MICROMETER MEASURES OF ENGELHARDT-STUMPE STARS.—During the winter of 1910–11 Dr. Lau employed the 10-inch refractor of the Urania Observatory for micrometer measures of faint stars measured by Engelhardt in the neighbourhood of stars given in Stumpe's catalogue. From these measures and Engelhardt's he has derived the proper motions, which he now publishes in No. 4523 of the *Astronomische Nachrichten*, with notes as to the colour and magnitudes of the pairs; of the fifty-four systems given, about two-thirds are optical, and one-third physical, systems.

PHOTOGRAPHS OF THE 1898 TOTAL SOLAR ECLIPSE.—From the Tokio Observatory we have received a copy of the report of their 1898 eclipse observations, published in 1910. The volume contains some excellent reproductions of photographs of the corona, which were taken at Jeur, in western India, and are described and discussed by Mr. H. Terao and Prof. S. Hirayama.

COOPERATION IN OBSERVING VARIABLE STARS.—The observation of variable stars is one that calls for only a modest equipment, and so can readily be undertaken by amateurs. In No. 166 of the Harvard College Observatory Circulars Prof. Pickering prints a list of 372 variables of long period, and asks for cooperation in the observation of them. Many are already being regularly observed, but more help is required, and, if desired, the results would be incorporated in the Harvard publications.

THE SCIENCE SECTION OF THE TURIN INTERNATIONAL EXHIBITION.

When the scope of the Franco-British Exhibition was under consideration, the British Science Guild approached the organisers and suggested that a science section should be arranged. The suggestion was agreed to; and it will be remembered how successful the exhibit was, and what a large amount of interest it aroused. Since then similar exhibits have been arranged at the Japan-British Exhibition and the present Coronation Exhibition, and still continue to attract attention.

The Exhibitions Branch of the Board of Trade has, at the instance of the Physical Instruments and the Chemical Committees of the Royal Commission appointed to deal with the exhibitions at Brussels, Rome, and Turin, organised an exhibit on somewhat similar lines. It was realised that at international and other exhibitions physical and chemical instruments and apparatus are not shown to advantage. The facilities for examination of the instruments are inadequate, owing to the fact that they are usually shut up in cases. Generally speaking, also, there is no one there to take them out and explain them to those who may be interested. It was therefore decided to instal working chemical and physical laboratories, in which exhibitors would have, for the first time in international exhibitions, an opportunity of having their instruments explained and demonstrated. The educational value of such a system of exhibiting is obvious, not only from the point of view of the manufacturers, but also to the public. The average person has no idea of what goes on in a physical or chemical laboratory, or what the apparatus, generally seen in a case, is employed for. In these laboratories actual experimental work can be seen in operation, and the demonstrators are there to give explanations to those seeking information. It should be mentioned here that professors and students from the universities and polytechnics on the Continent have taken great interest in the laboratories, in many cases spending several hours, and coming not once, but several times.

A Joint Committee of Mathematical and Scientific Instruments and Chemical Industries Committees was appointed to deal with the matter and to appoint competent scientific representatives to act as demonstrators in the laboratories.

The laboratory fittings were constructed by Messrs. Baird and Tatlock, Ltd., under the directions of the joint committee and personal supervision of Dr. F. Mollwo Perkin.

In the physical laboratory a dark-room has been set apart, where demonstrations are given with the well-known optical lantern of Messrs. Reynolds and Branson. The lantern employed is a special one fitted with a movable stage, so that it can be used for ordinary optical work and for illustrating practical experiments in science teaching. It is also fitted with a polariser, which, by moving the stage, can be brought into position, and by a further movement of the stage a microscope of special design can be used. Thus bacteriological, physiological, and natural-history specimens can be shown.

On the bench adjoining the dark-room Messrs. Reynolds and Branson exhibit other types of lanterns, and the Barr and Stroud lantern-slide apparatus. This very convenient piece of apparatus is fitted with graduated scales, which enable the operator without calculations or focussing on the screen, rapidly to prepare a lantern-slide.

Beyond this is an interesting exhibit by Robert Paul of electrical apparatus, including the Irwin oscillograph, on which are shown both the current and pressure curves of the alternating current, supplied by a small alternator of the Crypto Electrical Company, and complete apparatus for making measurements of self-induction by means of the Campbell variable mutual inductance, the alternating current being obtained by a microphone hummer.

On the next bench Messrs. J. J. Griffin and Sons show Sand's apparatus for the electro-deposition of metals, and their separation by means of an auxiliary electrode, the potentiometer box containing a capillary electrometer of special design. On the opposite bench Messrs. Townson and Mercer exhibit apparatus for the demonstration of the laws of mechanics, and also certain laboratory electrical instruments.

Messrs. Adam Hilger show their wave-length spectroscope. Other apparatus on this bench consists of a collection of electrical and magnetic testing instruments by Messrs. Baird and Tatlock, Negretti and Zambra, the well-known "Tintometer" for colour estimation, two mathematical models in plaster by Prof. Crum Brown, F.R.S., and a "Geryk" vacuum pump by the Pulsometer Engineering Co., Ltd.

On a separate bench Messrs. T. Oertling have a splendid collection of assay and chemical balances and accessories.

The central bench contains some interesting examples of modern electrical instruments made by the Cambridge Scientific Instrument Company, amongst which are the "Duddell" oscillograph, with camera outfit, for use on circuits up to 50,000 volts, shown in operation; a "Callendar" recorder connected to an open-wound thermometer, by means of which a continuous record of the laboratory air temperature is obtained; the "Thread" recorder, connected to a copper couple, arranged so that its extreme sensibility can be shown; a laboratory type pyrometer with a platinum platinum-iridium couple (this is used for showing the temperature of an electrically heated laboratory furnace).

Fig. 1.—General View of Chemical Laboratory.

Most of the firms showing in the laboratory also have good exhibits in the Physical Instruments Court.

On entering the chemical laboratory, the first bench on the left-hand side is a furnace bench of Yorkshire stone with a uralite hood. On this bench various furnaces by Messrs. Fletcher Russell and Co., Ltd., are exhibited, such as are employed in metallurgical and assay work; also laboratory burners of various design.

On the opposite side is a bench which is in part fitted up for electrochemical analysis, and here actual analytical operations are from time to time carried out by the laboratory demonstrator. On another part of the same bench the method of assaying gold in order to test its fineness is illustrated in a series of twelve operations by Messrs. Johnson and Matthey, who have also supplied the platinum electrodes for analysis. First a gold link taken from a watch chain is shown, (2) the hammered gold, (3) the rolled gold, (4) a weighed quantity ready for assay, (5) the gold with a piece of silver wrapped in lead, (6) the same in a cupel, (7) the gold-silver alloy hammered and rolled after cupelation, (9) the rolled and coiled alloy in the parting flask, (10) the gold after parting with nitric acid, (11) the gold annealed, (12) the assayist's report. The assay balance and muffle employed in such operations are also shown. In still another part of the same bench various crucibles and other apparatus used in assay work are shown by the Morgan Crucible Co.

At another bench Messrs. Townson and Mercer show a large assortment of apparatus employed in various operations. Thus there is a centrifuge operated by means of an electromotor which is shown in operation. There is also apparatus for the analysis of explosives, and general apparatus, such as the Lewis Thompson calorimeter, hot-air ovens, vacuum drying apparatus, &c. A portion of this bench, which is provided with water and electrical heating, is reserved for general demonstrations, such as operations of filtration, crystallisation, precipitation, and so on. Demonstrations in dyeing are also given here, and the action of dyes on mordanted and unmordanted cotton, silk, &c., illustrated. The apparatus for dyeing and material for these experiments are supplied by Messrs. Read Holliday, of Huddersfield.

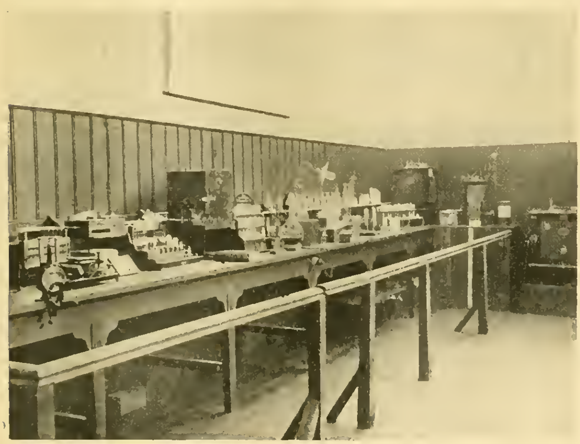


FIG. 2.—Bacteriological Bench where demonstrations were given.

Following this bench is a draught cupboard, which contains apparatus for the generation of sulphuretted hydrogen, carbon dioxide, and so on.

On the next bench the various apparatus employed in the analysis and examination of mineral oils is exhibited; for example, the method of estimating the viscosity by means of the viscometer is shown in operation, and also the taking of flash-points. Most of this apparatus is exhibited by Messrs. Baird and Tatlock, but the Mahler-Cook bomb calorimeter is shown by Messrs. J. J. Griffin and Sons, Ltd. There is also on the shelves a fine display of reagents and pharmaceutical products exhibited by Messrs. T. Morson and Son. On the opposite side of the bench the various apparatus employed in gas analysis is shown. There is also a good display of silica apparatus by the Silica Syndicate and the Thermal Syndicate. This apparatus has attracted a very great amount of attention, as in Italy it was generally not known that silica apparatus was manufactured in England.

At the end of the laboratory a long bench is devoted to bacteriology, where Messrs. Baird and Tatlock make a display of the various apparatus used in bacteriological work, and also show cultures on solmedia, a powdered form of bacteriological culture. At another portion of the demonstration bench Messrs. Edward Cook and Co., the well-known soap-makers, have a demonstrator who shows the methods employed in the standardisation of disinfectants by the Rideal-Walker method and by the Lancet method.

On the next bench there is a working laboratory apparatus exhibited by Ozonair, Ltd., showing the formation of ozone. On another part of the bench there is a most interesting exhibit of old chemical apparatus used in the eighteenth century, kindly lent by the Society of Apothecaries, London.

In the centre of one side of the room Messrs. Burroughs, Wellcome and Co. have an exhibit showing the results obtained by the firm in research work, and in the manufacture of substances of pharmacological importance. Thus the formation of ernutin from ergot is graphically displayed. Investigations in the Wellcome Physiological Research Laboratories have shown that ergot contains at least three active principles, and the exhibit is intended to show the production of these. This exhibit is of great interest, and demonstrates the high value of chemical research in technical operations.

There is also a lead-covered distillation bench, on which are shown the processes of distillation, fractionation, and extraction in operation.

This part of the British exhibit has attracted great attention, and the Board of Trade has been highly commended by other nations upon the new departure. At the same time, it must be mentioned that the whole of the British Section is most creditable to the Exhibitions Branch of the Board of Trade, without which it would not have been possible. Thus there is a splendid exhibit of textiles, and the exhibit of British motor-cars has attracted a large amount of interest. There is also a good exhibit of agricultural machinery and implements.

Most excellent catalogues have been drawn up to explain the various exhibits. The catalogue for the Mathematical and Scientific Instrument Section is in French and is splendidly illustrated. The apparatus is most carefully and fully described both from the theoretical and practical aspect, and Mr. E. H. Rayner, who edited the catalogue, is to be congratulated upon its excellence.

The Catalogue of Chemical Industries, of which there is an English and French edition, commences with articles descriptive of the following industries, which have been written or revised by the persons whose names accompany the articles:—The alkali industry, J. F. L. Brunner and J. I. Watts; sulphuric acid and nitric acid, Dr. F. Mollwo Perkin; the gas industry and coal-tar products, Prof. Vivian Lewes, cyanides and prussiates, A. Gordon Salamon and Dr. G. T. Beilby; electricity, Dr. G. T. Beilby; explosives, Walter F. Reid; nickel, J. F. L. Brunner; oils, fats and waxes, soaps and candles, Dr. J. Lewowitsch; petroleum and shale oil, Sir Boverton Redwood, Bart.; pharmacy, Thomas Tyrer and N. H. Martin; salt, J. F. L. Brunner and J. I. Watts; disinfectants and antiseptics, Dr. D. Somerville; rare metals, Dr. F. Mollwo Perkin. The catalogue is thus a small treatise on technical chemistry. The second part of the catalogue deals with the actual exhibits.

THE FOURTH INTERNATIONAL CONFERENCE ON GENETICS.

THE fourth International Conference on Genetics is the latest of a series of conferences which was inaugurated with the "Conference on Hybridisation" convened in 1899 by the Royal Horticultural Society. The Horticultural Society of New York undertook the organisation of the second conference, held in that city in 1902; the third "Conference on Plant-breeding" took place in London in 1906, again under the auspices of the Royal Horticultural Society; the fourth conference of the series, and the first to receive the title of "Conference on Genetics," has recently been held in Paris under the control of the Société Nationale d'Horticulture de France, which is to be very heartily congratulated on the success which attended all its arrangements.

As M. Ph. de Vilmorin has pointed out, genetics, though born of the studies provoked by the rediscovery of Mendelism, is itself of wider scope, and includes all that appertains to the physiology of heredity, the problems of fluctuating variation, selection, mutation, the transmission of acquired characters, cytology, &c. Most of the subjects were represented among the communications brought before the recent conference. There were, indeed, no papers dealing purely with cytology, though Dr. Swingle brought forward the tentative suggestion that the diverse types encountered in certain F_1 families might be due to different groupings within the cell of a given set of determinants; but the absence of cytological papers no more than reflects the present difficulty of producing any satisfactory cytological "explanation" of the phenomena of heredity, and we can only hope for better things in the future. Appended are short notes on a few of the communications made to the conference.

Messrs. Bateson and Punnett described some results of very great interest in regard to the special relations which have been found to exist in certain cases between distinct factors. Those who have followed recent progress in this work will remember that in not a few crosses, between plants differing from one another in respect of two characters, the phenomenon known as "partial coupling" between the factors for these characters has been exhibited; that is to say, the F_1 produces the four possible types of gamete, not in the approximately equal numbers which would result from a chance distribution of the factors, but in proportions represented by the general expression

$$(n-1)AB : 1Ab : 1aB : (n-1)ab,$$

where n is any power of 2 and is equal to one-half the total number of gametes produced.

Other crosses, on the other hand, gave results which suggested that, in certain circumstances, the same two factors were repelled from one another in gametogenesis. Unlike the phenomena of coupling, the repulsion appeared to be complete, so that no germ-cell received both factors, and consequently no germ-cell was without one of them.

This year, however, Punnett has discovered a case in which repulsion is not complete, but the gametes containing one or other of the two factors (but not both) are produced in greater numbers than the other types of gamete. That is to say, the middle terms of the gametic series are large, the end terms small—the converse to what occurs in "partial coupling"—and the gametic series is represented by the expression

$$1AB : (n-1)Ab : (n-1)aB : 1ab.$$

In Punnett's case the gametic series was of the form 1 : 3 : 3 : 1; even in this case, where n has its lowest value, only one plant having both recessive characters is to be expected in every sixty-four F_2 plants. With higher values of n, the proportion of double-recessives in F_2 will be smaller still, and it can scarcely be doubted that this is the explanation of the cases hitherto regarded as representing complete repulsion; at the same time, the isolated occurrence of double-recessives in families exhibiting repulsion is explained.

The di-hybrid F_1 may therefore produce the four types of gametes in proportions ranging from

$$(n-1) : 1 : 1 : (n-1)$$

through

$$1 : 1 : 1 : 1$$

to

$$1 : (n-1) : (n-1) : 1$$

Bateson and Punnett point out that the conception underlying the terms "partial coupling" and "repulsion" is no longer justified, and they substitute the phrase "reduplication of terms" in a series of gametes.

Profs. Baür and Lotsy described experiments in crossing different species of snap-dragon. *Antirrhinum majus* (in the normal and peloric forms) was crossed reciprocally with *A. molle*, with *A. latifolium*, *A. sempervivum*, &c. The characters of the hybrids and of the very numerous forms obtained in F_2 were illustrated by means of coloured drawings. The experiments showed conclusively that segregation takes place in these species-crosses; how numerous are the factors to be considered may be judged from the fact that, of the 500 F_2 plants raised, scarcely any two were alike. Among these plants there appeared an interesting new type resembling the flowers of the yellow-rattle (Rhinanthus) in the shape of the corolla.

Several papers dealing with cereals were presented, some of them of no little importance from the economic point of view. Dr. Nilsson-Ehle described experiments indicating that precocity and resistance to cold depend upon combinations of Mendelian factors. Dr. Surface described the results of selection for such characters as protein-content, &c. He showed that in one case of successful selection for high protein-content, the plants raised after the ninth generation were all the descendants of a single progenitor, that is to say, selection had resulted in the isolation of a pure line possessing the desired quality. This result agrees with much that has been done since Johannsen first clearly presented the idea of pure lines, and agrees, too, with the new results which Prof. Boeuf communicated on the present occasion.

Dr. Orton described some work of the highest economic importance in the raising of varieties of agricultural plants resistant to the attacks of disease. Many varieties of cotton, the cow-pea (Vigna), and the water-melon are susceptible to the attacks of species of Fusarium; the cow-pea, in addition, is liable to the attacks of the nematode *Heterodora radicicola*. Immune or highly resistant varieties of all these plants have now been obtained, in the case of the water-melon, however, only after crossing with a non-edible but resistant wild type.

At the session devoted to papers dealing with animals, Prof. Federley described an interesting case in Pygæra of the transmission of a disease through females, themselves unaffected by the disease, to their male offspring, all of which died of the disease. Dr. Walther, of Vienna, gave an account of his investigations into the inheritance of coat-colour in horses, a subject with regard to which he has secured a great wealth of material.

Finally, mention must be made of a new case of brachydactyly in man, described by Dr. Drinkwater. This case differs from the previous one in that there is no ankylosis of the short median phalange with the terminal phalange, and the fingers are intermediate in length between the extreme brachydactylous and the normal types. The abnormality is present in about one-half of the members of the affected family.

Much as there was of interest in the proceedings of the conference, not the least memorable of its features was the visit which the members were privileged to pay to the establishment of MM. Vilmorin, Andrieux et Cie. at Verrières-le-Buisson. One's only regret was that the time at our disposal was all too short for even the most cursory inspection of the wonderful collection of plants which has been gathered together here, and of the experiments in breeding and selection which are being carried on by M. Ph. de Vilmorin himself and by the firm of which he is the head. It is useless to attempt in a limited space to give any detailed description of Verrières; it need only be said that the whole establishment, gardens and museum alike, admirably reflects the enthusiasm which M. Ph. de Vilmorin, like the members of his family who have preceded him, has always shown for the scientific as well as the more obviously practical aspects of horticulture and plant-breeding.

PHYSIOLOGY AT THE BRITISH ASSOCIATION.

THE presidential address in Physiology has appeared in full in NATURE (September 14), and the remainder of the sectional proceedings can be summarised under three heads: reports of committees and papers related to them, discussions, and other communications.

Reports of Committees.

Committee on Anaesthetics.—The report contains four appendices. The first describes the installation of a chloroform-balance for daily use in hospital practice. The detailed instructions by Prof. Waller will be extremely useful for anyone who wishes to establish one of Prof. Waller's instruments. The second appendix contains some estimations of the probable percentage of ether inhaled by the "open" method of ether administration. The third appendix relates the experience gained by the use of a chloroform-balance in the out-patient department of St. George's Hospital, and the fourth is a recapitulation of the effect of recent advances on the practice of anæsthesia.

This report was followed by a paper by Dr. A. Vernon Harcourt, F.R.S., on additions to the use of a chloroform inhaler. As objection had been made to the vacuum principle of the author's chloroform inhaler, he has adapted his ingenious apparatus to work by the plenum system, and also for use with oxygen.

Committee on Dissociation of Oxyhaemoglobin at High Altitudes.—The hydrogen ion concentration of blood can be determined by the percentage saturation of hæmoglobin with oxygen at low pressures of oxygen. Using this method, it was found that at high altitudes the hydrogen ion concentration of the blood was increased.

The remainder of the reports contained information of such detailed nature that it is not possible to give a summary of their contents, but in some cases the work has already been published elsewhere.

Discussions.

Discussion on Inhibition.—Prof. C. S. Sherrington, F.R.S., opened the discussion by pointing out that it would be of great importance to discover the intimate nature of inhibition. The processes of inhibition are fundamentally the same whether they occur in the central nervous system or in apparently muscular organs such as the heart. He then described many of the phenomena of inhibition as exhibited by rhythmical reflex movements of the limbs. In dealing with the reciprocal action of muscles, it seems necessary to assume, as suggested by Macdonald, that there is an intercalated neurone in the inhibition path. Any after discharge from the muscle, which ought to have finished contracting, would lead to clumsiness in the alternating movements of flexion and extension; but inhibition removes all after discharge. In the same way inhibition diminishes the tonus in muscles antagonistic to those that are contracting. The utility of a common final path is evident, because there cannot be more than one movement going on at the same time; and so long as a path is held by inhibition contraction cannot occur, and *vice versa.* Examples were shown of double stimulation and algebraical summation of excitation and inhibition in both flexors and extensors. Two antagonists may be in action together, but their activity increases and decreases in reciprocal proportions; hence the smoothness and accuracy of trained movements. The conditions favourable to inhibition are fatigue and administration of chloroform, and those favourable to excitation are increase in the "background" stimulation and administration of strychnine and tetano-toxin. According to circumstances, the same stimulus may give either excitation or inhibition.

Dr. John Tait, rhythmical stimulation of cooled frog's nerve. The Wedensky effect was described, and Frohlich's explanation of the phenomenon was stated. By cooling the nerve a result was obtained similar to that of Wedensky. The effect is greater the greater the degree of cooling, the longer the piece of nerve cooled, and the more rapid the rate of stimulation. Conduction by the nerve is entirely blocked at $-2°$ C., and the phenomenon is present near this point. Fatigue favours the effect. Wedensky effect is shown by well-fed, but not by under-fed, animals.

Dr. Keith Lucas, conduction between muscle and nerve with special reference to inhibition. Frohlich's explanation of the Wedensky effect does not hold in homogeneous tissues, as a second stimulus within the refractory period does not prolong the refractory phase. By indirect stimulation it was found that the blocking occurs at the junction between muscle and nerve. The refractory period of nerve is less than that of muscle, and a stimulus sent into the nerve shortly after the end of the refractory period causes a second refractory period. A stimulus to the nerve just after the end of the refractory period is so diminished in strength that it cannot pass the motor end plate. The explanation is that each stimulus to the nerve reduces the response to the succeeding stimulus, and thus all except the first are too weak to pass the resistance of the junction between muscle and nerve; thus there is a single contraction of the muscle with the first stimulus, and no further response as the stimulation continues. By applying the same processes to the synapses of the central nervous system, an explanation of central inhibition was given. Prof. Waller then spoke, and Prof. Sherrington replied.

Discussion on ventilation in confined quarters, especially in relation to ships. Dr. Leonard Hill, F.R.S., introduced the subject by explaining that under ordinary conditions the percentage of oxygen is never reduced to a dangerous extent, nor is the carbon dioxide increased beyond reasonable limits. The great factor in ventilation is to provide air under suitable conditions to promote evaporation from the skin and stimulate the nerve endings in the skin. He then described experiments showing that circulation of air in a closed chamber produced the same effect as admitting fresh air in promoting a feeling of well-being. A draught is dangerous, as it causes a local cooling, but cooling of the whole surface by evaporation from the skin is beneficial. He described some of the special difficulties met with on board ships, and advocated the wet- and dry-bulb thermometers as a test of the efficiency of ventilation. Fresh air is beneficial, as it dilutes harmful products, such as bacteria.

An abstract furnished by Prof. N. Zuntz, of Berlin, was read. He agreed with Dr. Hill that oxygen and carbon dioxide are not the predominating factors in ventilation, but he pointed out that there might be poisonous gases given off under some conditions. He then showed that unless the carbon dioxide be kept down to the limit usually given as the maximum allowable, the air becomes almost saturated with the moisture given off from the lungs. Therefore the moisture must be kept down by dilution with fresh air or by condensation on cold surfaces. The use of fans will not entirely remove the need for fresh air, but they will improve the working efficiency of the men.

Dr. C. J. Martin, F.R.S., spoke in support of Dr. Hill's view by referring to the conditions in Australian gold mines.

Fleet-Surgeon Whitelegg gave instances of the difficulties encountered on board battleships, where, of course, the fighting efficiency was the first consideration. He then described some of the precautions taken before men were allowed to enter unventilated spaces. Dr. Hill then replied.

Other Communications.

Prof. H. J. Hamburger, on the influence of iodoform, chloroform, and other substances dissoluble in fats on phagocytosis. In the absence of the author an abstract of this paper was read. In high dilutions the substances used promoted phagocytosis. This effect is the result of the substances dissolving in the lipoids of the cell wall, whereby the surface tension is lowered. When the surface tension is lowered there is less resistance to an increase of surface, and hence amœboid movements occur more easily.

Dr. J. Tait and Mr. J. A. Hewitt, certain physical questions regarding blood vessels and blood cells. Blood does not adhere to the endothelium of blood vessels. This is associated with a large amount of ether soluble material in the endothelial cells. Coating glass vessels with oil delays coagulation, as it prevents the adhesion to the glass of certain blood cells. Possibly the high blood-blood-vessel surface tension, as shown by non-adherence of the blood to the vessel wall, is a factor in preventing coagulation of blood in the vessels. Contact of amœboid corpuscles with particles of carmine or Indian ink causes phagocytosis if the surface tension between corpuscle contents and particle is less than that between the plasma and particle. When a corpuscle adheres to the wall of a blood vessel it is driven outwards if the surface tension between corpuscle and blood-vessel wall is less than that between corpuscle and plasma, and hence diapedesis occurs. The association of hæmolytic and hæmorrhagic poisons may be due to a lowering of the surface tension causing both processes.

Mr. W. W. Waller, an attempt to obtain photographic records of the emigration of leucocytes. This was illustrated by a number of photographs showing blood vessels with white corpuscles escaping from them. Several interesting points were mentioned, such as a tendency for several corpuscles to escape at the same point, and apparently to form colonies after their escape.

Dr. Hariette Chick and Dr. C. J. Martin, F.R.S., the chemistry of heat coagulation of proteins. Coagulation takes place in two stages, denaturation and agglutination. Denaturation is due to the presence of water, depends on the temperature, and is an exponential function of the concentration. The temperature coefficient is remarkably high. Egg albumin differs from hæmoglobin owing to a change in reaction during coagulation, but by using boric acid to keep the hydrogen ion concentration constant the egg albumin then behaves like hæmoglobin. Increase of acidity favours denaturation. Agglutination depends on the concentration of hydrogen ions. Three factors, namely, surface tension, electrical charge, and velocity of Brownian movement seem to regulate the agglutination.

Prof. Freundlich spoke on this communication, referring to the importance of such investigations into the processes of coagulation.

Dr. W. N. F. Woodland, recent views concerning the physiology of gas production in connection with the gas bladder of bony fishes. The structure of the rete mirabile duplex is concerned with the secretion of oxygen. The composition of the gas varies in different species. The pressure of any particular gas may be greater than that in the blood stream, and hence there must be some process of secretion. Fish which change their depth rapidly secrete oxygen to compensate for the effects of pressure. A weighted fish rises after some time, mainly due to increase of oxygen in the swim bladder. It has been stated that a toxin is formed which causes hæmolysis of the red blood corpuscles, but none was found as the result of activity, nor, as previously stated, were gas bubbles found in the secreting cells. The author urged physiologists to undertake the study of the process of oxygen secretion.

Prof. J. S. Macdonald and Dr. J. E. Chapman, heat production and body temperature during rest and work. By means of the calorimeter at Sheffield the heat production of a fasting man was determined at rest and then during the performance of work. Heat output lags behind heat production owing to a rise of body temperature, which stores a certain amount of heat. The lighter the clothing the more nearly the heat output keeps pace with the heat production. Fatigue is not shown in the record of heat output, but it is shown in the rate of cycling.

Dr. H. E. Roaf, carbon dioxide output during decerebrate rigidity. The carbon dioxide output was measured during decerebrate rigidity, and then after abolishing the rigidity. Abolishing the rigidity by curare or by cutting the motor nerves did not lower the carbon dioxide output. Hence decerebrate rigidity differs from ordinary muscular contraction, as there is no increased production of carbon dioxide during rigidity.

Dr. F. W. Edridge-Green, the frequency of colour-blindness in males. The percentage of colour-blind men has been underestimated. The author finds at last 6 per cent. are colour-blind, and that 25 per cent. have diminished colour-vision.

Prof. G. J. Stokes, paramnesia. The author suggests that the same idea may reach the brain by two different routes, one passing through a greater number of synapses, and thus arriving after the other. Hence in certain cases a feeling that the incident is not new, although it could not possibly have happened before.

Miss May Yates, the nutritive value of whole meal and white bread. This was a correction of some statements made in a recent Local Government Board report. It was claimed that the report did not correctly compare the nutritive value of white flour and flour without removal of the germ and bran.

Prof. A. D. Waller, F.R.S., read an interesting historical paper reviewing the documentary evidence of the discovery of the distinction between motor and sensory nerves.

It was an unfortunate coincidence that the two foreign guests who had accepted invitations as representatives of physiology should at the last moment have been prevented from attending the meeting. Apart from this, the meeting was an agreeable and interesting one for physiologists.

AGRICULTURE AT THE BRITISH ASSOCIATION.

THE outstanding event this year was the elevation of agriculture to the position of a full section; henceforward agriculture comes definitely within the purview of the British Association, and permanently figures as Section M. The increasing output of work by investigators in this country fully justifies this step, while the great interest always shown in agricultural matters by the members of the association encourages the hope that the new section will at least contribute its share to the attractiveness of the meetings.

The problems presented by soils, crops, and animals are so complex that agricultural investigators are bound to keep in close touch with workers in pure science in order that their methods and conclusions may be critically examined. At the British Association meetings more than anywhere else such critical discussions are possible, and in permanently arranging for them the association is fulfilling the first of its declared objects—"to give a stronger impulse and a more systematic direction to scientific inquiry."

The president's address dealt broadly with the application of genetics to the problems of agriculture and horticulture (see NATURE, September 21), and several of the papers dealt with special aspects of this subject. In an interesting communication Mr. C. C. Hurst discussed the genetics of horse-breeding. Chestnut coat colour is recessive to bay and brown; consequently chestnut horses always breed true when mated together, notwithstanding their bay and brown ancestors. Bays and browns, however, are of two kinds, one throwing chestnuts, the other not. Grey is dominant to bay, brown, and chestnut, but since grey × grey matings are rare in England, English grey thoroughbreds are nearly all heterozygous, throwing bays, browns, or chestnuts; a homozygous grey is, however, known in Germany which throws nothing but greys. In certain strains a partial coupling is observed between coat colour and racing power, bay and brown descendants of St. Simon being much better racers than the chestnuts. There is apparently a partial tripling of brown coat colour, high racing power, and female sex in St. Simon's own offspring.

Prof. Wilson described his studies of the inheritance of milk yield in cattle, the earlier accounts of which have attracted a good deal of attention. After eliminating abnormalities due to time of calving, period of lactation, food, shelter, and age of the animal, it is found that full-sized mature cows fall into three grades, giving, respectively, 500 to 600, 650 to 850, and about 1000 gallons of milk a year. The two extreme grades are approximately pure, while the middle grade is a hybrid.

A different type of problem was dealt with by Mr. W. J. Backhouse. A systematic inquiry was undertaken into the gametic composition of our common plums with the view of putting the raising of new plums on a scientific basis. At the height of the flowering period the flowers of certain plums were carefully hand-pollinated with their own pollen. Some varieties proved remarkably self-fertile, the flowers setting very well to fruit. Other varieties, however, proved self-sterile, and set absolutely nothing. It is understood that these interesting observations are being followed up.

A useful day was spent in discussing the bacterial diseases of plants. Prof. Potter opened with a summary of our present knowledge of the subject. The old idea that the plant was not susceptible to the attacks of bacteria is now known to be erroneous; indeed, certain bacterial diseases can be faithfully reproduced with absolute certainty by inoculation in healthy tissues. The plant possesses many vulnerable points of attack; infection may take place through the water pores, the stomata, the floral nectaries, and wounds, the vessels of the xylem affording a suitable channel for the dispersion of the invading bacilli. Further, certain bacteria secrete a toxin and cytolitic enzyme which destroy the protoplasm and rapidly dissolve cellulose. The actual penetration of the bacterium through the cell-wall has been observed. A complete homology has been established between the parasitism of bacteria and that of various fungi. Saprophytic bacteria, like fungi, develop under certain conditions into virulent parasites, and their aptitude as parasites may be increased or suppressed by variations in nutrition. The nature of the soil, manurial treatment, and other factors materially affect the constitution of the host and its predisposition to infection. Mr. Brooks followed with an account of the gum disease of the sugar-cane, caused, as Irwin F. Smith has shown, by a specific bacterium, *Pseudomonas vascularum*. A disease of cherry trees, accompanied by profuse gumming, has been traced by Aderhold and Ruhland to *Bacillus spongiosus*. On the other hand, the mosaic disease of the tobacco plant, formerly attributed to bacteria, is now regarded as the result of some physiological disturbance within the plant.

Dr. Pethybridge described his investigations on the bacterial diseases of the potato plant in the west of Ireland. From a confused group of diseases formerly known as "yellow blight" he has disentangled a definite disease, "black stalk rot," resembling the "black leg" of other authors, and caused by an organism which he names *Bacillus melanogenes*. The organism not only brings about the untimely death of plants in the fields, but also causes a most serious rot in stored potatoes, even healthy unwounded tubers being capable of infection through their lenticels.

Mr. A. S. Horne emphasised the effect of external conditions on the incidence of disease. The probability that a plant will thrive in a given spot depends upon certain combinations of factors relating, respectively, to (1) the structure and internal constitution of the plant and the organisms associated with it; (2) the soil and soil organisms; (3) the climate, season, and aërially-borne organisms. Disease may occur if the optimum arrangements of the factors be disturbed.

Another day was spent in considering how best the university agricultural departments can come into contact with the practical farmer. Mr. R. Hart-Synnot opened with a description of the Irish system and a modification that seemed suitable to English conditions. It is admitted that the English system has not been entirely successful; indeed, it became evident in the discussion that some of the most successful departments have broken altogether from the conventional lines. Principal Ainsworth Davies considered that the universities should not only undertake research work and the training of experts, but should also disseminate the results obtained among the farmers, and act as bureaus of information generally. Mr. Burton dealt with the place of the agricultural instructor, whose title, he thought, ought to be changed to that of agricultural adviser.

A group of papers came in from the Cambridge Agricultural Department. Prof. Wood and Mr. Harvey described a very ingenious method of determining the baking strength of single ears of wheat. Hitherto it has been necessary to work with large quantities of flour, which can only be obtained with difficulty in plant-breeding experiments. The method suggested simply requires one gram of flour. On shaking with water an opalescent extract is obtained, the humidity of which affords a measure of the strength of the wheat. The sensitiveness of the method is increased by addition of iodine to the turbid extract. Mr. H. A. D. Neville gave a preliminary description of the mucilage of linseed. On hydrolysis with sulphuric acid, mucilage yields dextrose, galactose, arabinose, xylose, and small amounts of a cellulose-like substance and of an acid which forms a soluble barium salt. It appears to be completely digested by the animal, but is neither acted upon by saliva nor by pancreatic juice; it is rapidly decomposed, however, by the bacteria of the cæcum. Messrs. Marshall and Mackenzie introduced a technical subject of very great importance—the question of ovariotomy in pigs. This practice has been known for many years, but has not hitherto received the scientific attention it deserves. If the ovaries are removed after sexual maturity is reached, the uterus undergoes a gradual atrophy; on the other hand, the removal of the uterus has no effect on the development or functional activity of the ovaries. Further, if the ovaries are only incompletely removed, a fragment left behind may in the course of a few months regenerate into an ovary of considerable size. Ovariotomy frequently results in a deposition of fat in various parts of the body; hence its commercial value. In a second paper the same authors dealt with the temperature variations during the œstrous cycle in cows. The rise may be as much as 5°, whilst on the approach of heat a rise of 2° or 3° was usual. These results have special importance in connection with the tuberculin test, in which an animal is supposed to react if the temperature rises 2°.

Mr. H. W. Elwes gave an account of aboriginal races and little-known breeds of domestic sheep, which elicited an interesting discussion, in which Profs. Ridgeway and Wilson, the chairman, and others took part. Domesticated animals seem to have been curiously neglected by zoologists, and Mr. Elwes could find only few references to them in zoological literature. By dint of much inquiry in remote and comparatively inaccessible regions of the British Islands and elsewhere, he has succeeded in finding a number of aboriginal breeds interesting not only in their relationship to our present breeds, but because of their potential value to the practical man, inasmuch as they are extremely hardy and might be used to restore to some of our present breeds the constitution that has been partially lost. Another livestock subject was dealt with by Mr. J. Hendrick in his discussion of the effects of ventilation on the temperature and carbon dioxide content of the air of byres. The amount of pollution is sometimes extraordinary, more than 100 parts of carbonic acid per 10,000 having been recorded, whilst the average CO_2 content was 30 parts where ventilation was restricted and 12 to 15 where it was freer. In spite of the low temperature resulting from free ventilation, the health of the cows was better and their yield of milk was as good as in the warm, badly ventilated byres.

Messrs. Barker and Hillier described a disease known as cider sickness that causes a loss probably amounting to several thousand pounds sterling each year in the west of England alone. It is brought about by a bacterium capable of fermenting dextrose and lævulose with production of alcohol and carbon dioxide, together with a small amount of hydrogen, an unrecognised acid, and an odour resembling that of decaying lemons. It does not appear to attack saccharose, maltose, or lactose. Prof. Priestley and Miss Lee described an ingenious method of measuring the effects of various factors on the growth of micro-organisms. The rate of production of the metabolic products as measured by the change in electrical conductivity of the culture solution is taken as an index of growth, and is found to give results in accordance with the much more tedious process of counting. The particular factor investigated was the influence of electricity. Currents up to about 60 micro-amperes had a favourable effect on the rate of growth of *Bacillus bulgaricus*, whilst currents of greater strength inhibited their activity. No difference could be detected between the effects of direct and alternating currents. In a paper with Mr. Knight, Prof. Priestley dealt with the influence of electricity on the respiration of germinating seeds; a direct current was found to be harmful; a rapidly alternating current at low strength stimulated respiration, but had no effect at 150 micro-amperes; whilst stronger currents caused a decrease; the overhead discharge gave irregular results until some turpentine was introduced to absorb the ozone produced, and then an increase was observed in the amount of carbonic acid produced.

After a suggestion for the reform of the British system of weights and measures had been put forward by Mr. J. Porter, two papers, that brought the meeting to a close, were read by Prof. Bottomley. In the first he adduced further evidence in support of his contention that the bacteria Azotobacter and Pseudomonas fix more nitrogen per unit of carbohydrate consumed when grown together than when grown separately. In the second he claimed to have obtained evidence of the existence of bacteriotoxins in the soil.

A new feature introduced this year was a semi-popular lecture, by Mr. Hall, on the local soils and farming practices. So great was its success that a semi-popular lecture is likely to become a regular part of the programme of the Agricultural Section.

THE EAST AFRICAN NATURAL HISTORY SOCIETY.[1]

THERE has been no falling off in the East African Journal of Natural History: No. 3 of vol. ii. is as interesting as its predecessors. The scientific student of Africa welcomes these genuine, first-hand studies, these notes and records without the flim-flam, facetiousness, and vague inaccuracy which so often characterise the articles contributed to similar societies in young colonies.

In the part under review the most noteworthy articles, perhaps, are:—"Notes on the Common Pathogenic Protozoa in British East Africa," by R. Eustace Montgomery; "Some East African Pigs," by C. W. Woodhouse; and "Mendel's Principles of Heredity," by Dr. A. H. Marsh (this last with reference to the crosses between *Bos taurus* and *B. indicus*).

Mr. Montgomery is the veterinary bacteriologist for British East Africa. In his paper he devotes himself chiefly to describing the protozoa of the groups Mastigophora and Sporozoa. Of the first-named, the Spirochætæ—causing diseases among cattle and domestic poultry—are transmitted mainly or entirely by ticks of the genera Boophilus, Argas, and Ornithodorus, and another tick seems to be the introducer into the human system of the *Spirochaeta duttoni*, which is the cause of human relapsing fever. (The closely allied flagellate, *Treponema pallida*, is the cause of syphilis. We are all aware of the ordinary and normal manner of conveying the infection of syphilis, but the question arises whether in Uganda and similar countries where it rages infection may not also be conveyed by the agency of a tick.) There are four recognised trypanosomes in British East Africa and Uganda: *T. gambiense*, the deadly germ of sleeping sickness; *T. dimorphon*, which may produce disease in horses, cattle, dogs, &c., but does nothing to man; *T. vivax*, of which the same may be said; and *T. lewisi*, a parasite in rats. The transmitting agencies of the trypanosomes appear to be not only the notorious *Glossina palpalis*, or tsetse-fly, of equatorial Africa, but possibly also other Glossinæ, a gad-fly, Tabanus, and a mosquito, Stomoxys.

Among the East African Sporozoa, the genera Babesia, Nuttallia, Theileria, and Anaplasma are pathogenic among cattle and dogs. The transmitting agency for all these sporozoa of the suborder Acystosporea is a tick—Boophilus, Rhipicephalus, or Hæmaphysalis. Babesia is the cause of red-water, or Texas fever, and also of tick fever in the dog; Nuttallia creates biliary fever in horses, asses, and mules; Theileria is the parasite of East Coast fever in cattle; and Anaplasma produces a form of gall sickness in cattle.

With regard to the article on East African pigs (in which there is much fresh material concerning the appearance and habits of the giant forest pig), a puzzling mistake occurs in the first paragraph, wherein reference is made to an Abyssinian type of "wart-hog," *Phacochoerus johnstoni*. This should be *Potamochoerus johnstoni* (the East African river-hog); and it is not, we believe, Abyssinian in range, but equatorial East African.

A question is raised on p. 76 as to the attitudes of marabou storks during flight. It has always seemed to the present writer that in the normal attitudes of this bird when flying the neck was stretched out like that of other storks, or slightly curved and retracted, especially when wheeling. Others have asserted that the marabou drew back its neck into the ruff of shoulder feathers as a heron would do. It is a point which could best be decided by instantaneous photographs. As a general rule, storks, Balæniceps, and Scopus (besides ibises) stretch out their necks when flying; herons and pelicans retract them.

This No. 3 contains as a frontispiece a remarkable photograph of a record head of a Cape buffalo from Uganda—a splendid specimen almost recalling in length and curve of horns the extinct *Bos antiquus*. There is also an interesting article on birds in Uganda forests, another on anthropometry, and a third on the seasonal variation of the Junonia genus of butterflies.

H. H. JOHNSTON.

[1] The Journal of the East Africa and Uganda Natural History Society, vol. ii., No. 3, March, 1911. (London: Longmans, Green and Co.) Price 5s. 4d.

WHELKS AND THE VALUATION OF THE SEA.[1]

IN the first of these reports Dr. Petersen discusses the possibility of combating the harmful animals of the fisheries, especially the whelks (Buccinum and Nassa), in the Limfjord. It appears that these animals are exceedingly troublesome in the Limfjord owing to their great abundance and rapacity. They feed on the plaice caught in the nets (gill-nets), and Dr. Petersen estimates the loss to the fishermen at a third of the year's total catch, a very considerable amount. The process of deliberate extermination is not recommended, however, as being too costly and uncertain, nor does it appear possible to make any economical use of the whelks; but it is suggested that the fishermen should clear their nets at more frequent intervals, and for the rest hope for an epidemic among the whelks. The possibility of the latter seems by no means remote.

In the twentieth report Dr. Petersen displays the foundations of an extensive and notable work on the quantitative determination of the animal life on the bottom of the sea. The investigation is stated to be a logical extension of Hensen's ideas; but, as a matter of fact, the "census of the sea" of Hensen, Brandt, and Herdman is widely different from the "valuation of the sea" of Petersen. Where the former lay stress on the plankton, and ignore the part played by the organic matter dissolved in sea water and in the bottom soil, the latter rather discredits the plankton, pointing out, in agreement with Lohmann, that its "producers" are not always able to supply sufficient food for its own "consumers," and lays stress on the organic matter. In the first part of this report Dr. Boysen Jensen discusses the results of his chemical analysis of the bottom soil and sea water, and concludes, *inter alia*, that the organic matter must come essentially from the benthos flora (algæ, and especially Zostera) in the Limfjord. The benthos animals—*e.g.* the oyster—are dependent on this organic matter, and not on the plankton.

It follows from this that the methods of investigation used by Dr. Petersen are entirely different from those of the planktologists. The basal idea is to determine the quantity of animal life on a fixed unit of surface (0·1 $m.^2$) at as many different stations as possible, and at all seasons of the year. For this purpose Dr. Petersen has designed a special apparatus, which is simple in construction and can be used at any depth. To count the animals, after sifting, from such a unit of surface is obviously a much easier matter than the enumeration of the plankton. But Dr. Petersen goes much further, and, with the assistance of Dr. Boysen Jensen, gives the equivalents for each species in grams of organic matter. This common denominator thus serves as a basis of comparison of the value, not only of the different species, but also of different areas or fishing grounds. From this basis also it is possible to compare the amount of nourishment available and the amount consumed, as by the fishes. Even the fishes are reduced

[1] Nineteenth Report from the Danish Biological Station. Some Experiments on the Possibility of combating the harmful Animals of the Fisheries, especially the Whelks in the Limfjord. By C. G. Joh. Petersen. Pp. 20. (1911.)

Twentieth Report from the Danish Biological Station. Valuation of the Sea. I. Animal Life of the Sea-bottom, its Food and Quantity (Quantitative Studies). By C. G. Joh. Petersen and P. Boysen Jensen. Pp. 81; with 6 tables, 3 charts and 6 plates. (1911.)

to the common denominator; and it is shown, for example, that in the Limfjord the annual increase in weight of the plaice is only about one-sixth of the amount of organic matter consumed, and that the annual consumption of the plaice and eel together is only about one-ninth of the nourishment available.

The work is stated to be in its beginning, and this report is to be regarded as the introduction only; even so, it is remarkable for its broad and philosophic insight into fisheries problems and its wealth of ideas and practical suggestions. It can be strongly recommended to the planktologists—as an antidote. K.

SCIENTIFIC WORK OF THE IMPERIAL INSTITUTE.

WE have received a copy of the "Report on the Work of the Imperial Institute, 1910" (Cd. 5467–23), which contains a prefatory statement describing the organisation and objects of the institute, and includes summaries of the investigations carried out by the scientific and technical staff during the year. These comprised the examination of various minerals; of vegetable products such as cotton, rubber, oils, tobacco, foodstuffs, and so forth; and of a few animal products, including sponges, shells, feathers, and hair. Among the minerals mention is made of thorianite from Ceylon, containing 51·1 per cent. of thoria and 24·9 per cent. of uranoso-uranic oxide, the case being of special interest as indicating the kind of rock with which thorianite may be expected to occur in other localities.

Deposits of lignite from Southern Nigeria have been found to yield briquettes of excellent quality, and it is now clear that the use of local fuel, by obviating the heavy expenditure on imported coal, will materially assist the development of the West African colonies.

In the East African Protectorate an immense deposit of "soda" is to be worked; it consists essentially of sodium sesquicarbonate, and merely requires heating to furnish commercial "soda" of good quality. Numerous samples of rubber were examined, though only one actual consignment of any magnitude is described; this consisted of about 650 lb. of Landolphia rubber from the Bahr-el-Ghazal, which was of good chemical quality and realised fair prices.

In connection with the production of lemon-grass oil, the report states that the cultivation and distillation of lemon-grass in Uganda is now securely established. Samples of wheat from the East African Protectorate and from Northern Nigeria were found to be of excellent quality, and some "Turkish" tobacco from the Cape Province was regarded by experts as very promising. During the year three papers on geological and mineralogical questions, and one on the synthesis of caoutchouc, were contributed to scientific journals by members of the staff of the institute.

EXHIBITION OF MODEL AND EXPERIMENTAL ENGINEERING.

MR. PERCIVAL MARSHALL and those who are acting with him are to be congratulated on the success of the third biennial exhibition of model and experimental engineering. As before, this is held at the Royal Horticultural Hall, and it closes next Saturday. Model engines and boats, both sailing and steam, and kites, have always supplied an unfailing attraction to the younger generation; but now the amateur mechanic and experimentalist has a wider and more attractive field, largely dependent on the gas or petrol engine, a field in which in the last two years enormous strides have been made. Aëroplanes and hydroplanes of model size are doing wonders, though, of course, in most cases the engine of the aëroplane is made of elastic. The gyroscope and electricity afford more subject-matter for the experimentalist, as the model engineer now so often becomes, to work upon. Even wireless telegraphy is not outside his reach. When it is realised that a speed of more than twenty miles an hour has now been reached by a model "speed boat," and about half a mile has been traversed by a model aëroplane, it must be felt that the model engineering and experimental art as fostered by the society for which Mr. Marshall is doing so much is more than mere toy-making—it has a valuable educational influence.

It may be said that there are two types of small machine or model, one the faithful copy on a small scale of the big machine, and the other the small machine made so as itself to be as good as possible as a working machine. The two ideals are wholly distinct; each has its attractive side, each is well represented at the exhibition; but it is the second that is the most instructive, and this appeals most to the scientific imagination. While the visitor cannot help admiring the model of an engineering workshop with its steam engine, shafting, travelling crane, lathes, shapers, and planing machines, all beautifully made, and with leg vices, spanners, and small tools all in keeping, and while so beautifully made a model is quite instructive, model machines made not a bit like their large prototypes, but with their proportions altered so as to make them work as well as possible, are more interesting. They may fail in appealing to the æsthetic sense, if that be the sense which makes scale models so attractive, but if so they satisfy the reasoning faculty and experimental sense, and to the writer they appear the more important. Of course, at times proportions become so wildly inverted as to lead to a ludicrous appearance; but that only indicates the triumph of reason over the imitative art. For instance, there is a model petrol engine with pressure tank, carburettor, and engine in which the proportion of carburettor and cylinder irresistibly remind one of Lear's "young bird in that bush."

The only regret, and this is expressed not for the first time, is that Mr. Marshall so far has been unable to organise his exhibition at a time of year when boys are having their holidays.

FORTHCOMING BOOKS OF SCIENCE.

IN addition to the books announced in NATURE of October 5, the following works may be expected:—

AGRICULTURE.

W. H. and L. Collingridge.—Manures for Garden and Farm Crops, W. Dyke. *John Murray.*—A new edition of Elements of Agriculture: a Text-book Prepared under the Authority of the Royal Agricultural Society of England, by the late Dr. W. Fream, edited by Prof. J. R. Ainsworth-Davis, illustrated.

ARCHÆOLOGY.

Cambridge University Press.—The Thunderweapon in Religion and Folklore: a Study in Comparative Archæology, Dr. C. Blinkenberg, illustrated. *Oxford University Press.*—Four Years' Excavations at Thebes, the Earl of Carnarvon and Mr. Howard Carter, with chapters by Mr. F. L. Griffith, M. George Legrain, Dr. Moller, Prof. Newberry, and Prof. Spiegelberg, illustrated.

BIOLOGY.

Blackie and Son, Ltd.—Methodical Nature Study, W. J. Claxton, illustrated. *Gebrüder Borntraeger (Berlin).*—Die Wirbeltiere, Prof. O. Jaekel, illustrated; Symbolae Antillanae seu fundamenta florae Indiae Occidentalis, edited by I. Urban, Band iv., fasc. 4; Flora von Steiermark, Dr. A. von Hayek, Band ii., Heft 1; Handbuch der systematischen Botanik, Prof. E. Warming, new edition by Prof. M. Möbius; Kulturpflanzen und Haustiere in ihrem Übergange aus Asien nach Griechenland und Italien sowie in das übrige Europa, V. Hehn, new edition, edited by Prof. O. Schrader. *Cambridge University Press.*—Types of British Vegetation, by members of the Central Committee for the Survey and Study of British Vegetation, edited by A. G Tansley, illustrated; The Vegetation of the Peak District, Dr. C. E. Moss; Life in the Sea, J. Johnstone; Heredity and Eugenics, edited by J. M. Coulter; American Permian Vertebrates, S. W. Williston, illustrated. *W. H. and L. Collingridge.*—Orchids for Amateurs, C. A. Harrison, illustrated; Rock Gardens and Alpine Plants,

E. H. Jenkins, illustrated. *Herbert and Daniel.*—Evolution in the Past, H. W. Knipe, illustrated. *Hutchinson and Co.*—The Flower Fields of Alpine Switzerland, G. Flemwell, illustrated; The Story of Evolution, J. McCabe, illustrated. *Jarrold and Sons, Ltd.*—Horses and Practical Horse Keeping, F. T. Barton, illustrated; Farther Afield in Birdland, O. G. Pike, illustrated; Wild Animals and the Camera, W. P. Dando, illustrated; My Book of Little Dogs, G. V. Stokes and F. T. Barton, illustrated; Our Dogs and All About Them, F. T. Barton, new edition, illustrated. *John Murray.*—Further Researches into Induced Cell-reproduction and Cancer, H. C. Ross, illustrated; The Genus Rosa, E. Willmott, drawings by A. Parsons, in parts, continued; Science of the Sea: an Elementary Handbook of Practical Oceanography for Travellers, Sailors, and Yachtsmen, prepared by the Challenger Society for the Promotion of the Study of Oceanography, and edited by Dr. G. H. Fowler, illustrated; and a new edition of Recent Advances in the Study of Variation, Heredity, and Evolution, R. H. Lock, illustrated. *Williams and Norgate.*—Introduction to Science, Prof. J. A. Thomson. *Grant Richards, Ltd.*—The Complete Wildfowler Ashore and Afloat, S. Duncan and G. Thorne, illustrated; The Birds of the British Islands, C. Stonham, parts 19 and 20, completing the work. *Seeley, Service and Co., Ltd.*—The Wonders of Bird Life, J. Lea. *Whitcombe and Tombs, Ltd.*—An Australian Bird Book, J. A. Leach, illustrated.

CHEMISTRY.

Gebrüder Borntraeger (Berlin).—Chemisch-technisches Praktikum, Dr. W. Moldenhauer; Die Chemie der Cellulose, Prof. C. G. Schwalbe; Magnetochemie, Prof. E. Wedekind, illustrated.

ENGINEERING.

Cassell and Co., Ltd.—Electrical Engineering, by H. H. Simmons, in 14 parts, illustrated. *Seeley, Service and Co., Ltd.*—The Wonders of Modern Engineering, A. Williams.

GEOGRAPHY.

Cambridge University Press.—The Climate of the Continent of Africa, A. Knox, illustrated; The Physical Geography of South Africa, A. L. Dutoit; Cambridge County Geographies, illustrated: Buckinghamshire, Dr. A. M. Davies; East London, G. F. Bosworth; West London, G. F. Bosworth; Northamptonshire, Rev. M. W. Brown; North Lancashire, Dr. J. E. Marr, F.R.S.; Monmouthshire, H. A. Evans; The Isle of Man, Rev. J. Quine; Oxfordshire, Rev. P. H. Ditchfield; Dumfriesshire, Rev. Dr. J. K. Hewison; Midlothian, A. McCallum; Perthshire, P. Macnair. *John Murray.*—Rambles in the Pyrenees and the Adjacent Districts—Gascony, Pays de Foix and Rousillon, F. H. Jackson, illustrated. *G. Philip and Son, Ltd.*—Philips' New Historical Atlas for Students, Prof. R. Muir; Philips' Chamber of Commerce Atlas: a Graphic Survey of the World's Trade, with a Commercial Compendium and Gazetteer Index; Philips' Modern School Atlas of Comparative Geography, edited by G. Philip, new edition; The Imperial Stations from Gibraltar to the Far East, prepared for the Visual Instruction Committee of the Colonial Office. *Whitcombe and Tombs, Ltd.*—The Geography of New South Wales, Historical, Physical, Political, and Commercial, Dr. Woolnough, assisted by A. W. Jose, G. Taylor, with introduction by Prof. T. W. David, illustrated.

GEOLOGY.

Gebrüder Borntraeger (Berlin). Geologischer Führer durch das Mainzer Tertiärbecken, Dr. E. Mordziol, illustrated; Geologische Charakterbilder, edited by Prof. Stille: Heft 7, Westgrönland, Basalt- und Sedimentgebirge, by A. Heim; Heft 8, Der Odenwald bei Heidelberg und sein Abbruch zur Rheinebene, by W. Spitz and W. Salomon, illustrated.

MATHEMATICAL AND PHYSICAL SCIENCE.

Cambridge University Press.—An Elementary Treatise on Cross-ratio Geometry, with Historical Notes, Rev. J. J. Milne; and new editions of A Primer of Astronomy, Sir R. Ball, F.R.S., illustrated; The Mathematical Theory of Electricity and Magnetism, J. H. Jeans, F.R.S. *Hutchinson and Co.*—Photography, edited by H. P. Maskel. *John Murray.*—A New Geometry, A. E. Layng. *G. P. Putnam's Sons.*—Star Lore of all Ages, W. T. Olcott, illustrated. *Williams and Norgate.*—Astronomy, A. R. Hinks.

MEDICAL SCIENCE.

D. Appleton and Co.—A Text-book of Bacteriology: a Practical Treatise for Students and Practitioners of Medicine, P. H. Hiss, jun., and H. Zinsser; Treatise on Tuberculosis, edited by A. C. Klebs; Plastic and Cosmetic Surgery, F. S. Kolle; Clinical Symptomatology, with Reference to the Life-threatening Symptoms and their Treatment, A. Pick and A. Hecht; A Text-book of Medicine for Practitioners and Students, Dr. A. V. Strumpell; A Text-book in Psychotherapy, including the History of the Use of Mental Influence, directly and indirectly, in Healing, and in the Principles for the Application of Energies derived from the Mind to the Treatment of Disease, J. J. Walsh. *Gebruder Borntraeger (Berlin).*—Pharmakognostischer Atlas, Zweiter Teil der mikroskopischen Analyse der Drogenpulver, Prof. L. Koch, Band i., illustrated. *Herbert and Daniel.*—The Romance of Modern Surgery and its Making: a Tribute to Listerism, Dr. C. W. Saleeby. *J. Nisbet and Co., Ltd.*—Tuberculin in the Diagnosis and Treatment of Tuberculosis, Dr. W. C. Wilkinson; The Intensive Irradiation and Wave Current Treatment of Rheumatism, Sciatica, Lumbago, Neuritis, and Painful Joints, L. E. Creasy.

TECHNOLOGY.

Gebrüder Borntraeger (Berlin).—Internationale Zeitschrift für Metallographie, edited by Dr. W. Guertler, Band i., illustrated; Handbuch der bautechnischen Gesteinsprüfung, Prof. J. Hirschwald, illustrated. *C. Arthur Pearson, Ltd.*—Wires and Wireless, T. W. Corbin. *Seeley, Service and Co., Ltd.*—Mechanical Inventions of To-day, T. W. Corbin, illustrated; The Romance of Aëronautics, C. C. Turner. *John Hogg.*—A new edition of Silverwork and Jewellery, H. Wilson, with notes by Prof. U. Bisei, illustrated.

MISCELLANEOUS.

Gebruder Borntraeger (Berlin).—Gedanken und Vorschläge zur Naturdenkmalpflege in Hohenzollern; Die Gefährdung der Naturdenkmäler und Vorschläge zu ihrer Erhaltung, Prof. H. Conwentz, new edition. *Cambridge University Press.*—Byways in British Archæology, W. Johnson, illustrated; Assyrian and Babylonian Letters Belonging to the Kouyunjik Collections of the British Museum, edited by R. F. Harper, parts x. and xi. *John Murray.*—Early Norman Castles in the British Isles, E. Armitage, illustrated; The Excavation of Gezer, 1902–5 and 1907–9, Prof. R. A. Stewart MacAlister, 3 vols., illustrated.—*Scott Publishing Company, Ltd.*—The Composition of Matter and the Evolution of Mind, D. Taylor. *Williams and Norgate.*—Psychical Research, Prof. W. F. Barrett, F.R.S.; The Dawn of History, Prof. J. L. Myres.

THE SCIENTIFIC MISAPPROPRIATION OF POPULAR TERMS.[1]

ONE of the main functions of the British Association is to prevent the development of a scientific caste in this country. The essential ideas of caste and science are diametrically opposed; nevertheless, the spirit of caste has in times past invaded the spirit of science, with the natural consequence that the eager explorers of knowledge became the academic guardians of tradition; and the same invasion now would deprive science of the popular sympathy and support which are more than ever necessary for its steady development. The members of the corresponding societies have special opportunities for helping that part of the Association's mission, for their personal intercourse with all sections of the community enables them to do much "to obtain a more general attention to the objects of science." Their influence must be exerted mainly through words, and the proper use of words is a matter of vital importance to the welfare of science. The recent appeals

[1] Address to the Conference of Delegates at the Portsmouth meeting of the British Association, by Prof. J. W. Gregory, F.R.S., chairman.

for the improvement of the language of scientific literature are therefore direct contributions to scientific method; and as the societies represented at this conference are the strongest link between the technical specialist and those who take a friendly interest in science, special sympathy may be expected here with the complaints against the unintelligibility of some scientific writings owing to the excessive use of technical terms. I wish this afternoon, without denying that technical terms are sometimes used unnecessarily, to direct attention to a more neglected and insidious evil—the use of well-known English words with a technical meaning. The temptation to adopt an old word for a new idea, instead of inventing a fresh term, is often strong. It saves trouble—at the time. The old word is probably shorter than a new one would have to be, and its use avoids burdening a passage with an unknown and perhaps uncouth term. A sentence in which all the words are familiar appears to present no difficulties; a reader skims lightly over it pleased with the lucidity of the author and ignorant of the fact that it has been misunderstood, as the leading word conveyed to him a meaning different from that intended by the writer. The danger of a passage being misunderstood is more serious than that of its being not understood. It is worse to be misled by a plausible phrase than to be startled or repelled by a correct technical statement. A new word compels a conscientious reader to determine its true meaning, and should help him to a clear conception of the fresh idea; whereas the use of an old word with a new meaning discourages inquiry and encourages slovenliness in work and thought. The use of popular phraseology may render scientific literature apparently less strange; but if that phraseology be incorrectly used, the ultimate effect is to increase the divergence between the scientific and popular languages, and the estrangement between science and public opinion. For the scientific use of terms inconsistently with their ordinary meanings is apt to persuade the layman that the language of science is so different from his own that it is no use attempting to understand it.

Most sciences have adopted popular terms with new and restricted meanings; and if the origin of such a word be forgotten, scientific writers are apt to treat any use of it in its original sense as a popular blunder. For example, zoologists not only now reject spiders from the class of Insecta, but treat the idea that a spider is an insect as a mistake due to simple ignorance. Thus, to quote a recent standard work, J. H. and A. B. Comstock, in their "Manual for the Study of Insects" (1909, p. 12), remark that spiders "are often mistaken for insects," although the authors have abandoned "Insecta" as the name of the class in favour of Hexapoda. The word insect is much older than modern systematic zoology and the class Insecta. The word insect is derived from the Latin *insectum*, which is based on the verb *insecare*, "to cut into"; and it was used for animals the bodies of which are notched or incised into sections. This meaning of the word is well expressed in the definition by Philemon Holland, who is the earliest English author quoted in the "New English Dictionary" as having used the word insect. In his book, "The Historie of the World, commonly called the Naturall Historie of C. Plinius Secundus" (1601), he says, "Well may they all be called Insecta, by reason of those cuts and divisions, which some have about the necke, and others in the breast and belly; the which do go round and part the members of the bodie, hanging together only by a little pipe and fistulous conveiance."

The class Insecta was based by its founder, Linnæus, on the segmentation of the body, and not on the number of legs; it therefore included scorpions, millipedes, and spiders. It was not until half a century later that Lamarck excluded spiders from the class Insecta; and as late as 1864 we find so distinguished a naturalist as Bates[1] remarking that the spiders "Mygales are quite common insects." Even such a recent standard modern cyclopædia as the "Jewish Encyclopædia"[2] retains the millipedes as insects. The term insect should not, however, be applied to a coral polyp; "coral insect" is justly denounced as a misleading blunder, due to ignorance of the nature of the coral animal. The terms *insectum* and insect according to their original usage no doubt included worms, and

[1] "A Naturalist on the Amazon," p. 96. [2] 1906, vol. vi., p. 105.

Holland expressly mentioned earth-worms as insects. In many worms, however, the body is not divided into segments, and worms were therefore early and appropriately excluded from insects; so Milton writes[1] in his description of the bower in Eden:—

> "Other creature here,
> Beast, bird, insect, or worm, durst enter none."

Johnson's Dictionary (first edition, 1755) accepted a definition restricting insects to animals whose body is nearly divided in the middle into two parts. "Insects may be considered together as one great tribe of animals; they are called insects from a separation in the middle of their bodies whereby they are cut into two parts, which are joined together by a small ligature, as we see in wasps and common flies." This definition, while admitting spiders, excluded worms. The present zoological separation of insects from other air-breathing arthropods is based mainly on the presence of six legs. The term Hexapoda is therefore more suitable for the class as now defined than Insecta; and the restriction of Insecta in systematic zoology to a group based not on the insection of the body, but on the number of legs, is less accurate and appropriate than its previous use in zoology and in popular English. It would seem better to admit that the spider is an insect, but insist that it is not a hexapod.

The term worm, on the other hand, illustrates cases in which a restriction of popular meaning is both appropriate and convenient. A worm was originally not necessarily one of the Vermes of the zoologist. Thus the worms mentioned in the Old Testament included various insect larvæ. Dr. Ridewood tells me that the manna collected by the Israelites in the desert was probably a small lichen, and that the worms bred in it[2] were probably fly grubs; and the references by Job and Isaiah to worms that cover the dead may include both insect grubs and nematodes. When Job reminds the sinner of the worm that "shall feed sweetly upon him,"[3] he had in mind the larvæ of blowflies; and though the worms that ate Herod[4] may have been an endoparasitic worm or fluke, the worm that caused the withering of Jonah's gourd[5] was probably a beetle larva.

In popular English, moreover, worms always included snakes, as shown both by Dr. Johnson's definition of a worm, "A small, harmless serpent that lives in the earth," and by Shakespeare in Cleopatra's inquiry:—

> "Hast thou the pretty worm of Nilus there,
> That kills and pains not?"[6]

Uniformity between popular and zoological terminology can best be secured in regard to the term worm by inducing the public to use it only for one of the Vermes, for it is less necessary to have one term for all creeping things than to distinguish noxious snakes and centipedes from the lowly and useful worm.

The word fish illustrates how a popular word may become unduly extended and then be again restricted with fuller knowledge. The word is of very ancient origin, and was probably originally limited to what the zoologist accepts as fish. The term fish is not derived from the primitive Aryan language, and it was not introduced until the Latin-Teutonic section had separated from the Indian and the Greek; and as the term was invented by people who apparently had no knowledge of the sea, they doubtless used it for fresh-water fish.[7] The primitive hunters who went to the coast may have extended it to shellfish, and it was adopted in the English crayfish by a corruption of the French *écrevisse*. When whales and dolphins were discovered, they were accepted as fish in ignorance of their affinities, for such aquatic animals as seals and otters were never included among fish, since their mammalian characters were obvious. That whales, porpoises, and their allies are not fish is now admitted in current language, though the old usage survives among whalers. The terms whale-fishery and seal-fishery are firmly established; but they are unobjectionable, because those industries have so many important features in common with the capture of fish. The general current limitation of fish to the fish

[1] "Paradise Lost," iv. [2] Exodus, xv. 20. [3] Job, xxiv. 20.
[4] Acts, xii. 23. [5] Jonah, iv. 7. [6] "Antony and Cleopatra," v. 2.
[7] See O. Schrader, "Prehistoric Antiquities of the Aryan Peoples," 1890, pp. 117–118, 127–128, 353–354.

of the zoologist is only a return to the primary meaning of the word.

Chemistry supplies an excellent illustration of the justifiable adoption of an old term with a revised meaning. Element is used in its later classical meaning, and Chaucer in 1386 shows that it was used in Early English in a similar sense. He says in the Frere's Tale (line 206):—

> "Make ye yow newe bodies alway
> Of elementz."

Its modern chemical use means the resurrection of the word element to a new period of usefulness.

The chemical adoption of the terms metal and non-metal for the two classes of elements is, on the other hand, an example of the inconvenience that results when a new definition is only approximately coincident with a well-established current meaning. The word metal appears to be derived from the Greek *μεταλλον*, connected with *μεταλλάω*, "to seek after," through the Latin *metallum*, a mine or quarry, or substance obtained by mining. Hence road metal for stone is correct.

By the time of Johnson the word metal was usually restricted to those products from mines which have metallic as distinct from earthy or stony properties. Johnson's definition—"We understand by the term metal a firm, heavy, and hard substance, opake, fusible by fire, and concreting again when cold into a solid body such as it was before, which is malleable under the hammer, and is of a bright, glossy, and glittering substance where newly cut or broken"—states the general idea of a metal.

The chemical adoption of the word for the larger of the two classes of elements has resulted in the use of the word metal in science with two contradictory senses; thus in elementary geology the word is used with its chemical meaning; but in economic geology metal is used in its commercial sense.

Sodium and potassium are therefore metals in elementary geology and academic mineralogy; but they are not metals in advanced economic geology. This double use of the word is an occasional source of confusion and discounts any good advice that may be given to students as to precision in the use of terms. It is perhaps too late to change, but it would have been better if the chemists had adopted technical terms for the two groups of elements instead of applying the term metal to a material so unlike the ordinary idea of a metal as is sodium.

Geology has been a particularly flagrant sinner in the misuse of popular terms. Its nomenclature has not only unconsciously absorbed and modified many English words, but committees of experts have deliberately committed such wholesale piracy that our language has been left bankrupt in some departments. Thus terms are needed in stratigraphy for the various subdivisions of the sedimentary rocks and for the lengths of time occupied in their deposition. The International Geological Congress proposed the following series of terms, beginning with the larger divisions:—

Formation	Equivalent Time
Group.	Era.
System.	Period.
Series.	Epoch.
Stage.	Age.

Although a systematic nomenclature would be very useful, this scheme has not been generally adopted; and I think the reason is that, by assigning definite meanings to all the indefinite terms available, there is nothing left for use in an indefinite sense. Thus a number of beds, which together may be either more or less than a subdivision of a system, cannot be called a series without risk of misunderstanding. All the above eight terms are required for use in geology with their current English meanings. The scheme proposed by the International Geological Congress involves using these words sometimes in a technical and sometimes in a non-technical sense. In literature the difficulty may be overcome by printing the words with capital letters when they are used as the names of definite divisions; but that is impossible in speech. The principle recommended by the International Geological Congress was excellent, but the scheme proposed has proved impracticable owing to its application of old words to new things.

Buckman adopted a sounder policy when he introduced the term Hemera for the time equivalent to a zone.

Geologists have adopted some common words with meanings which render geological phraseology unintelligible or even ludicrous to the man who has not been warned that they require special interpretation. Thus the need in elementary teaching for emphasising the difference between mineral species and mineral aggregates has led to the frequent use of the term mineral as an abbreviation for mineral species. Some authors have been led by this practice to deny that mineral aggregates are minerals, and therefore assert that coal, most iron ores, oil shale, mineral oil, &c., are not minerals. According to that view the mineral industry has little concern with minerals; and the mineral resources of the British Isles, which are generally regarded as extensive, are reduced according to this nomenclature to practically nothing.

Another triumph of dauntless logic is the use of the word rock. It is no doubt convenient, when speaking of the crust of the earth, to have one term to cover all its materials; and rock is used in this way just as the dust in the atmosphere and the salts in the sea may be included with the air and the water. Hence has arisen the geological convention of calling any large constituent of the earth's crust a rock, quite regardless of the cohesion of its particles. G. H. Kinahan, for example, in his "A Handy Book of Rock Names" (1873), says, "Thus loose sand, clay, peat, and even vegetable mould, geologically speaking, are rocks" (p. 1); and on p. 131 he includes ice among rocks.

Now this use of the term ignores the very essence of the popular idea of a rock. The term appears to be derived from the same word as crag, and the essential quality of a rock is firmness. The parable of the man who built his house upon a rock would need to be retranslated, and Shakespeare's "He's the rock, the oak not to be wind-shaken,"[1] loses its meaning if rock may be loose, drifting sand. The conventional use of the word rock in geology has been so widely adopted that objection to it may appear pedantic. Rosenbusch,[2] however, has defined "Rocks as the geologically independent constituents, of more or less constant chemical and mineralogical composition, of which the firm ('feste') crust of our earth is built." Hence such definitions as that in my "Structural Geography" (p. 21) of rocks as the firm coherent masses which form the main part of the lithosphere may shelter behind the high authority of Rosenbusch.

Reference to the paradox of calling clay and sand rocks reminds me that the word clay is now used in two very different senses in two sections of geology. In mineralogy the clays are a group of mineral species which are hydrous silicates of alumina. To the merchant, the farmer, and the economic geologist the essential quality of clay depends on texture and not on chemical composition. The [illegible]d clay appears to be based on the same root as clog and cleave, while the Russian glina and the Greek *γλία* connect it with glue and glutin. The root of the word clearly refers to the adhesiveness which clay owes to its plasticity.

The essential property of clay is that it becomes plastic when wet. In England this property is chiefly found in material, which, being formed from decomposed felspars, is a hydrous silicate of alumina; but other common materials have the same property, if ground to the requisite fineness. Quartz flour is a common clay-forming material in many parts of the world, and much of the material called clay by the farmer is pure silica. Hence the definition of economic and agricultural geologists that clay is earthy material, which is plastic when wet, its particles being no more than 0·05 mm. in diameter, is a more common-sense definition than any based on chemical composition.[3]

If a name be wanted to distinguish clays which are silicate of alumina from clays of different composition,

[1] Coriolanus, v. 2, 117. Cf. also Zangwill "Feeling solid-based upon eternal rock."

[2] H. Rosenbusch, "Elemente der Gesteinslehre," Stuttgart, 1910, third edition, p. 1.

[3] Ries's definition—"Clay is the term applied to those earthy materials occurring in nature whose most prominent property is that of plasticity when wet" (H. Ries, "Clays, Their Occurrence, Prooerties, and Uses, with especial reference to those of the United States," 1906, p. 1)—is an example of those based on texture and not on composition.

then a new name should be invented, instead of adopting a definition which refuses to accept as clay the slime of the quartz miner, much of the Scottish boulder clay, and any one of the nine brick-clays in the table of brick-clay analyses given by Ries.[1]

I have referred to a few instances to illustrate the frequent misappropriation of current terms by various branches of science, in the hope that the members of the corresponding societies will use their influence to discourage this practice. It should be remembered, however, that there are many cases in which it is a wise policy to transform a current popular term. It may be even justifiable, as in the case of minium and cinnabar, to use a word with the very opposite of its original meaning. A term may be adopted and redefined where, as in the cases of fish and worm, the popular meaning involves a wrong idea, which it is advisable to correct, or overlooks a distinction which is practically important. Change and growth in nomenclature must be allowed. A dead language is very good for fixed ideas; but rigid adherence to original meanings is a bondage from which it is to be hoped scientific terminology will be always free. It is useless to suggest rules as to when popular terms may be revised; each case should be judged on its merits.

The casual adoption of current words with new meanings is often an attempt to secure specious simplicity at the price of subsequent confusion. Deissmann's recent book, "Light from the Ancient East" (1910), directs attention to the misconceptions that have similarly arisen in theology, for he urges that words used in the New Testament are now understood, in what the authors of that volume would decidedly call a non-natural sense. The idea that science is being driven into an intellectual wilderness owing to its technical terminology is an idle bogie. Reference to the sporting or business columns of any daily paper will show that all specialised pursuits have their own special language. The language of golf is as technical as that of geology, and I venture to urge that science will lose more by the misuse of current English than by the invention of new terms for new ideas and new materials. A rose by any other name may smell as sweet, but we cannot get sweet-smelling roses if we order them under the name of dandelions. In short, to put new meanings into standard English words appears as unjustifiable as to put home-brewed beer into Bass-labelled bottles.

[1] H. Ries, *ibid.*, p. 185.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The next combined examination for sixty-eight entrance scholarships and a large number of exhibitions, at Pembroke, Gonville and Caius, King's, Jesus, Christ's, St. John's, and Emmanuel Colleges, will be held on Tuesday, December 5, and following days. Mathematics, classics, and natural sciences will be the subjects of examination at all the above-mentioned colleges. Most of the colleges allow candidates who intend to study mechanical sciences to compete for scholarships and exhibitions by taking the papers set in mathematics or natural sciences. A candidate for a scholarship or exhibition at any of the seven colleges must not be more than nineteen years of age on October 1, 1911. Forms of application for admission to the examination at the respective colleges may be obtained as follows:—Pembroke College, W. S. Hadley; Gonville and Caius College, The Master; King's College, W. H. Macaulay; Jesus College, A. Gray; Christ's College, The Master; St. John's College, The Master; Emmanuel College, The Master; from any of whom further information respecting the scholarships and other matters connected with the several colleges may be obtained. The forms of application must be sent in on or before Saturday, November 25.

The syndicate appointed to consider the question of providing pensions for professors and others in the service of the University has considered the desirability of framing a contributory scheme. The stipends, however, which the University is at present able to pay do not seem to the syndicate sufficiently large to justify a tax for providing pensions. The syndicate has also considered whether the University should enter into an arrangement with an assurance company or should form its own pension fund; but it recommends that the University should establish its own pension fund. In its scheme the syndicate has aimed at providing pensions for professors (with certain exceptions), readers, and certain officers on the basis of compulsory retirement at a given age; the maximum pension to be 500*l.* a year or five-sixths of the stipend, whichever is the less; and the actual pension to be in a proportion, varying with the length of service, to the maximum pension. The amount of pension is further limited to 500*l.* a year, inclusive of any college pension, stipend, or emolument. The syndicate proposes that in the first instance the pension scheme should apply only to professors, readers, and officers appointed in the future, in which case the annual contribution for pensions would for many years probably be small. But it is hoped that the University may be able in due course to provide pensions for some of the present staff if they are willing to place themselves under the scheme. There are nineteen professors, twelve readers, and nine university officers of the present staff who would be under the age of sixty on January 1, 1911, and entitled to pensions according to the scheme.

The syndicate appointed to consider the financial administration of the various scientific departments of the University, and the financial relations between these departments and the museums and lecture-rooms syndicate, has issued a revised report, in which the following rules are formulated, among others:—(1) That the responsibility for the working and superintendence of each of the scientific departments and for the administration of the departmental fund rest with the professor who is the head of the department. (2) That, subject to any subsisting agreement for the retention of fees by individuals, all fees received for lectures and practical courses be paid into the departmental fund. (3) That a university buildings syndicate be established in substitution for the museums and lecture-rooms syndicate, and that all university buildings be placed under its charge except the University Press and any other buildings specially committed by the Senate to any special board or syndicate. (4) That a general maintenance fund for university buildings be established in substitution for the museums and lecture-rooms maintenance fund, and that it be referred to the financial board to advise the Senate what annual payment should be made to this fund.

The financial board has reported on the college contributions for 1911. In its opinion the sum of 30,071*l.* should be raised in the present year by contributions from the colleges for university purposes. This report has been accepted by the Senate.

It is proposed to establish a post of demonstrator in medical etymology in connection with the Quick Laboratory. The appointment will be made by the Quick professor of biology with the consent of the Vice-Chancellor, and the office will terminate with the current period of the tenure of the Quick professorship.

THE governing body of the Lister Institute has made the following appointments:—Drs. E. E. Atkin and W. Ray to be assistant bacteriologists, Mr. A. W. Bacot to be entomologist, and Dr. Casimir Funk to be a research scholar.

AN international exhibition is being arranged by the Imperial Russian Technical Society to illustrate the organisation and equipment of schools. The exhibition is to be opened on April 15, 1912, and will last until the following July 15. This will be the first exhibition of its kind to be held in Russia. Full particulars and the conditions for exhibitors can be obtained from the executive committee of the International Exhibition "Organisation and Equipment of Schools," St. Petersburg, Panteleimonskaia, 2.

REUTER'S correspondent at Simla states that about 30 lakhs of rupees (200,000*l.*) have been collected for establishing a residential Hindu university at Benares with an adequate European staff. Mr. Butler, of the Viceroy's Council, in writing to the Maharaja of Darbhanga, indicated the conditions upon which the Government would recognise the university, and these conditions have been accepted by the promoters of the scheme. The Maharaja of Darbhanga has given five lakhs of rupees (about 33,330*l.*) towards the university.

It is announced in *Science* that the late Dr. William Flynn, of Marion, has bequeathed his entire estate, valued at about 6000*l.*, to the Indiana Medical College, in which he was a member of the faculty for many years. From the same source we learn that among the public bequests made by Mr. G. M. Pullman was that of 240,000*l.* for founding and endowing the Pullman Free School of Manual Training at Pullman, Ill. This fund has increased to more than 500,000*l.* The first step towards founding the school was the purchase, in 1908, of forty acres within the limits of the town of Pullman at a cost of 20,000*l.* Mr. Laenas Gifford Weld, until recently professor of mathematics and dean of the faculty of liberal arts in the Iowa State University, was appointed principal in May, and entered upon his new duties on September 1. He will visit the leading technical and trade schools in this country and in Europe before the preparation of definite plans is undertaken.

SOCIETIES AND ACADEMIES.

MANCHESTER.

Literary and Philosophical Society, October 3.—The president, Prof. F. E. Weiss, gave an address on recent researches on heredity in plants. After mentioning the work of earlier investigators, Prof. Weiss referred to the experiments of Mendel on the crossing of different strains of peas. From the results Mendel deduced the two fundamental laws of heredity: first, the dominance of certain unit characters in the first hybrid generation, and, secondly, the segregation of the dominant and recessive characters in the second hybrid generation. This latter law, though not its numerical ratios, was independently discovered by Naudin. These discoveries remained almost unnoticed for half a century, until de Vries, Correns, Bateson, and others brought them prominently before biologists at the beginning of the century. Confining himself to the phenomena of heredity in plants, Prof. Weiss dwelt upon some of the investigations of Correns and Bateson on colour inheritance in *Mirabilis jalapica* and sweet peas, and referred also to his own experiments in crossing the scarlet and blue forms of the common Pimpernel. The resultant cross was completely scarlet, like one of the parents, but in the subsequent generation 25 per cent. of the offspring were pure blues. The same result was obtained by crossing the blue form with pollen from a pink variety of Pimpernel, blue being recessive in the first hybrid generation. Prof. Weiss also dealt with the numerical ratios exhibited in the inheritance of paired characters, and with some of the more complex manifestations, such as the appearance of coloured flowers as the offspring of two white parents. Dealing with the analysis of hybrid plants, he referred to his experiments with *Geum intermedium*, the cross between the common and water avens, a hybrid not uncommonly met with in the limestone dales of Derbyshire. This plant exhibits in the size, colour, and shape of its flowers an intermediate condition between its two parents, and is thus easily distinguished from either. The flowers of the hybrid possess both the yellow plastids of the common avens and the red sap (anthocyanin) of the water avens. When pollinated with its own pollen, this very fertile hybrid gives rise to plants some of which have red flowers with no trace of yellow, while others are yellow with no red sap, and, in addition, a number of plants with pure white flowers were obtained. A similar "throwing" of white flowers was observed in the offspring of the hybrid between the primrose and the oxlip. The question of the determination of sex has also been attacked from the botanical point of view by Correns with some success, and his results, on the whole, tend to confirm the view that this problem may yet be satisfactorily solved on Mendelian lines.

DIARY OF SOCIETIES.

THURSDAY, OCTOBER 19.

INSTITUTION OF MINING AND METALLURGY, at 8.—The Economics of Tube-milling: H. Standish Ball—Fallacies in the Theory of the Organic Origin of Petroleum: Eugene Coste.

FRIDAY, OCTOBER 20.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—The Endurance of Metals: Experiments on Rotating Beams at University College, London: E. M. Eden, W. N Rose, and F. L. Cunningham.

TUESDAY, OCTOBER 24.

ZOOLOGICAL SOCIETY, at 8.30.—On a New Tree-Frog from Trinidad, living in the Society's Gardens: E. G. Boulenger.—Distant Orientation in Amphibia: B. F. Cummings.—The Duke of Bedford's Zoological Exploration of Eastern Asia.—XV. On Mammals from the Provinces of Sze-chwan and Yunnan, Western China: O. Thomas, F.R.S.—Game Sanctuaries and Game Protection in India: E. P. Stebbing.

WEDNESDAY, OCTOBER 25.

BRITISH ASTRONOMICAL ASSOCIATION, at 5.—The President's Address.—Jovian Latitudes: C. T. Whitmell.—Meteors from Taurus: W. F. Denning. Note on the Resisting Medium: F. W. Henkel.—Observations of the Kiess Comet: Major S. A. Eddie.—Saturn's Rings: F. H. Beattie—Conjunction of Mars and Saturn: H. MacEwen.

THURSDAY, OCTOBER 26.

THE CONCRETE INSTITUTE, at 8.—Fire-proofing: R. L. Humphrey.

FRIDAY, OCTOBER 27.

PHYSICAL SOCIETY, at 5.—Further Observations on the After-glow of Electric Discharge and Kindred Phenomena: Hon. R. J. Strutt, F.R.S.—Homogeneous Fluorescent X-radiation of a Second Series: Prof. C. G. Barkla and J. Nicol.

MONDAY, OCTOBER 30.

ARISTOTELIAN SOCIETY, at 8.—The Relations of Universals and Particulars: Hon. Bertrand Russell, F.R.S.

CONTENTS.

THURSDAY, OCTOBER 26, 1911.

AGRICULTURE IN DRY COUNTRIES.

Dry Farming: a System of Agriculture for Countries under a Low Rainfall. By Dr. J. A. Widtsoe. Pp. xxii+445. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1911.) Price 6*s.* 6*d.* net.

ACCORDING to the author's calculations, nearly six-tenths of the land surface of the earth receives less than twenty inches of rain per annum, and therefore requires the adoption of special agricultural methods differing from those in use in moister regions. In the strict historical sense it may be that the "dry farming" methods are really the older, for some of the ancient civilisations—Babylon and Egypt—flourished in "dry" regions. But to-day the dry farming methods are new, and are rapidly being extended over the regions of deficient rainfall that are now coming into cultivation.

Dry farming is different from irrigation, which is not touched upon in the present book. It consists in cultivation methods that reduce the loss of water from the soil by evaporation, and thus leave a maximum amount for the crop. Hence it implies a certain rainfall; at least ten inches a year are wanted, and success is not certain with less than fifteen inches.

A clear account is given of the differences between the soils of semi-arid and of humid regions, so far as these can be connected with the differences in rainfall. In humid regions the fertility of the soil is largely bound up with the clay fraction; a good deal of washing has gone on, and there is a tendency for the clay to wash into the subsoil, thus limiting the distance to which air can penetrate. A sharp distinction therefore arises between the surface and the subsoil, the latter being unsuited to plant growth. In semi-arid regions, on the other hand, the washing is reduced to a minimum; clay does not wash into the subsoil (it is said that clay does not even form to any great extent, but no evidence is set forth), and the difference between surface and subsoil does not arise; hence all parts of the soil are adapted to plant growth. Two deductions are drawn: the semi-arid soils are richer in plant food and stand in less need of fertilisers than humid soils; and recourse can be had more freely to deep ploughing.

Dry farming in the States, in its modern sense, is said to have been begun by Brigham Young and his followers when, in 1847, they went into the Great Salt Lake Valley. In this arid region starvation seemed to be the only possible ending to the colony, but suitable methods of farming were gradually evolved, and the results are matters of history. But the methods were not put together until H. W. Campbell, in 1895, published his "Soil Culture and Farm Journal." Then a boom began. The railway companies, with true commercial instinct, set up demonstration farms in dry regions for the benefit of intending settlers, and glowing accounts were given of what dry farming methods would do. The question aroused great interest in the British colonies, where large semi-arid tracts occur, and commissions and deputations were sent to study the methods on the spot. It is unfortunate that commercial interests were ever involved, because for a time the whole system was looked on with considerable suspicion by agriculturists, but Mr. Widtsoe's book will go far to satisfy the most sceptical that the methods are really effective.

Naturally there has been a good deal of change in methods, but the general conclusions to which Mr. Widtsoe is led are as follows. The soil should be a clay loam, uniform to a depth of at least eight feet. After the land has been cleared and broken it should lie fallow for one year, all weeds being rigorously hoed down; it should then be ploughed deeply in autumn. If crops are to be sown immediately (as they should be if the winter season is not too cold) the plough is followed by the disk cultivator and the harrow; if not, the land should lie up rough during winter, be further ploughed in spring, disk cultivated and harrowed. After every shower of rain the land is to be cultivated; the hoe or the harrow must be kept going all the season, and directly after harvest the land must be disked. Two great principles are that a fine layer of dry soil is to be maintained on the surface; and every weed must be killed.

It was originally thought necessary to compress the soil below this surface layer, but later experience shows this operation to be superfluous. A recent development, however, is the summer-cultivated fallow, adopted every third or fourth year in regions of fifteen to twenty inches rainfall, and every alternate year in regions of less than fifteen inches rainfall. By constant cultivation a large proportion of the rainfall can be kept in the soil for the next crop.

Wheat is the best crop, maize the second best; but a rotation is desirable, including a leguminous crop. As cattle cannot be kept the straw is not wanted; the grain is therefore cut off with a "header" and the straw ploughed in. Up to the present fertilisers have not been used, and the soil, so far from showing signs of impoverishment, is said actually to increase in fertility. However, the author does not counsel disuse of fertilisers, but insists that the soil must give out unless manure is added.

The necessity for a summer fallow arises from the fact that crop production is only possible where sufficient moisture is present. It is particularly to be noticed that no economy is attempted so far as the plant itself is concerned: extraneous sources of loss only are cut off.

As in other branches of agriculture, the facts are ahead of the hypothesis. The distribution of water over a complex mass of particles like the soil has not been worked out, but it is clearly regulated by the surface attractions between the particles and the water. Further, it is supposed that evaporation takes place only at the surface, and scarcely at all—only about 0·2 inch per annum—from the layers below, but this supposition is a little difficult to reconcile with the phenomena of diffusion of air into the soil.

Soil students and agriculturists will welcome the book as a useful summary by a man on the spot of what has been achieved so far, and they will be put in a position better than before to disentangle the real from the imaginary in the accounts of dry farming they come across.

E. J. R.

THE GROUSE AND ITS AILMENTS.

The Grouse in Health and in Disease: being the Final Report of the Committee of Inquiry on Grouse Disease. Two vols. Vol. i., pp. xxiii+512. Vol. ii., appendices, pp. vii+140+11 plates (41 maps). (London: Smith, Elder, and Co., 1911.) Price 2*l.* 2*s.* net.

ALTHOUGH, as its name implies, the Grouse Disease Inquiry Committee was formed to investigate the nature and causes of the mortality which has been so prevalent of late years in the one species of game bird peculiar to the British Isles, it has accomplished a great deal more than this. For in the handsome volumes before us we have the life-history and organisation of the grouse, coupled with those of the various parasites by which it is infested, described in a manner never before attempted in the case of any other wild bird. This magnificent piece of work, it should be added, has been carried out from start to finish by private effort and enterprise; for although the committee was officially appointed by the Board of Agriculture and Fisheries in the spring of 1905, its funds have been entirely furnished by private subscriptions. The whole investigation is, indeed, a striking, and we believe, a unique example of what can be done by the combined efforts of sportsmen, gamekeepers, field-observers, and biological experts; and to Lord Lovat, the chairman, and all those who have worked with him are due the gratitude of naturalists and sportsmen, not only in the British Islands, but throughout the world.

The first volume opens with an introduction by Lord Lovat, in which are recorded the formation of the committee, the scope of the inquiry, and a general summary of the results of the investigation. Then follow six chapters by various experts dealing with the natural history of the grouse in its normal condition, among which special reference may be made to Mr. E. A. Wilson's elaborate and careful account of the changes of the plumage, both in health and in disease. Since, however, much of this has already appeared in the Zoological Society's Proceedings, it will be familiar to many of our readers. Part ii., containing ten chapters, is devoted to the diseases of the grouse; while the third part, with the remaining seven chapters, treats of the management and economic aspects of grouse-moors. The second volume, containing only 150 pages, is devoted to lists of the names of the committee, correspondents, and subscribers, together with a number of statistical tables.

Since various notices of the progress of the inquiry have appeared from time to time in NATURE, the present review must be short. It will accordingly suffice to mention that grouse suffer chiefly from two diseases, namely, strongylosis, due to a thread-worm, *Trichostrongylus pergracilis,* and the so-called coccidiosis, caused by the sporozoon now known as *Eimeria avium.* The former attacks adult birds, and may accordingly be regarded as the chief cause of the great epidemics of "grouse disease" which have in past years wrought such destruction. The latter, on the other hand, as has been recently mentioned in our "Notes" columns, in connection with a paper by Dr. Fantham on coccidiosis in poultry, confines its attacks to young birds, which are either killed outright or recover; this disease, which was discovered during the investigation, can, therefore, have little or nothing to do with the great epidemics among adult birds. In the report the parasite of coccidiosis is referred to as *Eimeria* (*Coccidium*) *avium.* This, we may point out, is misleading, since to the systematist it would indicate that Coccidium is a subgenus of Eimeria, whereas it is really a synonym of the latter which has been discarded on grounds of priority. If this rejection be definitely accepted, we may suggest that it would be advisable to rename the disease eimeriosis, since it is obvious that if there be no such genus as Coccidium the retention of the name coccidiosis is illogical. There would, moreover, be the further advantage that we should have but one name to remember in place of two. For a somewhat similar reason, Dr. Shipley suggests on p. 207 of the first volume that strongylosis should be renamed trichostrongylosis, although there is the genus Strongylus.

The account of the life-history of the thread-worm of the grouse is written by Dr. R. T. Leiper; Dr. Shipley communicating a general account of the group (Nematoda) to which it belongs. The sporozoon (Eimeria) is discussed by Dr. Fantham, whose article appeared previously in the Proceedings of the Zoological Society. As mentioned in the "Notes" columns of NATURE some time ago, this intestinal parasite especially affects the duodenum and cæca (unusually long in the grouse), and has two developmental phases, namely, an asexual schizogony, and a sexual form in which cysts and spores, suited to a life outside the host, are produced.

Of less importance, from the point of view of the sportsman, are the tapeworms of the grouse, which are described by Dr. Shipley. Although the birds are attacked by three species of these organisms, two only need be mentioned here, namely, the large *Davainea urogalli* and the small *Hymenolepis microps,* of which the latter is by far the more dangerous to the life of its victims.

As regards future prospects, the great hope appears to lie in the proper method of managing the moors. "To put it briefly and in practical language," writes Lord Lovat, "moor-management is the science of distributing the stock of birds over the moor, so that at no period of the year can any area be so infested by the strongyle worm as to make it a source of danger to the least well-nourished bird in that area."

R. L.

CLIMATIC CHANGE.

Palestine and its Transformation. By Prof. E. Huntington. Pp. xvii+443. (London: Constable and Co., Ltd.; Boston and New York: Houghton, Mifflin and Co., 1911.) Price 8*s.* 6*d.* net.

SEVERAL years of travel in Asia Minor, Persia, India, and central Asia, and a prolonged study of the arid and semi-arid regions of those lands, have furnished Prof. Huntington with special qualifications for investigating the effect of physical environment on human distribution and modes of life and thought in Palestine, where history reaches back to a far remoter period than in most lands. Eight months of the spring and summer of 1909 were spent in traversing the country in many directions; and since the rainfall was exceptionally deficient in the early months of that year, the struggle for subsistence on the margins of the more arid portions was strongly emphasised.

The first half of the book deals with the form of the different parts of Palestine, and its relation to the geological structure on one hand, and the distribution, occupation, and past history of the inhabitants on the other. It is this physical basis that distinguishes the present volume from many descriptions of the same region. The isolated plateau of Judæa is indicated as the heart of the land from its isolated and uplifted position, in which it stood apart from the great highways of trade which passed to the north and to the south of it, while the moisture from the Mediterranean gave it a moderate fertility. On the west the broken foothills of the plateau form a transition zone, the Shephelah, between the plateau and the coastal plain alternately controlled by the Hebrews of the highland and the Philistines of the sea margin. But on the west, facing the valley of the Jordan on the leeside of the plateau, rainfall rapidly diminishes, and the desert conditions are sharply contrasted with the comparative fertility of the Shephelah but five and twenty miles away. Similarly the present form of Samaria, due to original folding worn down by erosion to a peneplain which has since been elevated and partially dissected, has opened this portion of the land to the peoples of the East, the coast-dwellers, and traders from Africa, so that the great trade routes and the routes of armies passed through it. The peculiar characteristics of Phœnicia, of Bashan, of Galilee, of the Dead Sea depression and the neighbouring deserts, are in like manner brought out and illustrated by the author's own travels through them and the incidents therein noted, presenting a most vivid picture of the land and the influence of its form on the history of its inhabitants.

In the second half of the book Prof. Huntington treats more especially of the climate of Palestine and reviews the present-day conditions, which he contrasts with the more favourable ones which existed, in his opinion, at an earlier date. He has put forward the same hypothesis in relation to central Asia, Greece, and Asia Minor, on previous occasions, giving numerous data in support of a modification of climatic conditions during the past twenty or thirty centuries. The lines of evidence reviewed are (1) the density of the population of Palestine at various periods; (2) the distribution of woodland; (3) ancient migrations, trade routes, and lines of invasion; (4) the distribution, location, and water-supply of abandoned sites; (5) the fluctuations of the Dead Sea.

Under the semi-arid conditions which prevail over the greater part of the country, and the strictly seasonal character of the rainfall, even small departures from the normal amount react powerfully on the economic conditions throughout the area, so that there must always be a strong inclination to postulate definite deterioration of climate where signs of former occupation now abandoned are to be seen. Some of the caravan routes in northern Africa, now but little used, give little sign of their practicability for the great caravans which we know used them a few decades ago, but which altered economic conditions have suppressed. Human settlements cannot always furnish evidence that all in a given spot were occupied at the same time, and the preservation of perishable objects affords some testimony that past rainfall was not of great abundance. The author argues that there have been pulsations in the rainfall, dry periods succeeding others of greater humidity; and that, on the whole, in Palestine a diminution of rainfall from the earliest historical times to the present era has been in progress, while the pulsations within these periods often coincide with great race movements.

The importance of these alternations of dry and humid periods of moderate intensity will be generally admitted, and on the margins of desert regions the effects will be most strongly marked; but while their reality is beyond question, and the evidence for a certain decrease in the average total rainfall from the earlier historic times to the present day is obtainable in certain areas, the direct connection of race movements with such climatic variations at certain periods of history seems to be scarcely established as yet. But in any case, a most valuable summary of the subject as it relates to Palestine is given, and a survey of the history of it and the surrounding lands furnishes occasion for indicating race movements and events which apparently coincide with more or less favourable conditions of climate. An orographical map, as well as a photograph of a model of Palestine, enables the form of the land to be appreciated, and the photographs are most instructive, though the geographer will wish they had been larger. The diagrams in the text suffer from the paper being unsuited to this form of illustration.

H. G. L.

A GUIDE TO ELECTRICAL TESTING.

Testing of Electromagnetic Machinery and other Apparatus. By B. V. Swenson and B. Frankenfield, assisted by J. M. Bryant. Vol. ii., Alternating Currents. Pp. xxvi+324. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1911.) Price 11*s*. net.

"THE efficient direction of any industry to-day demands a very large amount of technical knowledge which cannot be learned at the bench or in the shops."

With this quotation, taken from the writings of Prof. J. B. Johnson, the authors dedicate their work to his memory, and this also gives the keynote to the book. It is essentially a guide to electrical testing, so that the reader may be fitted for that particular technical knowledge which is required in the test-room of a modern electrical engineering works. The reader must, however, not be a beginner; on the contrary, he must be familiar with the scientific side of electrical engineering generally, so that all he needs is a kind of finishing-touch in his technical education which will make his work in a particular direction more efficient.

In the book under review this finishing-touch is given in the matter of testing alternating-current machinery and apparatus. In all there are 127 tests described. In each case the description begins with references to the literature on the subject; then is stated the object of the test, and after that comes a short dissertation on "theory and method." In some cases the authors add suggestions as to the collection of data, the plotting of curves, the extension of the test to somewhat different cases, and questions as to the effect of varying some of the conditions of the standard test. All this is extremely useful to the advanced student, but only to him. A beginner could only blindly follow instructions, and could not grasp the true scientific meaning of the thing he is doing.

It is perhaps natural that in a book written, in the first instance, for the students of an American university, methods and tests devised by American engineers should receive more attention than equally good work done in Europe; but when the authors christen old and well-known methods by American names, they go a little further in the direction of local patriotism than is warranted. As an instance, I take the Joubert method of taking the E.M.F. and current curves of an alternator. After describing the original method (by the way, the authors spell the name Jobert), where a ballistic galvanometer is used, they describe a "Bedell method" and a "Mershon method." Both these are nothing else than the Joubert method as it has been used for a generation in Europe. In the former, the ballistic galvanometer is replaced by a condenser and electrostatic voltmeter, and in the other by the well-known device of a potential slide and D.C. voltmeter.

Again, some methods which originated in Europe are either ignored or mentioned without reference to the inventor. Thus the well-known Sumpner method of testing transformer efficiency under full load whilst only the lost power need be supplied from outside, is given without Dr. Sumpner's name being mentioned. These are, however, minor blemishes; the important thing is that the authors have given us a valuable collection of accurate tests which can be carried out with such apparatus as may reasonably be supposed to be available in the test-room of a modern electrical engineering works.

GISBERT KAPP.

EDIBLE FATS.

Edible Fats and Oils: their Composition, Manufacture, and Analysis. By W. H. Simmons and C. A. Mitchell. Pp. viii+150. (London: Scott, Greenwood and Son, 1911.) Price 7s. 6d. net.

FAT enters into human food in a considerable variety of forms, and the modern tendency is to increase the variety. Whilst in earlier days the animal products—butter, lard, and dripping—were the principal fats consumed as foodstuffs, in recent times a large number of vegetable oils and fats have also been brought into use for the same purpose. New oils and "butters" have been found; improved processes of purification have been introduced; and the industry has become one of notable magnitude. It has greatly augmented, and therefore cheapened, the supply of fat available for human consumption.

What the authors have done in the volume before us is to collect from various sources particulars of the edible fats and oils now in use, and arrange them in a convenient form for reference. These particulars include short descriptions of the origin, manufacture, physical and chemical characters, and methods for the analysis of the various products dealt with, which fall into the four main classes: butter, lard, butter-substitutes, and salad-oils. From the scope of the book, however, the descriptions are necessarily often meagre. They would serve well as an introduction to the subject, or for easy routine work in examining the various articles, but would require to be supplemented in the more difficult cases which are met with in practice.

A somewhat curious analogy is recalled by the name of Mège-Mouries, mentioned in connection with the origin of butter-substitutes. The production of beet sugar, which has now reached very large dimensions, is said to owe its early development to the encouragement given it by Napoleon I. in his policy of making France independent of foreign supplies. Now, just as this variety of sugar has supplemented and partly ousted cane sugar, so margarine has supplemented and partly supplanted butter; and the introduction of margarine we owe to investigations fostered by Napoleon III.

M. Mège-Mouries was commissioned by this monarch to find, if he could, a cheap but wholesome substitute for butter, to be used by the French poor. He eventually succeeded in doing this, utilising the softer portions of beef suet for the purpose. Later, owing to scarcity of this ingredient, it became necessary to include a proportion of vegetable oils, and this has led to a greatly extended consumption of such oils. The margarine industry is now quite a considerable one, the annual importations into this country alone being valued at more than two millions sterling.

If we consider the effect which the production of beet sugar and of margarine has had, first in augmenting the supply of foodstuffs for the human race in general, and secondly in benefiting the agriculture of the particular countries engaged in the production; and if we further remember that this effect, so far as can be foreseen, is destined to continue, from year to year and generation to generation, is it altogether paradoxical to suggest that the two Napoleons' claims to remembrance might justly be based less upon their military operations than upon their vicarious attentions to sugar and margarine? If the swords have not been beaten into ploughshares, they have perhaps been beaten by them.

C. S.

ELEMENTARY PHYSICS.

(1) *An Elementary Text-book of Physics.* Part i., General Physics. By Dr. R. Wallace Stewart. Pp. v+414. (London: C. Griffin and Co., Ltd., 1910.) Price 4*s*. 6*d*. net.

(2) *Magnetismo e Elettricità.* Principi ed Applicazioni Esposti Elementarmente da Francesco Grassi. Quarta edizione. Pp. xxiii+878. (Milano: Ulrico Hoepli, 1911.) Price 7.50 lire.

(3) *Intermediate Physics.* Prepared in accordance with the new regulations of Indian Universities. By Prof. P. L. Narasu. Pp. xii+637. (Madras: Srinivasa Varadachari and Co., 1911.)

(4) *Elementary Light: Theoretical and Practical.* By W. H. Topham. Pp. vii+212. (London: Edward Arnold, n.d.) Price 2*s*. 6*d*.

(5) *Practical Physics: an Elementary Course for Schools.* By J. Talbot. Pp. viii+112. (London: Edward Arnold, n.d.) Price 2*s*.

(6) *A College Text-book of Physics.* By Prof. A. L. Kimball. Pp. ix+692. (New York: Henry Holt and Co., 1911.) Price $2.75.

(7) *Die Elektrizität.* By Prof. F. Adami. Erster Teil. Pp. 127. Bücher der Naturwissenschaft, herausgegeben von Prof. S. Günther. 9. Band. (Leipzig: Philipp Reclam, junr., n.d.) Price 40 pfennig.

(1) THIS volume is presented as part i. of the series by the late Dr. Stewart, although the volumes on sound, light, and heat have already appeared, and publication occurs subsequently to the unfortunate death of the author. It may be said at once that as regards mode of treatment, type, and diagrams, this part is uniform with those which have preceded it, and deserves the same praise as has been given to them. There are one or two points, however, which call for criticism, and the first is with reference to the title. Actually, the contents are chiefly concerned with what is usually termed mechanics, and only a comparatively small portion is devoted to the ordinary physical properties of matter. Strictly speaking, of course, mechanics is a section of physics, and its inclusion, especially if treated experimentally rather than mathematically, is desirable in every elementary physical text-book. It is unfortunate, however, when, as in this case, such inclusion has secured the exclusion of several essentially physical properties of matter and the inadequate treatment of many others. Thus we find, for example, the viscosity of liquids only briefly referred to, and no mention at all of the same property in gases. The second criticism is in connection with two definitions in the mechanics which are vague and even misleading. In common with so many other text-books on this subject, this book lacks the fundamental definition of "mass." The author introduces the term "mass" without definition in order to define force, and then uses this definition for the purpose of defining mass. Few writers on mechanics appear to realise that a definition of mass *apart from force* is the essential first step from the point of view of absolute measurement. The other definition to which exception may be taken is that of simple harmonic motion in terms of the uniform motion in a circle of a second particle. The effect of this is to suggest to students that this second particle *really exists* in all cases of simple harmonic motion.

(2) The fourth edition of this book has been produced in order to include the numerous and important advances in this subject which have been made since 1902, particularly those which have practical applications. The subject is treated in considerable detail, but essentially from a non-mathematical point of view, and it should be possible for a novice to obtain considerable insight into the fundamental principles of magnetism and electricity, and the many useful devices depending upon them. The earlier chapters are devoted to the usual descriptions of phenomena and statements of laws in electrostatics, magnetism, and current electricity, but, owing to the absence of mathematics, exact treatment is impossible, and the absolute units of potential, current, &c., are not defined. Although the obvious intention of the author is to lead up to what is practically electrical engineering, some space is devoted to descriptions of radio-active phenomena and the electronic theory of conduction through gases. The final chapters on telegraphy and telephony—both wireless and otherwise—and the applications of electricity to traction are the most detailed in the book. Good diagrams are given, but some of the photographic reproductions leave much to be desired.

(3) Whatever may be said of the merits of this book in other respects, there can be no two opinions concerning its chief failings. These are the obvious carelessness both in correcting the proofs and in producing the very numerous diagrams. Upon opening the book we are met at once by two pages of *errata*, containing some sixty or seventy corrections to the text. That these are, nevertheless, incomplete is indicated by a rather amusing mistake on p. 30, where we are told that "the direction of gravity is shown by the 'plum-bline.'" It may also be mentioned that the diagram illustrating this instrument is a typically poor one. Many of the figures, besides being badly printed, follow the old style of depicting hands, or even complete persons, performing certain experiments. The book is specially designed to meet the requirements of students preparing for the intermediate examinations of the various Indian universities, but the author claims that it is suitable for the initial stage of any college course. For some reason it is not divided into chapters, nor even into distinct sections dealing with the various parts of the subject—an arrangement which may tend to confuse the student. With regard to the subject-matter, here again we find the same vagueness in defining "mass" as has been mentioned above in the criticism of Dr. Stewart's book. This inexactness occurs in several other places, notably in the following statement:—

"The absolute unit of potential is too large. Hence $\frac{1}{300}$ of the electrostatic absolute unit of potential *is taken* as the practical unit of potential and is termed a volt."

A similar erroneous description of the "coulomb" is also given.

(4) The author has prepared a book comprising the

theory and laboratory work suitable for various examinations of the standard of London matriculation. The general arrangement of the work is very neat and methodical, descriptions of the experiments in connection with the theory being appended to each chapter. There are also numerous examples collected, principally from papers set in the London matriculation. The author has adopted the "ray" method, since he regards it as easier to understand than the "wave" method; but he is careful to proceed in such a manner as to admit of the development of the wave theory at a later stage without apparent contradiction, and, in the final chapter, introduces the student to the elements of this theory. To those who need the information it supplies this book may be in all respects thoroughly recommended.

(5) This consists of a series of simple experiments in heat, light, electricity, and sound. The procedure is to give the boy exact instructions of what to do, and to tell him to observe and record his results. Occasional questions bearing on the experiments are also asked. This method is certainly preferable to that which is sometimes adopted, viz. to allow the student to invent his own experiments. As the author points out, the ordinary schoolboy is usually incapable of originality in a subject which is new to him, and should at first, at any rate, follow instructions implicitly. In schools this collection of experiments should be found useful.

(6) The leading feature of this text-book is the extraordinary amount of ground covered in relation to the size of the volume. Attention is devoted to all the usual branches of physics, and many details are found which seldom occur in elementary treatises; indeed, from a purely descriptive point of view the work should suffice, not merely for preparation for intermediate, but also for final examinations. This condensation of material has been made possible, however, only at the expense of that mathematical treatment which is essential for both examinations. That this is no oversight is clearly indicated by the author's preface, in which it is asserted that mathematical reasoning, even of a simple sort, is found a stumbling-block by many students. This may be true, but we cannot agree that it forms a justification for overlooking the fact that an exact knowledge of physics is impossible without frequent recourse to mathematical processes. From the author's point of view, however, consistency demands that no unproved formulæ should be quoted, but this is by no means the case. The result of this avoidance of exact treatment has been to render the book very unequal, the descriptive portions being distinctly adequate and good, but the equally essential mathematics is looked for in vain. In fact, the contents may be described as insufficient for the serious student, and at the same time much too detailed to be useful as a popular treatment of the subject. The type and diagrams are good, and the more important statements are either in heavy type or in italics.

(7) There is no subject in which there is a greater demand for books on popular lines than electricity. This pamphlet forms the first part of such a book, and is devoted to electrostatics and magnetism.

OUR BOOK SHELF.

Geologischer Führer durch das Mainzer Tertiärbecken. By Dr. C. Mordziol. I. Teil, Allgemeine Übersicht und Exkursionsführer in die Umgebung von Mainz und Wiesbaden. Pp. xii+168, with 39 figures in the text. (Berlin: Gebrüder Borntraeger, 1911.) Price 5.60 marks.

IN view of the increasing interest taken in Germany in field geology, it is to be regretted that this small guide to a very accessible district should be issued at so high a price. Schubert's Dalmatia in the same series is, in fact, slightly cheaper, and students at Bonn, Giessen, and Heidelberg may feel that they have a right to more liberal treatment. Dr. Mordziol, of Aachen, indicates at the outset the limits of the basin of Mainz, a region of subsidence, in which the youngest deposits lie in the centre, while the older Cainozoic strata appear upon the margins. The gravels laid down by the Rhine in glacial times actually lie below the present level of the sea (p. 2). On the south, the basin merges into the sunken valley-floor of the upper Rhine, as is apparent on any orographic map of southern Germany.

The hilly ground bordering on the basin includes a great variety of rocks, and the problem of the gneisses on the south side of the Taunus, which may be of Devonian age, is regarded as still undecided. The true interest of the basin itself lies in its Cainozoic strata. The author (p. 15) supports Sandberger's division of Oligocene from Miocene at the base of the Cerithium limestones, in opposition to Dollfus and Steuer, who include this limestone and the whole brackish water series above it as Miocene. These strata are clearly described and illustrated, and the terrestrial sands and gravels (p. 65), derived from the decay of earlier Cainozoic and still older rocks, are held to be of Lower Pliocene age. We may remember that the Deinotherium beds of Eppelsheim, north-west of Worms, containing Mastodon, Machairodus, and Hipparion, are included in this interesting area.

The author, in tracing characteristic siliceous pebbles onward from the Hipparion-sands into Holland, makes out a case for the existence of a pre-glacial northward-flowing Rhine (p. 68). He then proceeds to illustrate the basin by a series of excursions, in which the underlying Permian strata are not overlooked. An index of places is much needed, but will probably accompany the second part.

G. A. J. C.

Evolution. By Prof. Patrick Geddes and Prof. J. Arthur Thomson. Pp. 248. (Home University Library of Modern Knowledge.) (London: Williams and Norgate, n.d.) Price 1s. net.

PROFS. GEDDES and J. Arthur Thomson have added yet another to the large number of books already existing which are designed to deal with evolution in a manner suited to the needs both of the beginner in serious study and of the general reader. The reputation of the authors will have led us to expect at least accuracy in the statement of facts, and this anticipation is certainly fulfilled in the little volume before us. Apart from the region of fact, we seem to discern a twofold influence at work, leading, on one hand, to a caution in interpretation so extreme as sometimes, we fear, to confuse the inquirer; and admitting, on the other, a boldness of speculation which is somewhat likely to disconcert him.

As an example of the former tendency may be mentioned the authors' manner of dealing with the crucial question of the inheritance of somatic modifications. No uncertain sound should be given on a point like this, but it is doubtful whether the student with only the present book before him would be as much impressed as he ought to be with the importance of the issue. The use of the word "saturating" (p. 197) does not make for clearness. The working of the second tendency is to be seen chiefly in those parts of the book which deal with social analogies and applications. These appear to us, although interesting and unconventional, to be somewhat far-fetched. But the book is a good one, and will make a strong appeal to the thoughtful. F. A. D.

The Evolution of Kingston-upon-Hull, as shown by its Plans. By Thomas Sheppard. Pp. 203. (Hull: A. Brown and Sons, Ltd., 1911.) Price 3*s*. 6*d*. net.

WHEN this island first became the home of man the site of the city of Kingston-upon-Hull bore an aspect very different from that which it assumes at present. The North Sea washed a long line of cliffs extending from Hessle to Bridlington, and the Humber, even then a mighty river, ran straight out to sea. Then followed the great Ice age, which left behind it masses of glacial drift, the foundation of the present city. The milder climate which succeeded produced abundant vegetation, which gave rise to the bed of peat which covered the site. A single bronze axe found in it was probably dropped by some visitor from a canoe, and supplies the only record of prehistoric man. Then the water encroached on the land and laid down great deposits of silt along the present valley. The Romans do not appear to have occupied the place, and the first attempt to embank it is attributed to the Danes, who have left marks of their occupation in the plan of the older parts of the city. In time the place gained increased importance by the absorption of the adjoining villages, and in the fourteenth century the site was surrounded by a wall, of which, and of the old manor and palace of the King, whence the name of the city was derived, only a few stones remain. The later development of the city can be traced in the fine series of reproductions of old maps and drawings which illustrate this useful contribution to local history.

Proceedings of the American Society for Psychical Research. Vol. v., part i., April: A Case of Hysteria. By Dr. W. H. Hamilton, Dr. J. S. Smyth, Dr. Louis Millard, and James H. Hyslop. Pp. 672. (New York: The Society, 1911.) Price 6 dollars.

Is it worth while? Here is a tome of 660 pages devoted to the investigation of an apparently healthy young woman, Miss Burton (pseudonym), aged twenty-two, who is supposed to be able to pass into a trance-like state at will in order to become a "medium" in communication with the spirit world. There are the usual stories of raps, touchings, whistling, singing, combined whistling and singing, whispering, tambourine-playing, table levitation, &c., all by the spirits. The investigations show that the whole thing is trickery; but the investigators concede that this young damsel was perfectly honest so far as her phenomenal consciousness is concerned, but that her subconscious self was deceitful.

A Revised Catalogue of the Indigenous Flowering Plants and Ferns of Ceylon. By Dr. J. C. Willis. (Peradeniya Manuals of Botany, Entomology, Agriculture, and Horticulture, No. 2.) Pp. 188. (Colombo: H. C. Cottle, Government Printer, 1911.)

A CATALOGUE of Ceylon plants was prepared by Dr. Trimen, and published in the Journal of the Ceylon Branch of the Royal Asiatic Society in 1885; this has long been out of print; hence the necessity for the new catalogue now issued by Dr. Willis. The book is divided into two sections, enumerating respectively native and introduced plants; the latter section includes nearly all the valuable economic pants. The catalogue supplies Sinhalese and Tamil names, also references to the pages in Trimen's "Flora of Ceylon," where descriptions of the species can be found. It is noticeable that very few new species have been discovered recently. The total numbers amount to 1095 genera and 3074 species in the first section, and in the second to 285 genera and 387 species. About twenty genera and very many species are endemic.

LETTERS TO THE EDITOR.

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

The Scientific Misappropriation of Popular Terms.

IN his interesting address to the Conference of Delegates at the Portsmouth meeting of the British Association, as reported in NATURE of October 19, Prof. J. W. Gregory makes certain remarks to which I venture to take exception. I comment on them partly because they push the principle of priority further than it need be pushed, and partly because I am afraid that Prof. Gregory's advice "to admit that the spider is an insect" may be taken to heart by some of his audience at Portsmouth or by some of his readers in NATURE.

Zoologists will not be surprised to learn that the word "insect" formerly had a wider application than at present. Many of them will feel that Messrs. J. H. and A. B. Comstock are not fairly treated by being taken to task for telling their readers, in a general manual, that a spider is not an insect. So far as the account of the use of the word "insect" is intended to be a historical account of the subject, and no more, criticism is unnecessary. But if it is a serious attempt to reinstate "insect" in its former meaning, I think it should be resisted on the ground that this procedure would introduce confusion where everything is at present clear, and that it has no compensating advantages to recommend it.

We are, fortunately, not obliged to apply the rules of priority to zoological names of higher value than genera. There is no compulsion to substitute Insecta for Arthropoda on nomenclatorial grounds; and it cannot be disputed that to do so would be productive of endless confusion. I am prepared to follow Prof. Gregory in thinking that it may be inconvenient to employ a familiar popular term in an altered signification in scientific writings. But in the present instance the wider use of "insect" has been so long abandoned in literature that even in popular works the majority of authors understand "insect" exactly as it is understood by a zoologist.

For one reason or another it is not unusual for a word in popular use to change its meaning during the gradual evolution of a language. It would be simply pedantic, in many of these cases, to attempt to go back to what is supposed to be the original meaning. Would Prof. Gregory recommend us to use the last word in "mice and rats, and such small deer," in its earlier signification in preference to the meaning it has acquired in modern times?

Prof. D'Arcy Thompson has put zoologists under a deep debt of gratitude by the recent publication of his translation of the "Historia Animalium" of Aristotle. Those of us to whom the original has hitherto been practically a sealed book may learn from this translation that Aristotle, in a professedly zoological work, used γένος in practically the sense in which we use "class." I will conclude by asking whether the principles of priority are to be held to give any countenance to the substitution of "genus" for "class" in systematic zoology.

SIDNEY F. HARMER.

58 Albemarle Road, Beckenham, October 21.

Iron Bort.

We have been getting occasional pieces of a curious material from the diamond mines, which may prove to have a relation to the mineral described in NATURE of September 7 (J. R. Sutton, "A New Mineral?"), and also may throw some light ultimately upon the origin of the diamond. To outside appearance, in extreme cases, the material has a cindery look; in less extreme cases its diamond affinities are fairly evident. It can be readily disintegrated with a mineralogical file, but it has hard corners which will scratch corundum. The specific gravity is 3·3 to 3·5, *i.e.* slightly lighter than diamond. It is insoluble in acid, is feebly magnetic, and when suspended by a light thread or floated on water (on a cork) shows distinct polarity under the influence of an ordinary large steel horse-shoe magnet. When it is crushed a small bar magnet will readily take up small specks of it. (The mineral previously described in NATURE, by the way, shows no polarity.)

Some months ago I casually examined some pieces of this material, and concluded that they were diamond (bort) with enclosed impurities. Some of the impurity is now proved to be iron, which shows that the statement sometimes made that diamond is not found in association with iron is not quite correct.

Some pieces of this material which had been extracted by the electromagnets at the pulsator were brought in by Mr. Stewart (the manager of the pulsator) a few days ago. They were very unlike the stuff readily recognisable as diamond, but the chain of gradation from these to something more nearly approaching true bort is fairly complete. Whether a diamond buyer would put the same commercial value upon them as he would upon bort is quite another question. Up to the present time I have not come upon any true bort which shows the same magnetic properties. Like true bort, however, this material is a good conductor of electricity.

As a distinctive name for this variety of bort, or iron bort—if bort it may strictly be called—Stewartite would be suitable.

J. R. SUTTON.

Kimberley, September 30.

A Starling's Deception.

THREE weeks ago, or, to be quite correct, on September 22, I was considerably startled and surprised, on going into the garden at 9.30 a.m., at hearing what I thought was a wryneck's call in a tree not many yards off. I listened, and in a few minutes the cry came again clear and distinct as one hears it in the spring and early summer. I was astonished, knowing it to be a rare thing to hear the wryneck after the middle of July. I approached the tree (in which two or three starlings were chattering and whistling) and tried to get a sight of the supposed wryneck, but did not, although the call was repeated several times. I put down my failure to the thickness of the foliage and the ivy-grown trunk, somewhere in the midst of which the bird was doubtless in hiding.

Well, the next morning, and on several days following, the unseasonable, but otherwise very pleasant, note continued to be heard, and always from the same tree and, apparently, in association with the starlings, for I noticed that the cry invariably came after one of the starlings had whistled. The whistle, in fact, seemed to be the signal for the wryneck to sing.

It struck me as being altogether very curious, and I determined to find out, if possible, more about it. So one morning (September 27) I resolved to investigate the matter more closely. Standing under the tree, and after a little patient waiting, I got a starling well into view and watched him carefully. Wagging his head from side to side he chattered and cackled for all he was worth; then came the whistle, and immediately afterwards the wryneck's note, in uttering which I quite distinctly saw the quick movement of the beak. And so the mystery was solved! I waited, hoping to see a repetition of the performance, but the bird, I fancy, caught sight of me and flew away. On two or three of the following days I tried to catch him in the act again, but was not successful. In the early days of October the cry was not heard (at any rate by myself), but it fell on my ear once more, and for the last time, on October 6, and from the same tree.

Starlings are great mimics, I believe, and I am wondering if this particular bird has been reared in the immediate vicinity of a wryneck's nest, and so caught the note from the parent wryneck. However this may be, I thought the incident would interest your readers, and perhaps elicit additional facts of a similar nature from some of them.

I may add that in 1901, from August 19 to September 10, a friend and myself heard almost daily what we firmly believed to be a wryneck's cry. It surprised us, certainly, but, other than being very interested in hearing the unseasonable note, we never investigated the matter properly. The question now arises, were we and the neighbours deceived by a starling in 1901 as I was so nearly deceived by one this autumn?

BASIL T. ROWSWELL.

"Les Blanches," St. Martin's, Guernsey, October 18.

Hot Days in 1911.

MR. MACDOWALL's dot diagram in NATURE of October 12 certainly shows high correlation between the number of hot days in a quinquennium and the difference between this and the number of hot days in the next quinquennium, and Mr. Corless in NATURE of October 19 finds the value of the correlation coefficient to be $-0{\cdot}725$; but the conclusion is not that the number in one quinquennium is correlated with the number in the next.

If x_1 is the departure from mean value of the number of hot days in one five-year period, and x_2 that in the next succeeding, then, if these are wholly independent variables, sum $x_1x_2=0$, the minus values neutralising the plus, and the coefficient of correlation between x_1 and x_2-x_1, which is

$$\text{sum } x_1(x_2-x_1)/\sqrt{\text{sum } x_1^2}\times\sqrt{\text{sum }(x_2-x_1)^2},$$

becomes

$$-\text{sum } x_1^2/\sqrt{\text{sum } x_1^2}\times\sqrt{\text{sum }(x_2^2+x_1^2)},$$

or $-1/\sqrt{2}$, since sum $x_2^2=$ sum x_1^2 in a long series.

The value $-1/\sqrt{2}$, or $-0{\cdot}707$, is within the limits $-0{\cdot}725\pm0{\cdot}059$ given, and the conclusion is that the correlation between successive quinquennia is nil.

This conclusion, based on the figures of Mr. Corless, must render ineffectual Mr. MacDowall's endeavours to make long-range forecasts of weather by correlations at five years' distance, and will disappoint any hopes that the new method may have raised in the minds of "official meteorologists."

H. E. SOPER.

University College, London, October 23.

MR. MACDOWALL, in dealing with the number of "hot" days in a year (NATURE, October 12, p. 485), compares two series of numbers which are not independent, and uses the comparison in an attempt to make seasonal forecasts. His method does not appear to be statistically legitimate. He obtains a series of numbers $N+n_1$, $N+n_{11}$, . . . $N+n_{m-4}$, representing the total number of "hot" days for periods of five years, 1, 2, 3, 4, 5; 2, 3, 4, 5, 6, &c., and plots a diagram showing the relation between $N+n_r$ and $n_{r+5}-n_r$, N being the mean of the five-year totals. If the scales of ordinates and abscissæ were the same, and the series of numbers $N+n_3$, &c., represented a random selection, we should expect to find in the diagram a number of dots distributed more or less symmetrically about a line bisecting externally the angle between the axes. This is what Mr. MacDowall obtains in his diagram on p. 485, allowance being made for his difference of scale. The diagram, as it stands, cannot therefore help the forecaster.

We should expect also to find a large correlation coefficient between $N+n$ and $n_{r+5}-n_r$. For a long series of numbers in which there was *no correlation* between $N+n_r$ and $N+n_{r+5}$ the value of the coefficient between $N+n_r$, $n_{r+5}-n_r$ would be $-\frac{1}{2}\sqrt{2}$, or $-0{\cdot}71$, say. Mr. Corless finds from Mr. MacDowall's figures a value $-0{\cdot}73$. Clearly, therefore, this cannot be taken to prove periodicity.

The total number of "hot" days in the nine years preceding 1911 is, according to Mr. MacDowall, 586, compared with an average of $9\times77=693$, so that unless there is a variation of very long period or a secular change we must in the next few years experience a preponderance of summers with more than the average number of "hot" days.

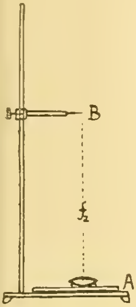
E. GOLD.

Hampstead Garden Suburb, N.W., October 23.

Determination of Refractive Index of a Liquid.

THE following simple method of finding the refractive index of a liquid available in small quantities may be of interest.

A plane mirror A is placed on the base of the stand, and on it is put the double convex lens in such a position that its centre is beneath the needle point B. With the eye directly above B, the observer adjusts the sliding arm until the needle point and its image just coincide, as found by parallax. The distance from B to the centre of the lens is then accurately found—let it be f_1. The experiment is then repeated, after first placing a drop of the liquid upon the mirror, when it will be spread out to a plano-convex lens between the glass lens and the mirror—let the new focal distance be f_2; then evidently the focal length f of the liquid lens will be given by $1/f = 1/f_2 - 1/f_1$.



But since the focal length of the liquid lens is also given by the relation $1/f = (\mu - 1)/r$, where r is the radius of curvature of the surface of the glass lens, it is evident that from a knowledge of r the index of refraction of the liquid can be at once found.

If r is not known it can be found by putting a sheet of paper between the lens and mirror, and again obtaining an image of B coincident with itself by reflection in the lower surface of the lens. If this new distance from the lens be called d, we have, since reflection is now only at the upper surface of the lens, $\mu\ r - 1/d = (\mu - 1)/-r$, or $r = (2\mu - 1)d$, where μ now, of course, refers to the glass, and can, if necessary, be calculated.

The apparatus is thus complete in itself, and three readings of the position of B give all the data required.

G. N. PINGRIFF.

Market Bosworth Grammar School.

The Nematodes of the Thames.

IN a recent letter to NATURE on the "Ooze of the Thames," I alluded to the number of nematodes which I had observed. I found as I continued my researches at least three different species were present. I have since been working on some ooze from near the Tower Bridge, and again find three different species, some of which are quite distinct from the forms taken at Kew. Thus the two localities yield at least four, if not five, different kinds. They range from about 3 mm. to 20 mm. or more in length. Considering the important part which some of these lowly creatures play in human and animal pathology, it would seem that the Thames mud offers a wide field for investigation. May we hope that this note will direct the attention of London naturalists to a subject of great importance lying close to hand?

Swadlincote. HILDERIC FRIEND.

Miniature Rainbows.

WITH reference to the recent correspondence on miniature rainbows, there is, or was, a most perfect example at the beautiful waterfall known as "Stock Gill Force," situate half a mile outside the little town of Ambleside, near the head of Lake Windermere, County Westmorland.

About five o'clock in the evening is the best time to see it, and, of course, the sun must be shining.

RICHD. COULSON.

4 Waltham Terrace, Blackrock, Co. Dublin, October 15.

Olive Trees.

IN this part of the world when an olive plantation is being made trees of more than 6 inches in diameter in the stem are put in, with all roots cut off short. In the hole where they are planted about two handfuls of barley are also put in.

Considering the age of the trees and the way the roots are cut away, it would seem impossible that the tree would ever grow.

These facts may be of interest; and I should like to know what useful purpose is served by the barley.

Smyrna, Asia Minor. DORA BARFIELD.

EXPLOSIVES ON BOARD BATTLESHIPS.

SOME people have been tempted of late to look back to the old days when black powder held its sway, indifferent to the effects of temperature, and always to be trusted so long as it was kept dry. "Villainous saltpetre" it was called, with a rough affection, and after storing it on shore in magazines plumed with lightning conductors, or comfortably near the boilers on board ship, we never gave it a thought until it was fed, in its flannel bag, into the gun. Then came armour and the long and hard contested duel between protection and penetration. The velocity of the projectile had to be increased. The old black powder, treat it as we would, could only deliver its rather clumsy blow which, while it imparted but a low velocity to the shell, gave an unpleasant, percussive strain to the gun. It was a push that these heavier projectiles required, not a blow.

This state of things led to the introduction of slow-burning powders, and they progressed very slowly. First, the size of grain of black powder was increased until it attained the dimensions of a two-inch cube. The improvement, however, was slight, and the internal stresses on the bore of the gun were still too great. The next step towards real progress was the introduction of what was known as cocoa, or brown powder, in which materials other than dogwood or alder furnished the carbon. This had but a short reign, its place being taken by various propellants which were frankly chemical compounds. To give a list of all this class of propellant, with which experiments and lengthy trials have been carried out with more or less success, would be far beyond the scope of this article; but the interest of the scientific world gradually focussed itself on compounds having nitro-cellulose as their chief constituent, especially after the wonderful discovery that two high explosives, gun-cotton and nitroglycerine, when chemically compounded, tamed and restrained each other, so that a propellant resulted of which the speed of burning could be regulated at will by increasing or diminishing the size of the grain or cord, and also by adjusting the proportions of its constituents. Thus came to man's hand a propellant which far outstripped black powder even in its improved forms, and threw into shade the cocoa powder which, after all, remained in the category to which the French artillerists contemptuously alluded as *poudre brutale*.

"Now," triumphantly exclaimed the gunmakers, "here is a propellant which will enable us to increase the striking velocity of our armour-piercing projectiles, and also to flatten our trajectories to an extent never before contemplated. The cemented steel plates will no longer confer invulnerability on the battleship, and our chances of hitting her will be vastly enhanced." So, to suit the new powders, guns were lengthened and charges increased, and the muzzle velocities rose by leaps and bounds, while the destructive stresses on chamber and bore were minimised by the employment of a propellant the characteristics of which may be summed up in the one word "suitable." Every nation adopted a powder in which nitrocellulose played the leading part, the variants being the proportions of nitroglycerine and the quantities and qualities of additional restrainers.

For a time all went well; but we, as a nation, were pointed at as being behind the times because our cordite, since it contained rather a large proportion of nitroglycerine, developed more heat, and produced more bore-erosion than powders of what had become practically pure nitrocellulose. But soon a cloud, no bigger than a man's hand, appeared above the horizon, and it was found that this class of propellant exhibited an almost sentient dislike to extremes of temperature. Not being a mechanical mixture, like the old black powder, it proclaimed itself a chemical compound with a marked tendency to instability, in a somewhat disconcerting manner. Great heat disorganised it altogether; extreme cold brought the nitroglycerine, if there were any used in the manufacture, to the surface, and this did not add to the gunner's confidence in it. The tendency to deterioration from exposure to undue heat, however, was seen to be the more to be feared of the two, and it was a drawback with which it was exceedingly difficult to deal. So far as cordite was concerned, it was found to remain stable at temperatures under 80° Fahr., but in some of the older ships, owing to steam pipes being led near, and even in some cases through, the magazines, temperatures as high as 140° were recorded, and these were equalled by those in limber boxes in some stations in India.

To keep a check on this deterioration the heat test, invented by the late Sir Frederick Abel, has always been used in this country and in the Colonies, and to its frequent application is most certainly due our immunity from explosions on board battleships. One is almost tempted to write *unberufen* before stating that we are exceptional among the larger navies in having *not* lost a ship by the explosion of its own powder. We have had our warning and have profited by it. Some ten years ago a cordite cartridge ignited on board one of our battleships, but did not fire those around it. Up to 1906, when spontaneous ignition of cordite took place with what might have been disastrous results at Haiderabad and Ferozepore, cordite, with the exception of the one cartridge mentioned above, had not given rise to an accident in thirteen years. Catastrophes were averted at both these places by conspicuous acts of daring on the part of officers and men, in the first-named by drenching boxes of cordite set smouldering by one in which the cartridges had fired, and in the other by the removal of nine tons of black powder from a burning magazine within a few feet of which were stored 135 tons of black powder.

There is now little doubt that the destruction of the United States ship, the *Maine*, was due to the spontaneous explosion of her own defective powder, and also of other ships which have since been similarly lost; the Japanese have lost two, the French two (including the *Liberté*), and the Brazilians one ship. About four years ago we began to set our house in order by installing cooling apparatus in the vicinity of the magazines, by which the temperature is kept below 80° Fahr., and the ventilation system gives the charges what may be described as an atmospheric washing, as the surrounding air is being constantly cooled and changed. Great care is taken, moreover, in the construction of our ships to protect the magazines from heat given off from boilers and steam pipes. It is natural that both magazines and boilers should be placed below the water-line, and in the least vulnerable part of the ship, and that, therefore, they should find themselves fairly close together; but a good thickness of insulating material can be interposed, and the lagging of steam pipes, purposely added to ensure the retention of heat, much diminishes radiation in their vicinity. Such precautions as these serve to reduce risk of spontaneous ignition to a minimum, and they are well worth the initial cost; but alone they are insufficient, and to them must be added periodical examinations of the propellant, the heat test being then the detective.

It would appear that gelatinised nitrocellulose is liable to be attacked by an organism which rapidly brings about its deterioration, and that nitroglycerine acts to a certain extent as an antiseptic. Another theory is that the nitroglycerine hardens the substance, and renders it less susceptible to climatic influences. The net result, however, is that pure nitrocellulose is undoubtedly less stable than nitroglycerine compounds such as cordite, and that the measure of immunity of the latter from effects of extremes of temperature varies directly with the proportion of nitroglycerine. The main difficulty, therefore, with which the authorities have to contend is the natural leaning towards a propellant which will be proof against baneful climatic influences, even though it may have a greater erosive effect on the gun. For naval services these considerations have to be nicely balanced, but the preponderance must ever be on the side of safety. Guns can be changed when worn out, and their cost, when compared with that of a ship and its crew, is negligible; hence the absolute necessity for cooling apparatus, the insulation of the magazines, effective drowning arrangements, and periodical inspections of the powder.

Nitro-compounds have one great advantage over black powder—they do not explode with nearly the same violence unless very closely confined. Even when, as in the case of the Ferozepore conflagration, the cordite is confined in metal-lined cases, it only burns with great vehemence, and, with effective flooding arrangements, there should be time to prevent disastrous explosions on board ship. At Ferozepore the removal of the black powder, as described above, averted what might have been a terrible disaster. On board battleships the gases evolved by a large conflagration of any nitro-compound would be confined, more or less, by the protective steel deck, bulkheads, and watertight doors, but it is difficult to account for the terrible disruptive effects manifested in the explosion in the ill-fated *Liberté*. It is probable, however, that she had on board her full complement of high explosive (Mélinite) shells. The intense heat of burning cartridges would probably fire one of these, and this would certainly detonate those in the same shell-room. This, of course, is only conjecture, but the curious tearing of steel plates, and the projection of large pieces of heavy armour to great distances, would seem to point to something more in the nature of the detonation of a high explosive than the upheaval that would be caused by the imprisoned gases of a propellant. The inquiry into the cause of the catastrophe will no doubt throw light on this point, but its fatal consequences will tend to make all nations redouble their precautions, not only as regards the storage in battleships, but also in the direction of extreme care in the selection of a propellant which shall not only meet ordinary Service requirements, but on the stability of which they may place absolute trust.

DESMOND O'CALLAGHAN.

THE SHARMAN SYSTEM OF WIRELESS TELEPHONY AND TELEGRAPHY.

WIRELESS telephony by induction and conduction has of late years occupied an insignificant position, owing to the efforts that have been made to obtain satisfactory transmission of speech by means of undamped oscillations, such as are produced with the "singing arc." But provided that a reasonable distance can be overcome, the conduction system is one which demands serious attention on account of the small amount of power required and the simplicity of the apparatus.

The system on which Mr. A. W. Sharman has been at work for some time is based on the earlier experiments of Preece, but its essential feature is the "impulse coil," with which the microphonic currents are intensified before transmission through the conductive medium.

During the past twelve months the writer has had various opportunities of working with Mr. Sharman's apparatus, both on land and sea, and there has been ample proof of the possibilities of the system, as with of twenty feet between the extreme ends; the ends are attached to plates or rods—stair-rods proving eminently practical for placing in the earth.

The receiving circuit consists of two similar electrodes, which are placed in series with the telephone receiver. A change-over switch in the instrument enables one to speak or listen at will.

There appear to be several factors upon which the limit of clear speech transmission depends. Thus with a wider base line, *i.e.* a greater distance between the electrodes, longer distances can be covered, while with an increase in the battery power used with the microphone a similar result is obtained. There is a serious limit, of course, to increasing the primary energy, as the microphone will not admit of the use of more than eight or ten volts in practice; various forms of microphone have been tried, and those permitting of the use of the highest voltage and largest amount of current have proved the most successful.

A number of experiments have been made with the earth as the conducting medium, and distances of a mile have been covered without difficulty; the nature

Fig. 1.—Motor Boat fitted with the Sharman Apparatus for Wireless Telephony.

a primary energy of only a few watts clear telephonic communication has been established at distances ranging between half a mile and a mile and a half.

The speaking apparatus consists of a microphone, battery, and impulse coil, all of which are in series; tappings are taken off the coil, the two wires leading to metal electrodes, which are either stuck in the ground or submerged in the water, as the case may be. The impulse coil consists of a comparatively low number of turns of thick copper wire, wound round a soft iron composite core of special construction, and the result is that with every variation in resistance of the microphone, when someone is talking, a momentary current of great intensity is induced. This is "transformed down" by the portion of the coil used for transmitting the impulse to the conductive medium, the coil thus serving additionally as an auto-transformer. The wires leading from the impulse coil may be from ten feet in length upwards; thus with two ten-foot wires there would be a possible distance

of the ground does not appear to be a very important factor, as good speech has been transmitted through chalk, gravel, and various other soils, also from the interior of coal mines at a depth below the surface of nearly one thousand feet; in the latter case a number of different strata separated the two instruments, without any apparent detriment to the speech.

The electrodes appear to act as the foci of an elliptical disturbance, which travels chiefly in the direction at right angles to the major axis, and not at all in the line joining the two points. It is thus desirable to have the two base lines parallel, and the necessity for this provides a means of directing the energy, so that with a flexible base line, speech will only be carried in certain desired directions, and cannot readily be "tapped" in other directions. The directional effect was very noticeable in experiments recently carried out on the sea at Pegwell Bay, near Ramsgate, even when the distance between the water "plates" was a hundred feet and more.

A particular feature of the conduction system is that it is not superficial, as was at one time suspected. The clear telephonic conversation carried out between the low level in a mine and the surface dispelled the idea altogether, and hence no difficulty would be experienced in speaking from a battleship to a submarine, even when the latter was submerged to a very considerable depth.

In the experiments recently carried out by Mr. Sharman, a motor-boat was employed as the floating station, and two plates of iron buried in the sand led up to a shore station situated in a room in an inn on the cliff. Speech was carried on very distinctly on some occasions over a distance of a mile and a quarter, but there were some apparent variable factors, possibly water temperature, which prevented an absolute uniformity of results. An interesting point is that, when the tide was some distance out, there being half sand, half water, between the two stations, the speech was quite perfect, so that it is improbable that

FIG. 2—The Wireless Telephone Apparatus in use.

there is any refraction of the waves at the separating surface. It is possible that the currents were transmitted through the sand right up to the position immediately under the motor-boat, selecting the shortest path through the water, for, in the writer's opinion, increase in the conductivity of the separating medium does not by any means agree with increase in the loudness of the transmitted speech.

Considering the very small amount of primary energy used, the results so far obtained have been surprisingly good, and it is to be hoped that efforts to find a microphone capable of withstanding heavier currents will meet with success. The extreme simplicity of the system and insignificant bulk of the apparatus used are in themselves points which place it at once on a level with commercial telephony over wires. A great advantage of the system is that telephony or telegraphy are available at will, as impulses can be generated by means of a Morse key and low-resistance tuned buzzer, and signals transmitted over at least double the distances at present possible for speech. There is undoubtedly the prospect of considerable development in a system based on such simple foundations, and Mr. Sharman's future work in this direction will be watched with interest.

T. THORNE BAKER.

FORESTRY IN INDIA.

IN the issue of NATURE of October 12, attention was directed to Lord Curzon's spirited protest against the change of system in regard to the preservation of the ancient monuments of India. In a letter published in *The Times* of October 11, Sir W. Schlich enters a similar protest against the proposed abolition of the post of Inspector-General of Forests, the technical adviser of the Government of India on all questions referring to the administration of the forests of India. He points out the immense progress made during the last forty-seven years in the systematic management of the forests covering one-fourth of the total area of British India, a progress chiefly due to the initiative of successive inspectors-general of forests. He believes that the contemplated abolition, if carried out, for the sake of the possible saving of a few thousand rupees, if any, will have a disastrous effect upon the further progress of forest conservancy in India. This view is supported in a letter from Sir Herbert Maxwell, published in *The Times* of October 18.

Systematic forest management on scientific lines is of vital importance to the Indian community, not only in the British part of the country, but also in the Native States. Important questions must continue to be dealt with by the supreme Government, and serious mistakes can scarcely be avoided, if that Government has not its own expert at hand to advise it. Lord Lamington, in a letter published in *The Times* of October 20, though not attacking Sir W. Schlich's views, says that no one man can by any possibility be able to give trustworthy guidance "on the multitudinous points connected with forest administration over such a vast area as that of India and Burma." No Inspector-General would attempt to guide the details of the administration. His duty would be to advise on general policy, and that he would be able to do, because no sensible Government would think of appointing to the post a man who had not a sufficient knowledge of the conditions prevailing in the several provinces. Moreover, he would visit the different parts, just as heads of other departments do. At any rate, the same objection could be raised in the case of any other branch of the administration.

Decentralisation is desirable in such a large country as India, but it must not go so far as to deprive the supreme Government of the necessary technical advice. The Government of India will still have to deal with numerous questions, such as the establishment of further reserved State forests, legislation in connection with it, the general lines on which the management of the forests is to proceed, the control of the Imperial Forest College at Dehra Dun, the Research Bureau and its labours, extending over the several provinces, advice to Native States as regards forest administration, the education of the Imperial forest staff, as well as of the superior provincial staff, the organisation and reorganisation of the superior and subordinate staff, and last, but not least, the control of forest finance. Without a duly qualified technical adviser at headquarters, these questions cannot possibly be dealt with in a satisfactory manner. No doubt, the Secretary of State for India will take all these matters into consideration when dealing with the proposals now before him.

AN ALBUM OF GEOLOGICAL TYPES.[1]

THE success of the British Association series of photographs of geological interest has encouraged the issue of several further collections. Prof. Stille, of Hanover, has arranged for the publication of a series of pictorial monographs illustrating various geological and physiographic phenomena which are confined to special regions, and of areas which especially well illustrate geological principles. The parts announced deal especially with glacial geology, mountain structures, and physiographic types, such as the Karst.

FIG. 1.—Inland Ice seen from the Gaussberg. Reduced from "Geologische Charakterbilder."

The first of this series is a collection of six plates of Antarctic icebergs and land-ice, from photographs contributed and explained by E. Philippi, the geologist of the German Antarctic Expedition. The photographs are each $8\frac{1}{2}$ by 6 inches in size; they are excellently reproduced in appropriate tones of black, blue, and green.

The first photograph gives a general view of the inland-ice seen from the Gaussberg, near the headquarters of the German Antarctic Expedition. It is described as a vast ice sheet, now 300 metres thick, but in recent geological times at least 400 metres thicker. Its surface is free from moraines, but the ice contains bands of rock débris, showing that it has passed over or is resting on an uneven rocky surface.

The Antarctic floebergs are illustrated by a view of a large berg floating in Posadowsky Bay; its height varies from thirty to forty metres above the sea, and rarely exceeds fifty metres; but only one-sixth or one-seventh of the ice is above sea level. Herr Philippi refers to some of the bergs met with on the expedition as sixty miles long. The details of the composition of this berg are shown in a view of one part of its face, and its evidence is consistent with the belief in the snow-fed origin of the upper layers of these bergs. The presence of included bands of moraine material shows, however, that they have been either formed on land or have grounded at some time during their voyage.

The author contributes an interesting note on the characters of the included stones, which are described as usually angular; many have been flattened on one or more sides, like the facetted stones of some ancient glacial deposits. Stones which are ice-scratched on all sides are rare in these Antarctic icebergs.

FIG. 2.—Vertical wall about 40 metres high of an Iceberg with distinct stratification planes and fissures, Posadowsky Bay, Antarctic. Reduced from "Geologische Charakterbilder."

These photographs promise to be of great value to

[1] "Geologische Charakterbilder." Herausgegeben von Prof. Dr. H. Stille. Heft i., Eisberge und Inlandeis in der Antarktis, by E. Philippi-Jena. 6 plates. (Berlin: Gebrüder Borntraeger, 1910.) Price 3.60 marks.

teachers of both geology and geography; and their value would be much greater to British students if the titles of the plates were repeated in English, for which there is abundant space on the explanatory sheets. The titles are short and necessarily technical, and their translation, unaided by context, would be often too difficult for the students to whom these photographs should be of most value. J. W. G.

THREE-COLOUR KINEMATOGRAPHY.

IN spite of the large amount of work which has been done upon three-colour photography, it is doubtful whether the results obtained by the newer methods are in any way superior to those obtainable by the original three-colour projection process used by Maxwell in his classic lecture.

In three-colour photography, three negatives are taken, one through a red, a second through a green, and a third through a blue-violet filter. Having secured the negatives, we may then proceed to produce a three-colour photograph by one of two methods: either we may prepare black positives from our negatives and project the three positives by means of the three primary colours, or we may prepare from each negative a print in some substance such as bichromated gelatine, which can be dyed in the colour complementary to the taking filter. The superposition of these three-coloured positives will then give a coloured picture. It is found, however, in practice, that the first method, which is known as the additive process, gives results appreciably superior to the second or subtractive process. The cause of this lies in the fact that the dyes used for preparing the prints cannot completely absorb the colours which they are required to absorb, and, at the same time, completely transmit that portion of the spectrum which they should transmit. While the yellow dye is fairly satisfactory in this respect, and the red dye efficiently transmits red light, the red dye always fails to transmit sufficient blue light, and the light blue dye, used for the prints from the red negative, never transmits either sufficient blue light or sufficient green light, the deficiency in the transmission of green being usually very marked, and resulting in the reproduction of all dark green objects as browns, or at best, blacks.

For the first method or additive process it is, of course, necessary to use three separate projection systems, and owing to the great loss of light through the filters these are advisedly supplied from three separate light sources. Unfortunately the unsteadiness of arcs makes it very difficult, if not impossible, to use three separate arcs, and consequently the best system is probably that arranged to use three large Nernst burners, the triple lantern being arranged so that the three projection systems stand vertically one above the other, and the three positives, printed on one plate, can be inserted together and focussed simultaneously, the adjustments for register being made once for all upon the lantern, so that subsequent slides register automatically. If an arc lamp is used, as in Mr. Ives's apparatus, only one lamp can be used, and the light from this must be divided into three by means of a system of reflectors, a procedure which unfortunately is frequently very wasteful of light and leads only to unsatisfactory results.

Attempts to apply triple projection methods to kinematography have frequently been made, but have not yet come before the public, except in the "Kinemacolor" method, which uses only two colours, abandoning the third, and so eliminating much complication. A two-colour method can, of course, at best be only a compromise, but it would seem at present to be the most satisfactory for kinematograph work.

In kinematograph work it is not necessary to project the colours to be combined simultaneously, as in the ordinary projection method. The colours can be successively projected, the observer combining them by persistence of vision. The three negatives are taken in turn on one film, a rotating shutter being arranged behind the lens of the camera carrying the three filters; but if the image is not to flicker strongly on the screen, it will be necessary for all three filters to be exposed within the ordinary period of exposure of a single kinematograph picture, which involves an exposure for each filter of about one-fiftieth of a second, a rate of work which is not only a great strain on the film and apparatus, but represents very brief exposures when it is remembered that the negatives must be taken through strongly absorbing red and green filters.

Attempts have been made to project the three images simultaneously by means of three separate optical systems, as in ordinary three-colour work, but the difficulties of register have been found very serious, although it is not at all clear why this should be so if both positive and negative sets of pictures are handled simultaneously on films of three times the normal width.

In the "Kinemacolor" method, the spectrum is divided into two, one taking-filter being orange-red and the other blue-green. In order to get a satisfactory rendering of greens, the latter taking-filter must be rather greener than a true blue-green filter would be, and in the resulting picture blue is little distinguishable from blue-green, while a yellow is rendered rather as an orange than a true yellow. The results are, however, surprisingly good considering the theoretical difficulties of the method and the extreme badness of ordinary two-colour work, and they will doubtless be even better when the promoters of the process have learned that above all things they must avoid in their pictures the two colours which they are using for projecting. These two colours are a pure red and a very bright blue-green, or minus-red colour, and in some of the pictures at present there is a tendency to use these two colours in the composition of the original scene, so that one gets little girls dressed in red blouses and blue-green skirts, which colours the process renders with only too distressing fidelity. Considering the excellent way in which the process reproduces subdued colours, such as browns, there really seems no need for this. A much less serious defect in the process, and one which is, of course, unavoidable, is that when anything moves rapidly it is projected as a series of coloured images, so that a horse's leg on the screen may appear as a series of alternately red and blue-green legs.

There is no doubt, however, that kinemacolour is a success, and is a striking testimony to the good practical results which may sometimes be obtained from a theoretically inaccurate system.

In a recent patent it has been suggested that the successive and synchronous methods of projection might be combined, two projecting systems being used with two sets of pictures, one set representing only one-colour element, such, for instance, as red, while the other is composed alternately of pictures of the other two-colour elements, blue and green. A stationary red filter is used in front of one projecting lens, while the second film is projected through a rotating filter, part green and part violet. This would appear to be somewhat more complicated than the two-colour system, while the colour rendering should undoubtedly be superior; but the method does not appear to have, at present, reached the stage of practical use.

C. E. KENNETH MEES.

PROPOSED REFORM OF THE CALENDAR.

IN the issue of NATURE for April 27 a concise account was given of the various proposals which have recently been put forward for the reform of the calendar. There is no reason to think that the subject has gained any serious general attention in England, if the fixing of Easter and the dependent festivals be regarded as a distinct question. But it has received a certain recognition in the discussions of some public bodies of an international character, such as the Congress of Chambers of Commerce; and the Swiss Government has invited a conference for its formal consideration. In order to bring a definite scheme before the public a Calendar Reform Bill was presented to Parliament by Mr. Robert Pearce. The main features of the Bill were briefly described in the article quoted. The first day of the year is called New Year Day, and is placed outside the reckoning of the week and the month. In leap years a day called Leap Day is intercalated between the end of June and the beginning of July, and is equally excluded from the week and the month. By this device there are left 364 days in every year, which are divided into four equal quarters of 91 days. Each quarter is subdivided into three months containing respectively 30, 30, and 31 days. Since 364 is exactly divisible by seven, the first of January always falls on the same day of the week, and the result of making this day Monday is to give 26 weekdays in every month, the four longer months containing five Sundays. Every calendar date corresponds to a particular day of the week (*e.g.* Christmas Day always falls on a Monday), and the calendar is fixed, no longer changing as at present from year to year.

No doubt such a system possesses slight advantages from the point of view of simplicity over our present calendar. Apart from the objections which must be urged against any disturbance of conventions to which we have grown accustomed on anything less than adequate grounds, the great disadvantage attaches to the scheme that it interrupts the continuity of the weeks. The practical effect of this is seen where two or more calendars are in use side by side. Thus inconvenience must arise even now from the Jewish Sabbath falling on our Saturday. Under the provisions of the Calendar Reform Bill the case would be worse, for it would no longer hold a fixed place in the Christian week.

A second Bill has now been presented to Parliament, this time by Sir Henry Dalziel. While differing from Mr. Pearce's Bill, the new proposals contain nothing of importance which will be novel to readers of our previous article. For the Bill merely embodies the suggestions made by Mr. John C. Robertson at the fourth International Congress of Chambers of Commerce held in London in June, 1910. The differences arise in the treatment of the four quarters of 91 days. These are divided into three months containing respectively 28, 28, and 35 days. Thus each month contains an exact number of weeks, and is made to begin with a Sunday. Incidentally it is necessary to move Easter Sunday from April 14, as before proposed, to April 15. Also Christmas Day will fall automatically on a Wednesday instead of on a Monday. The advantage of the whole scheme is to obtain commensurability between the month and the week, but it is an advantage dearly bought at the sacrifice of even approximate equality between the months. This necessitates special legal provision for payments in the case of monthly contracts to be made proportional to the length of the month concerned. Moreover, it requires legal definition for the duration of a "month" from any given date. Thus we understand that a month beginning on any day of the last week of a long month (containing 35 days) will close on the last day of the following month. At least, this is the interpretation which, after careful thought, we have placed upon the following interesting example of Parliamentary draughtsmanship:—

"8. In calculating monthly periods the following rule shall apply:—In any period beginning in a long month and ending in a short month, the last day of the short month shall be held to be the corresponding day to any of the days in the last week of the long month."

If this interpretation be correct, a month may mean any period from 28 to 35 days in length. Surely the clause comes perilously near to a *reductio ad absurdum* to the whole scheme. We can imagine the following simple problem:—"A domestic servant is engaged on March 32 at 22*l*. a year. What is the amount of the first monthly payment, and when will it fall due?" We are utterly at a loss to solve the question, and suggest it for the consideration of the framers of the Fixed Calendar Bill.

The fundamental feature common to both the Bills alluded to is the use of the *dies non*. Mr. Alexander Philip, who was responsible for reviving the idea of this fiction and advocating its practical convenience, appears to have become impressed with the extent of the opposition likely to be encountered before it can be adopted. Accordingly, in a paper before the section of Economic Science and Statistics, read at the recent meeting of the British Association, and in a pamphlet with which we have been favoured, he seems to have abandoned those who are seeking to give legislative form to his ideas, and to advance a totally different suggestion. This requires that February shall gain two days, that July and October shall each lose one day, and that the extra day in leap-year shall be placed at the end of June. Then in each quarter (now containing three calendar months) a period of twelve weeks (always beginning on a Sunday) can be found, two such successive periods being separated by a week. The idea is that public engagements can be more conveniently fixed by reference to the proposed twelve-week period, while the correspondence between this reckoning and the ordinary calendar can be very simply exhibited by a "perpetual adjustable" arrangement. But this practically means that we should have two calendars side by side, and no further criticism seems to be necessary.

It is fairly evident that the group of people who are bent on introducing a change in our present calendar are not agreed as to the precise form which that change should take. In the meantime it is probable that public opinion in this country is not ripe for any reform. It would welcome a fixed Easter, but it is more than likely that any radical alteration of the calendar would be resented. Since the reformers adhere to the yearly divisions of the Gregorian system, no scientific question is involved at any point, and the public convenience and public feeling are alone concerned with the issue. H. C. P.

NOTES.

A SOMEWHAT tardy recognition of the service rendered by Amedeo Avogadro to systematic chemistry was made by the unveiling at Turin of a bronze monument to his memory on September 24, erected, as the result of an international subscription, under the auspices of the Royal Academy of Sciences of Turin. The King of Italy presided at the inauguration ceremony, which was attended by nearly all the more eminent Italian chemists and physicists, as well as by a number of representatives of foreign academies, including M. Haller, of the Paris Academy of

Sciences; M. Moureu, of the Chemical Society of France; Prof. Nernst, of the Chemical Society of Berlin; and M. Guye, of the Geneva Society. No representative of the Royal Society or of the Chemical Society was, unfortunately, able to be present. The date selected was the centenary of the publication of Avogadro's celebrated memoir.

Sir William E. Smith, C.B., Superintendent of Construction Accounts and Contract Work, has been appointed to succeed Sir Philip Watts, K.C.B., F.R.S., as Director of Naval Construction. Sir William E. Smith was born in 1850, and joined the Portsmouth Dockyard in 1861, when only eleven years of age. In 1865 he was apprenticed as a shipwright at Woolwich. In 1866 he was transferred to Portsmouth Dockyard, and, having spent four years' apprenticeship, joined the South Kensington School of Naval Architecture. He entered the Royal Corps of Naval Constructors in 1873, and succeeded Sir William White as an instructor of naval architects at the Royal College at Greenwich in the early eighties. Sir William E. Smith is the Admiralty representative on the Committee of Shipbuilding Materials, in connection with engineering standards. He represents the Institution of Naval Architects, of which he is a vice-president, on the executive council of the National Physical Laboratory.

At the annual statutory meeting of the Royal Society of Edinburgh, held on October 23, the following office-bearers were elected:—*President*, Sir William Turner, K.C.B., F.R.S.; *vice-presidents*, Prof. J. C. Ewart, F.R.S., Dr. J. Horne, F.R.S., Dr. J. Burgess, Prof. T. Hudson Beare, Prof. F. O. Bower, F.R.S., Sir Thomas R. Fraser, F.R.S.; *general secretary*, Prof. George Chrystal; *secretaries to ordinary meetings*, Dr. C. G. Knott, Dr. R. Kidston, F.R.S.; *treasurer*, Mr. J. Currie; *curator of library and museum*, Dr. J. S. Black; *councillors*, Prof. D. Noël Paton, Dr. W. S. Bruce, Prof. F. G. Baily, Dr. J. G. Bartholomew, Dr. R. H. Traquair, F.R.S., Prof. J. Walker, F.R.S., Prof. A. Robinson, Sir W. S. M'Cormick, Prof. Crum Brown, F.R.S., Prof. T. H. Bryce, Dr. Benjamin N. Peach, F.R.S., and Mr. W. A. Carter.

For several years past Dr. W. N. Shaw has organised for the months October to March a series of meetings at his office for the informal discussion of important contributions to meteorological literature, especially those by colonial or foreign meteorologists. When these meetings took place at the old Meteorological Office in Victoria Street their success was so great that the room available was scarcely sufficient to accommodate those who attended them. In the new quarters at South Kensington the space is nearly all that could be desired, and Dr. Shaw welcomes not only those who contribute observations to the office, but others interested in meteorology. The meetings take place on Mondays every fortnight, and the first of the series commenced last Monday. In the circular which announces the dates of the meetings a list of the suggested subjects for discussion is given, and these show the wide range which the discussions cover. The writer of this note has attended most of the meetings already held, and with others he knows that they serve a very useful purpose. The bringing together of those interested in meteorology and the friendly interchange of views is a sure way of accelerating the advance of the subject in question.

At the conclusion of the Harveian Oration, delivered by Dr. Theodore Williams at the Royal College of Physicians on October 18, the president of the college, Sir Thomas Barlow, presented the Baly and the Bisset Hawkins gold medals. The Baly medal was awarded to Prof. W. D. Halliburton, F.R.S. This medal was instituted in 1866 "in memoriam Gulielmi Baly, M.D.," and is awarded every alternate year to the person who is deemed to have most distinguished himself in the science of physiology, especially during the two years immediately preceding the award, and is not restricted to British subjects. The Bisset Hawkins medal was given to Dr. Clement Dukes. This medal was established in 1896 by Captain E. Wilmot Williams, at the suggestion of Dr. Theodore Williams, to perpetuate the memory of Dr. Bisset Hawkins. It is bestowed triennially on some duly qualified medical practitioner who is a British subject, and has during the preceding ten years done work deserving special recognition in advancing sanitary science or in promoting public health.

A Reuter message from Stockholm states that the Nobel prize for medicine has been awarded this year to Prof. Allvar Gullstrand, of the Upsala University, for his research work in connection with the dioptrics of the eye.

The fourth Norman Kerr lecture in connection with the Society for the Study of Inebriety will be delivered by Prof. G. Sims Woodhead on Tuesday, November 14, in the lecture theatre of the Pathological Department, Medical Schools, Cambridge, upon "The Action of Alcohol on Body Temperature and on the Heart."

At a recent meeting of the executive committee of the British Science Guild, a committee was appointed to consider the question of holding lectures and the reading of papers. Other matters considered were the reduction of postage on scientific literature, coordination of charitable effort, and pollution of rivers. In connection with the committee on the conservation of natural sources of energy, it was decided to print the report at the end of the year.

The members of the International Commission on Zoological Nomenclature have unanimously invited Prof. K. Kraeplin, Direktor des Naturhistorischen Museums, Steinthorwall Hamburg, Germany, to serve on the commission until the next International Congress, in the place of Prof. Maehrenthal, deceased; also Dr. P. Chalmers Mitchell, F.R.S., secretary of the Zoological Society of London, in the place of Dr. G. A. Boulenger, F.R.S., resigned.

A course of twelve Swiney lectures on geology, dealing with "The Natural History of Rocks," will be delivered by Dr. T. J. Jehu in the lecture theatre of the Victoria and Albert Museum, South Kensington, during November, on Mondays, Tuesdays, and Saturdays, beginning Saturday, November 4. Admission to the lectures is free.

As the result of a personal visit to Kew, the Rev. Hilderic Friend has been able to report to the director the discovery of a considerable number of new annelids in the Royal Gardens. These include, among others, *Achaeta bohemica*, Vejd., *Dero obtusa*, D'Udek., and others new to Kew; *Paranais naidina*, Bret., and others new to Britain; and *Limnodrilus aurantiacus*, Friend, *Enchytraeus exiguus*, Fr., and *Fridericia pulchra*, Fr., new to science. The descriptions of new species will appear in *The Naturalist* and elsewhere.

From Prof. A. G. Nathorst, of Stockholm, we learn that Prof. Paul Richter, of Quedlinburg, Germany, died on October 9, at fifty-seven years of age. Prof. Richter was well known among palæobotanists and geologists by his studies of the Cretaceous flora of Quedlinburg, of which he brought together extensive collections. He was the author of the following papers, among others:—"Die Gattung Credneria und einige seltnere Pflanzenreste" (1905), "Die Gattung Hausmannia Dunker" (1906), "Die Gattung Nathorstiana P. Richter und Cylindrites spongioides Goeppert" (1909), all of which are richly illustrated.

THE death is announced, at seventy-eight years of age, of M. Louis Grandeau, the distinguished French agricultural chemist, and author of the "Traité d'analyse des matières agricoles," perhaps the best known book of its time on agricultural analysis. M. Grandeau was one of the last surviving disciples of Boussingault, and maintained throughout the breadth of view and the lucid style of exposition that had characterised the master. He played a great part in the development of scientific agriculture in France, and held various high offices, such as the directorship of the Station agronomique de l'Est, a professorship at the Conservatoire nationale des Arts et Métiers, and was Inspecteur général des Stations agronomiques. He carried out numerous field experiments at L'École Mathieu de Dombasles, Nancy, and later at the Parc-aux-Princes, near Paris, and elsewhere, dealing with the effect of fertilisers on soils and on crops. He also made numerous investigations on the feeding of horses, especially of draft horses, his attention being attracted to this subject by his connection with the laboratory of the Compagnie générale des Voitures, Paris. There was no academic aloofness about M. Grandeau, and he recognised that the final test of his results must be their actual value to the practical man. Accordingly, he used the Press freely to disseminate his ideas; he was chief editor of the *Journal d'agriculture pratique*, and agricultural editor of the *Temps*. His main work was with technical problems. Of his more purely scientific work, perhaps the best known dealt with the black humic material that he extracted from soil, and regarded as an important agent in the nutrition of plants, a view, however, that has since undergone considerable modification.

THE first part of the plant protection scheme of the Selborne Society was to enlist the sympathy of the education authorities throughout the country, and the society has met with a hearty response to its suggestion that the authorities should distribute special leaflets to schoolmasters and schoolmistresses, and put up a card of advice to children in their schools. Many thousands of leaflets and cards have been asked for, and as the Selborne Society has authorised its plant protection section to apply any funds which it may receive to the furtherance of its own work, the society is now making an appeal to all those who desire to preserve the British flora to send subscriptions to the secretary at 42 Bloomsbury Square, London, W.C.

IN view of the reorganisation of the Aëronautical Society, a circular has been issued to members stating that persons desirous of joining the society as members under the old regulations (entrance fee 1*l.* 1*s.*, annual subscription 1*l.* 1*s.*) are still eligible if the application form is returned before November 1, 1911. A number of physicists, engineers, and others have already availed themselves of this privilege, including the Marquis of Tullibardine, the Hon. Maurice Egerton, Mr. Lionel de Rothschild, Profs. Archibald Barr, C. V. Boys, and H. F. Lunn, Captains A. H. Grubb and E. L. Gerrard, Lieuts. R. Gregory and C. R. Samson, Sir Charles D. Rose, Dr. W. Watson, and Messrs. Dugald Clerk, G. Holt Thomas, E. T. Willows, and Horace Short. In view of the uncertainty which probably exists as to the lines on which aëronautical problems may be developed in the future, it seems desirable that persons interested in aërial navigation, either on general or other grounds, who may wish to be associated with the future developments of the society should lose no time in putting themselves in communication with the secretaries, 53 Victoria Street, Westminster.

TAKING as his text the fact that the British Museum has recently established a series of free daily demonstrations in the exhibition galleries to parties of visitors, Lord Sudely, in a letter to *The Times* of October 21, headed "The Utility of Museums," strongly advocates the immediate extension of this system to other museums and kindred institutions throughout the country. The demonstrations, or peripatetic lectures, at the British Museum are declared to be admirable, although the attendance on the part of the public is still comparatively small. This, however, it is urged, might be increased by judicious advertising. Weekly demonstrations at the Imperial Institute, and lectures in some of the American museums (for which, except in the case of schools, small fees are charged), are declared to have attained a success far ahead of what was originally expected. Among London institutions, Lord Sudely specially selects the Victoria and Albert Museum and the Natural History Museum as being admirably suited for demonstrations of this nature, which should also be adopted at Kew. Should the officials at these establishments find it impossible to undertake these demonstrations in addition to their present duties, it is recommended that the respective staffs should be strengthened for this purpose. If lectures of this type were once established at all museums, the writer of the letter is of opinion that the attendance of the public would be largely augmented, while the knowledge and culture of the nation generally would be stimulated. As regards the Natural History Museum, it may be pointed out that popular explanatory labels are conspicuously displayed in most of the exhibition; but it may at once be acknowledged that a much larger amount of information could be conveyed (and, if the right persons were found, in a more interesting manner) by means of popular demonstrations.

IT would be interesting to know the condition of large dew-ponds, such, for instance, as that at Chanctonbury Ring, on the South Downs, at the end of the unusually dry summer of this year. Colonel W. Pitt states in the Journal of the Royal Society of Arts for October 20 that, curious to learn how dew-ponds in general have fared, he wrote to inquire of the Royal Engineers, under whose charge is that part of Salisbury Plain which is War Department property. The report received states that "all dew-ponds in the Plain have gone absolutely dry this summer without exception." The officer who supplied this information adds that the ponds are generally, but not always, placed where they will take surface drainage, and consequently they received, no doubt, a certain amount of what little rainfall there has been.

MR. J. R. HENDERSON, the successor of Mr. E. Thurston as superintendent of the Government Museum, Madras, reports considerable additions to the collections during the year 1910–11. On the archæological side the most important are eight gold-plated sheets of copper with figures of Siva and other Hindu gods, dating from the early sixteenth century. A collection of Pandyan gold coins from the south Canara district is one of the most interesting numismatic finds made in recent years in southern India. A large collection of birds, insects, and Mollusca made in the Shevaroy Hills by the superintendent forms a valuable accession. The marine aquarium, stocked with local sea animals and fishes, continues to flourish, the chief cause of mortality among the inmates being fights, in which victory is not always to the strong.

THE National University of La Plata has published in vol. xvii. of the *Revista del Museo de La Plata* a valuable monograph entitled "Los Tiempos Prehistóricos y Protohistóricos en la Provincia de Cordoba," prepared by Senhor Felix F. Outes, the secretary and director of the museum. This museum, founded by Dr. F. P. Moreno, has become, in its palæontological and anthropological departments, one of the most important in South America. It owes much to the collections of the late Dr. F. Ameghino, to which the present report is largely devoted. The writer reviews the collections from the earliest period, the most interesting series being the cave drawings and petroglyphs representing rude animal and other figures. The report—a scholarly production with full references to the literature of the subject—is an important contribution to our knowledge of the earlier civilisation of Argentina.

IN *Man* for October Prof. Flinders Petrie discusses a series of Roman portraits found at Hawara, on the eastern border of the Fayum, a site from which the most important existing specimens of this form of art have been obtained. The custom of decorating mummies with gilt stucco cases was much developed in Ptolemaic times. By the end of the first century A.D. it became the fashion to take the canvas portrait of the dead, which had hung in a frame on the house wall, and to place it over the face of the mummy as a substitute for a conventional stucco head. Wax was undoubtedly the medium for the colour, which was laid on either with a full brush or in a creamy state with short, sloping strokes. The personages depicted are of a mixed type, mainly European, but mingled in some cases with indigenous Egyptians, Syrians, and other Levantines attracted to the Fayum in the course of trade. Lastly, Roman jurisdiction had added an Italian upper stratum of officials, who had no objection to mixing with other local races; and we also find instances of a Spanish or Moresque-Spanish type in this curiously cosmopolitan population.

WITH the exception of one, by Dr. Annandale, on the batrachians and reptiles of Yun-nan, the papers in vol. vi., part iv., of Records of the Indian Museum are devoted to various groups of invertebrates, among which reference may be made to notes, by the same author, on fresh-water sponges from the Poona district of Bombay. One of these, *Corvospongilla burmanica bombayensis*, represents an Indian race of a species originally described from Burma.

THE appointment of Dr. F. A. Lucas to the directorship of the American Museum of Natural History has caused a vacancy in the office of chief curator of the Brooklyn Museum. According to the October issue of *The (Brooklyn) Museum News*, part of the work of excavating and laying the foundations of an extension of the Central Museum is in hand, while appropriations have been made for the erection of a new Children's Museum. A unique exhibit of animals and other organisms injurious to books and libraries was installed during the year. The insects include various larvæ passing under the general name of "book-worms," cockroaches, white ants, silver-fish, and the American spring-tail.

THE invertebrate marine fauna of the South Sandwich group (lying to the east of South Georgia) forms the subject of several short communications in series 3, vol. xiv., of the *Anales del Museo Nacional de Historia Natural de Buenos Aires*. In a general account of the history of the islands, which bears no author's name, although in the table of contents it seems to be attributed—apparently incorrectly—to Mr. Chevreux, it is recalled that the Sandwich group, which was discovered by Cook in 1755, consists of twelve islands, or rocks, situated in 58° S. lat. Most of the specimens were collected by Dr. F. Lahille, of the La Plata Museum, but others were obtained by Captain Larsen. The majority of the isopod crustaceans were examined by Miss Harriet Richardson, who describes two new species of Serolis, but a new Antarcturus is named in the article which bears no author's name. The amphipods comprise a new Œdiceroides and Eusirus, described by Mr. E. Chevreux; but the pynogonids, which were submitted to Mr. E. Bouvier, all pertained to previously known forms.

IN view of the attention now concentrated on the brown rat in connection with the spread of bubonic plague, and the damage inflicted by this rodent on agricultural produce, Mr. Newton Miller, of Clark University, has undertaken an investigation of the rate of its propagation, the results of which are published in the October number of *The American Naturalist* (vol. xlv., p. 623). From this it appears that these rats, which have a gestation period of from $23\frac{1}{2}$ to $25\frac{1}{2}$ days, breed in every month of the year, and may produce five or six litters annually, the number of young ranging from six to nineteen, and averaging between ten and eleven. Although full growth is not attained before the eighteenth month, sexual maturity is reached in both sexes at least as early as the end of the fourth month. In one particular instance seven litters were produced in as many months by a single female; and in cases when all the young perish at birth, it is presumed that there would be a dozen litters in the course of a year. In captivity brown rats devour nearly 50 per cent. of their young at birth, most, if not all, of these being eaten by the females. Full details are given in the article with regard to the growth and development of the young.

THE current issue (Bd. 43, Heft 3) of the *Morphologisches Jahrbuch* contains a description, by Dr. H. Bluntschli, of an ovarian dermoid cyst in which teeth of two dentitions are recognisable; and studies by G. P. Frets on variations in the vertebral column of fruit bats and squirrels, and by Dr. Kriegbaum on the anatomy of the pharynx of certain mammals, birds, and reptiles.

IN the *Zeitschrift für wissenschaftliche Zoologie* (Bd. 98, Heft 3) J. Sokolow gives an account of the eyes of Pantopoda ("sea spiders"), which he considers to be more primitive in structure than those of arachnids. Drs. Löhner and Micoletzky describe two new acœlous turbellaria, namely, a new genus, Monochœrus, and a new species of Convoluta (*C. pelagica*). The latter is light green in colour, owing to the presence in the parenchyma of clumps of symbiotic plant cells (zoochlorellæ). This worm, which is very voracious, feeding on pelagic copepods, was taken in numbers off the west coast of Istria.

THE source of Chinese medical rhubarb is discussed by Dr. C. C. Hosseus in an article—received as a separate pamphlet—appearing in *Archiv der Pharmazie* (vol. ccxlix.). The strongest evidence is put forward in a statement received from Mr. E. H. Wilson that *Rheum officinale* furnishes the commodity supplied from Tachien-lu, while the best quality, taken from a variety of *R. palmatum*, is exported from the Suntang region.

As in the Malay Archipelago, so in Siam, the family of Dipterocarpaceæ is predominant in the forests; but whereas species in the former region are numerous, only nine are recorded from Siam in the recent account provided by Mr. F. D. Ryan and Dr. A. F. G. Kerr in the Journal of the Siam Society (vol. viii., part i.). Of six species of Dipterocarpus, *D. tuberculatus* and *D. obtusifolius* are the most important, as they form in some localities almost pure, open jungle forests. *D. tuberculatus* is best developed on red clay; *D. obtusifolius* becomes dominant on sandy soil, while *Shorea siamensis* may also develop into forest on stony ground. Different forms, respectively tomentose and glabrous, were observed for several species; the tomentose form is associated with higher and drier situations. A peculiar feature is the storage of water by *D. obtusifolius*, so that if the stem be cut and turned upside down, a sufficiency is obtained to be serviceable to shooting parties.

OWING to the propensities of native growers and the traditions of the industry, the improvement and increase of cotton cultivation in India is a complicated problem; but, judging from the note compiled by Mr. B. Coventry, and published as Bulletin No. 26 of the Agricultural Research Institute, Pusa, appreciable success has already been attained with some measures, while others are proceeding favourably. The yield of Broach and other better-class native varieties has been improved by seed selection; coincidently stores have been established for distributing the pure improved seed. Promising results have been obtained by hybridisation at Surat and elsewhere. In Sind a good-class American cotton has been profitably raised, and Egyptian metafifi is being tried where canal irrigation is feasible. A signal failure is noted in the case of experiments with tree cottons, which have therefore been discontinued.

THE September number of *The American Journal of Science* contains an account, by Mr. O. A. Derby, of a big diamond recently obtained from the Bagagem district of Minas Geraes, where the famous "star of the south" was found. That stone weighed 255 carats; and the same locality also yielded the "Dresden diamond," with a weight when uncut of $119\frac{1}{2}$ carats; the new stone, "estrella de Minas," weighs 175 carats. All three diamonds are elliptical in shape, with curved faces. It is mentioned in the same note that the largest diamond known from Brazil was one found in 1906, the weight of which was estimated at 600 carats. Its owner, being doubtful whether it was really a diamond, caused it to be struck with a heavy hammer on an anvil, in the belief that if genuine it would be uninjured! Fragments weighing about 100 carats were saved, from which one diamond weighing 8 carats was cut.

THE valuable meteorological charts published by the U.S. Weather Bureau for the large oceans and the great American lakes for November have been received. In addition to the usual statistical and other useful information contained on the face of the charts, the reverse sides of those of the North Atlantic and North Pacific contain articles on the sea surface and air temperatures, currents, &c. It is shown, *inter alia*, that high barometric pressure usually prevails over the central portion of the North Atlantic, the crest lying between longitudes 25° and 40° W., having slightly increased since October. Low barometric pressure obtains north of 55°, between longitudes 20° and 50° W., having decreased since October. The increased steepness of the barometric gradient causes frequent storms over the Transatlantic routes.

A SUMMARY of the weather issued by the Meteorological Office shows that the rainfall for last week was again generally below the average, the only really appreciable excess being 0·48 inch in the south of Ireland. Contrary to recent experience, the duration of bright sunshine was below the average over the entire kingdom. The aggregate rainfall for the seven weeks of autumn as yet expired is below the average over the entire kingdom, except in the Channel Islands, where there is a slight excess, amounting to 0·09 inch. The deficiency in the west of Scotland is 3·59 inches, and in the north of Scotland 3·54 inches. The deficiency of rainfall since the commencement of the year is very great; in the north of Ireland it amounts to 8·76 inches, the west of Scotland 7·88 inches, the south-west of England 7·76 inches, and the Midland counties 7·70 inches. In the south-east of England the deficiency is 5·72 inches, where the excess of sunshine is 335 hours, which is the greatest excess in any part of the kingdom. The heavy rains of the present week will decrease somewhat the accumulated deficiency of rainfall.

ACCORDING to several communications which have been made to the *Physikalische Zeitschrift* recently, Drs. Elster and Geitel have succeeded in increasing the sensitiveness of the potassium photoelectric cell very materially by passing an electric discharge for a short time through the hydrogen in the tube. The potassium becomes covered with a greenish-blue film, which appears to give off negative electrons when illuminated much more readily than the metal itself. If the hydrogen remains in the tube the film disappears, and the sensitiveness of the cell falls. By replacing the hydrogen after the formation of the film by argon, the film becomes permanent and the sensitiveness constant. By covering the ordinary potassium kathode with a film of colloidal potassium a cell may be made sensitive to the infra-red rays. As an example of the use to which these sensitive cells may be put, the measurement of the decrease of the light from the moon during the eclipse of November 16, 1910, may be cited. With 232 volts on the cell full moonlight gave a current of 350×10^{-9} ampere, which sank to 220×10^{-9} as the moon entered the umbra, and to zero before totality was reached, owing to the passage of clouds.

THE Sociedad Matemática Española is to be congratulated on the success that is attending its efforts to remove a reproach from the annals of Spanish science. It was founded in April last, and has already published three numbers of its *Rivista*, a periodical which should play a notable part in the awakening and sustaining of mathematical interests throughout the peninsula. Each number opens with a biography and portrait, contains articles on pure and applied mathematics, reviews of current mathematical literature, articles on the history and methodology of the science, and a column for queries and answers. The society proposes to publish for the benefit of its members translations of foreign works on mathematics. This, when finances allow, is to be at less than cost price. On the same terms the society will supply to members translations of articles from foreign periodicals. A department has also been organised for the supply to members of references from the vast body of mathematical literature. The outlook is full of promise, especially when we remember that a much larger audience than Spain can at present produce awaits the appeal of the Sociedad in the intellectual centres south of the United States and north of the line joining Buenos Ayres and Valparaiso. The new society is a vigorous bantling. Time alone will show if it will rise to its opportunities. All information may be obtained from D. Jose Mingot, San Bernardo, 51, Madrid.

It is well known that the method of preparing nitrous oxide, which consists in heating ammonium nitrate, is not exempt from danger. A new and safer method of preparation, which gives a pure product, is described by A. Quarkaroli in the *Gazzetta Chimica Italiana* for September 19. It consists in heating 0·5 gram of nitre with 20–25 c.c. of formic acid, and collecting the gas which is evolved over a 20 per cent. solution of potash, which serves to absorb the carbon dioxide simultaneously formed. The heating must be done carefully, and it is best to apply a flame until the action just begins, and then remove it at once. When the action ceases another 0·5 gram of nitre is added to revive it, and this is continued until all the formic acid is used up. The action takes place quantitatively according to the equation

$$2KNO_3+6HCO_2H=N_2O+4CO_2+5H_2O+2HCOOK,$$

and this enables the decomposition to be applied to the estimation of nitrates. The action is carried out in a test-tube, and the gases collected over mercury in a graduated cylinder capable of taking 250 c.c.; the volume of mixed gases is first measured, and then the volume obtained after absorbing the carbon dioxide by introducing 2 c.c. of a concentrated solution of potash. The two measurements serve to control one another. The time occupied in an analysis by this method does not exceed five minutes, and as the results are practically as accurate as those obtained by the Schulze-Tiemann method, which takes an hour, the new method is to be preferred. In a second paper it is shown that the action involves initially the formation of nitrous anhydride, which then acts catalytically, and greatly accelerates the velocity of the change. By the addition of traces of substances such as chloric acid, hydrogen peroxide, or potassium permanganate, which destroy nitrous acid, the decomposition of the formic acid is greatly retarded; urea behaves in the same way, but is not quite so active.

A copy has been received of the "Collective Index of the Institute of Brewing," which forms an exhaustive book of reference to scientific work carried out in connection with the fermentation industries in all parts of the world. The original Laboratory Club first issued Transactions in 1887, so that the index covers the period 1887–1910. It is divided into an authors' index of 130 pages and a subject index of 415 pages, figures which suffice to indicate the enormous amount of work which has been done in connection with fermentation. Besides the publication of original papers and the discussion on them, the institute has included for some years appropriate abstracts of scientific papers in its volumes, and great praise is due to the editor and his colleagues for the efficient way in which this work has been performed. As a consequence, it is possible to keep more easily in touch with the scientific literature of fermentation than is the case in any other industry, and the collective index will make the journal of the society indispensable to future workers in this field. The matter is printed exceptionally clearly across the page, a method which, in our opinion, is far preferable to the double columns adopted by many other societies.

A paper on the endurance of metals was read by Messrs. E. M. Eden, W. N. Rose, and F. L. Cunningham before the Institution of Mechanical Engineers on Friday, October 20. The experiments, which were carried out at University College, London, took the form of determining the number of alternations of stress which a loaded rotating beam could withstand before rupture. The most remarkable point shown in these tests is the absence of all speed effect between 250 and 1300 alternations per minute. In the experiments of Reynolds and Smith a very large and perfectly definite speed effect was found for speeds between 1300 and 2000 alternations per minute. The entirely different results of the University College tests must be due to the different form of test and testing machine.

Some interesting figures are quoted from the report on breakdowns of various generating plants by Mr. Michael Longridge, chief engineer of the British Engine, Boiler and Electrical Insurance Company, in the leading article in *Engineering* for October 20. Two similar gas engines, built by the same maker, and bearing consecutive numbers, were at work 100 miles apart, and broke their crankshafts on the same day. The cause was bad design, the calculated stress being 21,000 lb. per square inch. Two cases of extraordinary endurance of cast iron are given, in both instances used for parts to which no one nowadays would venture to apply it. One of the cases was that of a cast-iron crank-shaft of an engine built in 1850. Between 1850 and 1873 the engine made 70,000,000 revolutions, and the stress on the neck at the beginning of the stroke was 3650 lb. per square inch; between 1873 and 1897 76,000,000 revolutions were made, the stress being 2270 lb. per square inch; between 1897 and 1910 41,000,000 revolutions were made with a stress of 2050 lb. per square inch. The other instance noted is that of a cast-iron gudgeon, which dated from before 1838. It has withstood, without fracture, at least 750 million applications of a stress equal to ± 1500 to 1700 lb. per square inch.

Messrs. Reynolds and Branson, Ltd., of Leeds, have issued an abridged catalogue of chemical apparatus and chemicals containing additions and corrections to the eleventh edition of their catalogue of chemical and physical apparatus.

The Emil Busch Optical Company, 35 Charles Street, Hatton Garden, London, E.C., has issued several well-illustrated pamphlets giving detailed particulars of the "bis-telar" objectives, of the Busch projection apparatus, and telephoto lenses.

Prof. Birkeland asks us to state that the times from U.S. Coast and Geodetic Survey stations given in his letter "On the Simultaneity of Certain Abruptly-beginning Magnetic Disturbances" in Nature of October 12 (p. 483) should have been in decimals of a minute and not in minutes and seconds; the correct times are thus:—Honolulu, 10h. 20·7m.; Porto Rico, 20·8m.; Cheltenham, 21·9m.

OUR ASTRONOMICAL COLUMN.

Mars.—In No. 4530 of the *Astronomische Nachrichten*, where M. Jarry Desloges's note concerning the brightness of Libya on October 12 is now published, there is also a message from Señor Comas Sola saying that on October 11 he observed a brilliant cloud on the Libya area.

M. Jarry Desloges also continues his preliminary account of the observations made at Massegros during the present opposition, and directs attention to numerous changes of appearance since 1909. A number of important "canals" are seen in the L. Mœris region, the lake itself presenting a variegated appearance. M. Cimmerium and M. Sirenum, seen under good conditions, appear as mosaics, while the L. Solis, although in a very pale region, is relatively dark and is surrounded by a complicated system of "canals"; it is constricted in the middle, and the eastern half is ever the darker. The "canals" around this lake appear abnormal, being very broad, diffuse, and pale. The south polar cap is still seen, but is very small, although at times very brilliant, and the north polar cap presents very sharp fluctuations of relative visibility, extent, and tone. The bluish tone seen in 1909 is still there, but seems to be more brilliant where the edges are better defined.

BELJAWSKY'S COMET, 1911g.—Dr. Kobold's ephemeris for comet 1911g is continued in No. 4530 of the *Astronomische Nachrichten*, from which we take the following abstract:—

Ephemeris 12h. M.T. Berlin.

1911	α (true) h. m.	δ (true)	log r	log Δ	mag.
Oct. 26	15 27·3	−9 12·7	9·7483	0·1309	4·3
,, 30	15 44·4	−13 13·0	9·8118	0·1649	4·8
Nov. 3	15 58·9	−16 36·8	9·8669	0·1961	5·2
,, 7	16 11·6	−19 32·0	9·9149	0·2266	5·6
,, 11	16 23·0	−22 3·2	9·9573	0·2507	5·9
,, 15	16 33·4	−24 15·3	9·9951	0·2744	6·2
,, 19	16 43·1	−26 11·9	0·0291	0·2960	6·5

The comet, then, is travelling down through Libra towards Scorpio, and its increasing south declination, its apparent proximity to the sun, and its decreasing brightness make it an almost impossible object except under the best conditions.

A number of earlier observations are recorded in the same journal, the general result being that about October 1–3 the comet was between the second and third magnitude, had a nucleus of magnitude 6·0, and a well-defined tail some 2° or 3° in length.

QUÉNISSET'S COMET, 1911*f*.—New elements and an ephemeris for comet 1911*f* are published by Dr. Ebell in No. 4530 of the *Astronomische Nachrichten*.

Ephemeris 12h. Berlin M.T.

1911	α (true) h. m.	δ (true) ° '	log r	log Δ	mag.
Oct. 24	15 42·2	+22 10·8	9·9378	0·1019	6·8
,, 28	15 43·8	+17 47·8	9·9230	0·1259	6·8
Nov. 1	15 45·0	+13 47·6	9·9109	0·1483	6·9
,, 5	15 45·8	+10 6·0	9·9020	0·1688	6·9
,, 9	15 46·4	+6 39·1	9·8969	0·1872	7·0
,, 13	15 46·8	+3 24·1	9·8960	0·2034	7·1

Perihelion passage takes place on November 12·39, and the comet is still observable, with increasing difficulty, in the evenings. The path lies through Serpens, and the comet will pass between β and γ Serpentis on October 29–30.

BROOKS'S COMET, 1911*c*.—Some photographs of Brooks's comet, taken by MM. Quénisset and Baldet at the Juvisy Observatory, are reproduced in the October number of *L'Astronomie*. One, on plate paper, taken with 2h. 3m. exposure on September 29, shows a large round head with two fine, slightly divergent streamers; between these, and at about 21′ from the nucleus, emerges the main tail, which presents but few of the undulations and condensations that characterised the tail of Morehouse's comet. A photograph taken with a short-focus camera on September 29 shows a tail 30° long going to the edge of the plate. The photographic intensity of the comet was then much greater than that of Daniel's comet, 1907*d*, but less than that of Morehouse's, 1908*c*.

THE CAPE OBSERVATORY.—Mr. Hough's report of the work done at the Cape Observatory during last year refers to many important pieces of astronomical research, from which we may but select one or two of the more striking facts. The travelling wire micrometer, in a modified form, was fitted to the transit circle, and gave excellent results; an instantaneous reversing gear has been fitted for use on stars near the pole. The heliometer was used on thirty-five nights for securing 166 observations of the position of Halley's comet. With the four-prism spectrograph attached to the Victoria telescope, 239 stellar spectra were secured, and with the one-prism spectrograph eleven photographs of the spectrum of Halley's comet were taken. The 6-inch equatorial was also used on the comet; and its mounting also carried other cameras, one, a Ross-Goertz (F=7·7) camera, having the large prism from the four-prism spectrograph mounted objectively; with this twenty photographs of the comet's spectrum were obtained, some showing also the tail. The astrographic reductions were submitted to the final control afforded by measures on overlapping plates. With the Dallmeyer photoheliograph 550 photographs of the sun were secured on 260 days between March 1 and the end of the year.

THE SPECTRUM OF P CYGNI.—The enigma presented by the mixed spectrum of P Cygni is somewhat further complicated by a preliminary note published by Mr. P. Merrill in No. 201 of the Lick Observatory Bulletins. It will be remembered that the spectrum is of the Orion type, with adjacent bright and dark lines, the latter being displaced toward the violet. Mr. Merrill now finds that the bright lines due to silicon are differentially displaced. Assuming that the wave-lengths of the bright lines of H, He, and N in the spectrum are those found for the same lines in laboratory and ordinary stellar spectra, the three bright silicon lines 4553, 4568, and 4575 are displaced 0·26 A.U. towards the red; the lines are also said to differ appreciably in appearance from the other lines in the spectrum.

MUSEUM CONFERENCE AT LIVERPOOL.

A CONFERENCE of members of the Museums Association and others interested in the work of museums was held at the Public Museum, Liverpool, on Wednesday, October 18. About sixty were present, including representatives from public museums at Manchester, Sheffield, Hull, Leicester, Stoke-on-Trent, Bolton, Warrington, and other towns.

After an address of welcome by Mr. F. J. Leslie, chairman of the libraries, museums, and arts committee, Dr. Clubb, director of museums, gave a brief description of the collections, and conducted the party on an inspection of the galleries. After tea the chair was taken by Mr. H. R. Rathbone, chairman of the museum subcommittee. Mr. E. Rimbault Dibdin directed attention to a clause in the Copyright Bill which has passed the House of Commons, the effect of which would be to take away the copyright in any work of art exhibited in a public gallery, and appealed to museum authorities to agitate for its rejection.

Dr. Clubb read a paper on the educational value of museums for schools, which was illustrated by the exhibition of some of the cabinets of natural history specimens which the museum circulated amongst the elementary schools of Liverpool, and by a number of drawings, wood carvings, and plasticine models made by pupils of one of the schools after a visit to the African gallery of the museum. Mr. P. Entwistle described the introductory series to the ceramic gallery in the Liverpool Museum, which exhibits the development of pottery from the earliest times, and includes a technological series explaining the process of manufacturing earthenware as now carried on. Mr. W. S. Laverock, in a paper on the botanical gallery of a public museum, said that he was forecasting an arrangement which did not as yet exist anywhere, which should include exhibits of English plants grouped according to their habit. This method would be more intelligible to the beginner than the usual systematic arrangement. Mr. J. W. Catmore described modern methods in taxidermy, which he illustrated by means of work in process and with examples of old and new specimens from the collections. The chairman suggested the desirability of adding pictorial backgrounds to some of the naturally mounted groups.

NEW BUILDINGS OF THE ROYAL ALBERT MEMORIAL UNIVERSITY COLLEGE.

FRIDAY last, October 20, was a red-letter day in the history of education in Devonshire, for the formal opening of the new University College buildings by the Lord-Lieutenant of the county was attended by such a gathering of influential people as to show that the County of Devon is now as much in earnest as the City of Exeter itself in the determination to maintain a fully equipped University College in its capital.

Dr. Alex. Hill, late master of Downing College, Cambridge, visitor of the college, delivered an address on the need for the highest branches of education and the importance of bringing such teaching within easy reach of all. Money spent in the establishment, endowment, and maintenance of such colleges, he said, would return to future generations an hundrdedfold. The Lord-Lieutenant, Earl

Fortescue, the Bishop of Exeter, Lord Clifford of Chudleigh, chairman of the Devon Education Committee, and the Sheriff of Exeter all followed in the same vein.

Hitherto, as was pointed out by the Mayor and by the principal, the college has been hampered and hindered in its growth by several causes. First among these was the inadequate accommodation of the old class-rooms and laboratories. This difficulty is no more, for the new buildings supply all that is essential for the needs of the present and for several years to come. The other difficulties have been acutely felt from time to time, especially when the commissioners from the Treasury have inspected the college. It had no permanent endowment fund, no long list of subscribers, and no considerable financial backing except from the city and citizens of Exeter itself.

At the meeting on Friday the governors were able to announce that they are making an attempt to raise an endowment fund of at least 30,000*l*., and the preliminary list already reached more than one-tenth of that sum. It seems certain that when the next inspection takes place the University College will be able to give a very different account of its position.

The buildings opened on October 20 represent the first instalment of a complete scheme for which the site has been secured, as funds do not at present admit of the erection of a great hall or of a wing to give modern accommodation for the fine art, applied art, technical and technological departments.

The front portion of the new wing contains chemical laboratories and lecture theatre, a common room for women students, six class-rooms and lecture-rooms for mathematics, classics, history, English, and modern languages, the biological laboratory and lecture-room, and rooms for the principal, professors, and staff. Behind this lies the day training college. There is no new provision for physics. This will be provided for in the York wing, opened in 1899 during the visit of the King and Queen when Duke and Duchess of York. The whole of this wing will now be devoted to physical science, except for one room allocated to geology.

New Buildings of the Royal Albert Memorial University College, Exeter.

AMERICAN ETHNOLOGY.

ABOUT the year 1895 Major J. W. Powell, director of the Bureau of American Ethnology, decided to prepare a linguistic map of that part of North America south of the Mexican boundary. This important work was, after the death of Major Powell, taken over by Drs. Cyrus Thomas and J. R. Swanton, who have now published the results in the 44th Bulletin of the Bureau of American Ethnology. Their report gives a detailed catalogue of the dialects in use throughout Mexico and Central America. Of particular interest is the evidence now provided, which corroborates the conclusion already arrived at that the linguistic elements of South America, at the time of the Spanish conquest, extended into the southern sections of Central America; and now for the first time the ethnical line dividing North and South America has been provisionally determined. This monograph is admitted not to be a final work, but an attempt to represent the present state of knowledge regarding a subject which may never be cleared entirely of obscurity.

It is a remarkable fact that the Cliff Palace in the Musa Verde National Park, Colorado, the largest, most picturesque, and most typical cliff-dwelling in the south-western States, so long escaped the knowledge of white settlers in the neighbouring Montezuma Valley. It is not mentioned in the early Spanish writings, and the first description of it was not published until about 1880. The classical account of these ruins is that by Baron Nordenskiöld in his "Cliff

Dwellers of the Musa Verde," translated from the Swedish original in 1893. This interesting monument, of which the most remarkable portion is a great round tower, has long suffered from the vandalism of casual treasure-seekers. It has now been taken in hand by the Government of the United States, which deputed Mr. Jesse W. Fewkes to effect a conservative restoration. The results of his operations are described in a valuable monograph, included in Bulletin 51 of the Bureau of American Ethnology. The buildings are prehistoric in the sense that there is no evidence of any culture derived from the white immigrants; and, though the relations of the Pueblo culture to that of the cliff-dwellers is still in some degree uncertain, the latter appears to be the earlier. Of special interest is the question of the disposal of the dead by cremation, the corpse being apparently dried before it was committed to the flames. The religion of this people, of which ceremonial dances formed an important part, cannot be clearly ascertained until the numerous cult objects obtained by excavation are more carefully examined.

GRANTS FOR AGRICULTURAL SCIENCE IN THE UNITED STATES.[1]

THE growth of the National Department of Agriculture during the past ten years has far exceeded that of all of its preceding history. This was pointed out by the Hon. Charles F. Scott, chairman of the House Committee on Agriculture, in submitting the new Agricultural Appropriation Bill last winter. As a full-fledged department with a Cabinet Minister at its head, the Department dates only from 1889. But if we go back to 1839, when 200*l*. was appropriated for "agricultural statistics," and include every dollar appropriated out of the Treasury of the United States for agricultural purposes down to and including the year 1900, the total sum is only 9,020,523*l*., while the aggregate of all the money appropriated from the end of 1900 to the end of the current fiscal year reaches a sum nearly double this, or 18,002,412*l*. For the fiscal year 1901 the appropriation for maintenance was 660,853*l*. This year the Department has at its disposal 3,094,127*l*. "Ten years ago the total number of persons employed in the Department was 3388: this year if all the rolls were called an army of 12,480 men and women would respond."

Under the Bill submitted by the committee referred to above, which after discussion and amendment received the signature of President Taft on March 4, provision is made for an even greater development during the ensuing year. The aggregate amount carried by the Act is 3,380,003*l*., which by far exceeds that granted in any previous measure, and is 177,590*l*. in excess of the estimates submitted by the Department.

There is an apparent increase over the Appropriation Act for 1911 of 682,476*l*., but of this 144,000*l*. is only nominal, since it merely replaces what has hitherto been provided automatically as a permanent appropriation to the State experiment stations under the Adams Act. It will be recalled that by the terms of that Act as subsequently construed in the Appropriation Act for 1907, definite appropriations were made only until July 1, 1911. The action taken by Congress now provides for the continuance of the Adams Fund on the same basis as the Hatch Fund, requiring the amounts to be appropriated annually in the Agricultural Bill. With due allowance for this item, however, there is still an actual enlargement of the appropriations of every bureau, and a net increase of fully 20 per cent. for the Department as a whole.

In general, the increased appropriations are for the purpose of extending and developing lines of work already under way, rather than the undertaking of new projects, and some of the principal increases are for what may be termed the administrative activities of the Department. One of the largest new items is an appropriation of 200,000*l*. for fighting and preventing forest fires in the national forests in cases of extraordinary emergency. This appropriation is in addition to the regular appropriation of 30,000*l*. for fire fighting under ordinary conditions, and supplements deficiency appropriations of more than 180,000*l*. incurred as a result of the disastrous fires of last summer.

The Federal meat inspection, which has been enforced by the Department from a permanent annual appropriation of 600,000*l*., receives an indirect increase of 31,000*l*. through the transfer of its clerical force to the statutory roll of the Bureau of Animal Industry. The Bureau of Chemistry receives 12,000*l*. additional for the enforcement of the Food and Drugs Act, and the Weather Bureau 15,098*l*. additional for its weather service. Provision is also made by an appropriation of 17,400*l*. for the enforcement of the Insecticide Act, which became effective on January 1, and for which a deficiency appropriation of 7000*l*. had been allowed for expenses to July 1.

A number of propositions involving general legislation were considered in connection with the Bill, but as finally enacted the law remains substantially a routine measure. The secretary was again authorised to continue investigations on the cost of food supplies at the farm and to the consumer, and a special appropriation of 1000*l*. was added for a study of chestnut-bark disease.

The Weather Bureau receives a total of 320,050*l*. Of this amount, 3000*l*. is for the restoration of the Weather Bureau station at Key West, Florida, wrecked by hurricanes in October, 1910. The allotment for maintenance of the bureau printing office was reduced to 3600*l*. by reason of the recent transfer of a portion of the equipment to the Government Printing Office. For investigation of climatology and evaporation 24,000*l*. was provided, as at present.

The appropriations to the Bureau of Animal Industry aggregate 330,150*l*. Aside from the increase due to the transfers from the Meat Inspection Act, previously referred to, the chief additions are those of 1424*l*. for the tick-eradication work, making that appropriation 50,000*l*.; an increase of 1400*l*. for the work of the Dairy Division, making its total 30,000*l*.; and of 1528*l*. for the Animal Husbandry Division, or 9496*l*. for that work. Under a new clause inserted in the Act, the Secretary of Agriculture is authorised to permit, under certain conditions, the admission of tick-infested cattle from Mexico into those portions of Texas below the quarantine line.

New appropriations were made of 13,000*l*. for the purchase of land for quarantine stations near Baltimore, Maryland, and Boston, Massachusetts; 2000*l*. for equipping the 475-acre experiment farm which has recently been acquired at Beltsville, Maryland; and 3300*l*. for constructing buildings at this farm and that at Bethesda, Maryland. It is expected to utilise the Beltsville farm for the experimental work of the Animal Husbandry and Dairy Divisions, and to reserve that at Bethesda for pathological investigations.

One of the largest increases in the Bill was accorded to the Bureau of Plant Industry, which will receive 60,696*l*. additional, making its total 412,337*l*. The lump-fund appropriation for general expenses is 288,307*l*., which is divided among thirty projects. Some of the largest of these are 70,000*l*. for the boll-weevil campaign (a net increase of 21,389*l*.); methods of crop production in the semi-arid or dry-land sections, and for the utilisation of lands reclaimed under the Reclamation Act, for which a net increase of 7654*l*. and a total of 28,612*l*. is granted: 28,584*l*. for the farm-management studies, of which 800*l*. is to be used in agricultural reconnaissance work in Alaska; studies of the production, handling, grading, and transportation of grains, for which 27,001*l*. is available, an increase of 4900*l*.; and the studies of fruit improvement and the methods of growing, packing, and marketing fruits, which will have 17,547*l*. The investigations of the cotton industry were extended to include the ginning and wrapping of cotton.

For the purchase and distribution of valuable seeds and plants the allotment made was 57,936*l*. This is an apparent decrease of 3982*l*., but it is accounted for in part by transfers of clerical employees to the statutory roll of the Bureau, and in part by the segregation as a distinct project of 4000*l*., which was formerly supported from this fund. The two items comprising this appropriation are the congressional seed distribution, which is continued on the usual basis, with 47,432*l*., and the allotment for the introduction of seeds and plants from foreign countries, which is increased to 10,504*l*.

[1] From the U.S. *Experiment Station Record*, vol. xxiv., No. 5, 1911. The dollars in the original have been converted into English currency.

The appropriations to the Forest Service reached a total of 1,100,620*l*., in addition to the various emergency appropriations to which reference has been made. This, as usual, represents the largest appropriation to any one bureau, and is also the largest increase over the previous year, the total for 1911 having been 1,001,620*l*. The policy of definite allotments to each of the 161 national forests for maintenance was continued. The Nebraska National Forest was authorised to furnish young trees free of charge to settlers in the surrounding region.

The sum of 30,000*l*. was granted for fighting forest fires and for other unforeseen emergencies, of which 14,000*l*. is immediately available. The allotment for permanent improvements on the national forests was increased from 55,000*l*. to 100,000*l*. Provision was made for the refunding to claimants of moneys erroneously collected in the administration of the national forests, and for the granting of easements under certain conditions for rights of way across the public lands, national forests, and reservations for the transmission of electrical power and for telephone and telegraph purposes.

Liberal provision for the development of investigational work was also made, 35,408*l*. being granted for investigations of methods for wood distillation and preservation and the economic use of forest products, including the testing of woods for paper-making, together with 3684*l*. for investigations of range conditions within national forests and range improvement, 50,238*l*. for silvicultural and dendrological experiments, and 6752*l*. for miscellaneous forest investigations and the preparation and dissemination of results.

The appropriation of the Bureau of Soils was increased to 52,412*l*. No appropriation was made for soil-erosion investigations, for which 1000*l*. has been allotted annually for many years. The soil-survey work received 29,000*l*., a net increase of 2608*l*., with a provision added limiting to 10 per cent. the expenditures in any State.

The Bureau was authorised to undertake a new line of work by the appropriation of 2500*l*. "for exploration and investigation within the United States to determine a possible source of supply of potash, nitrates, and other natural fertilisers," 500*l*. being made immediately available. It is expected that particular attention will be devoted to possible sources of potash in view of the present situation as regards the German potash supply. The work will also be supplemented by researches to be conducted by the Geological Survey, which received authority in the Sundry Civil Appropriation Act to expend 8000*l*. "for chemical and physical researches relating to the geology of the United States, including researches with a view of determining geological conditions favourable to the presence of potash salts." According to a recent announcement from the Survey, the expenditure of half this appropriation for the potash exploration is contemplated.

The Bureau of Entomology receives an aggregate of 120,384*l*. This is an increase of 13,948*l*., mainly for the extension of work to the alfalfa weevil and for enlarging the investigations on insects affecting rice and sugar-cane, for demonstration work against forest insects, and for additional studies in bee culture. The largest single allotment is for the continuation of the campaign against the gipsy-moth and brown-tail moth, for which the appropriation is 56,968*l*.

The large proportionate increase of 10,556*l*. was accorded the Bureau of Biological Survey, making its total 27,940*l*. All the various lines of work were continued on a more comprehensive basis, and new items were included of 500*l*. for the purchase, capture, and transportation of game for national reservations, and of 4000*l*. for the feeding, protecting, and removal of elk at Jackson's Hole, Wyoming, and vicinity. The latter appropriation is made immediately available, and remains available until expended.

The activities of the Office of Public Roads have been rapidly increasing in recent years, and to keep pace with the growing demands the appropriation was increased from 22,848*l*. to 32,144*l*. A new line of work authorised is the conducting of field experiments in road construction and maintenance, for which 2000*l*. is granted.

The total appropriation of the Office of Experiment Stations is 372,800*l*., of which 288,000*l*. is allotted to the State experiment stations under the Hatch and Adams Acts. Of the remainder, 11,300*l*. is for statutory salaries, and 7500*l*., a net increase of 1000*l*., is for general expenses. The allotment of 2000*l*. for the Agricultural Education Service was continued as at present.

The nutrition investigations received an increase of 1000*l*., making 3000*l*. available for this purpose. This increase will enable further extension of these investigations and the preparation of popular bulletins setting forth plans for the more economical and effective utilisation of agricultural products as human food, for which data a strong demand has been in evidence.

An estimate of 4000*l*., submitted for the preparation, publication, and dissemination of original technical reports of the scientific investigations of the experiment stations, by the Secretary of Agriculture in cooperation with the Association of American Agricultural Colleges and Experiment Stations, was favourably recommended by both the House and Senate Committees, but failed of passage.

The Alaska, Hawaii, and Porto Rico experiment stations were given 6000*l*. each, an increase of 400*l*. in each case, to equalise their funds with those received by the State stations from Federal funds, and the Guam station was continued at 3000*l*. The clause requiring the expenditure of 1000*l*. by the Porto Rico station for coffee experiments was omitted, thereby restoring the coffee work to the same basis on which it has been conducted for many years previous to the passage of the Act for 1911.

The irrigation and drainage investigations each received 20,000*l*., a net increase of 6564*l*. and 5196*l*. respectively. These increases will enable the extension of these lines of work, especially in the rendering of assistance to settlers in newly irrigated regions and in formulating plans for the reclamation of swamp lands. The provision requiring a special report of the aggregate expenses in the drainage investigations to date, and the areas in the several States and territories which have been investigated, was continued.

The work of the remaining bureaus was provided for along substantially the present lines. Including the increase previously noted for the enforcement of the Food and Drugs Act, the Bureau of Chemistry will receive 13,616*l*. more than at present, and a total of 192,756*l*. The Bureau of Statistics is given 46,324*l*.; the library, 8100*l*.; the office of the secretary, 55,290*l*.; the Division of Accounts, 19,504*l*.; the Division of Publications, 41,992*l*.; and the fund for contingent expenses, 22,000*l*. These all contain small increases, occasioned in general by the growth of the Department.

Eliminating the deficiency appropriations and that for the Forest Reservation Commission, these various appropriations, which are intimately connected with the work of the Department, would if added to the regular appropriations make a grand total of 4,514,003*l*. This is a large sum; but, as was pointed out by Chairman Scott in concluding the presentation of the Bill, "the money appropriated for the Department of Agriculture is an investment and not an expense. And that it has been a good investment the statistics showing the expansion of agriculture and the improvement in methods throughout our country bear eloquent witness. During these past ten years, while the Department of Agriculture has been expending 18,000,000*l*., the farmers of the United States have added to the wealth of the world the stupendous and incomprehensible sum of 16,000,000,000*l*. Without anything like a corresponding increase in the area of land under cultivation, the value of the farm products of our country has risen from slightly more than 800,000,000*l*. ten years ago to nearly 1,800,000,000*l*. in 1910.

"The conclusion is inevitable, therefore—and that conclusion could be made incontestable by innumerable other proofs if time permitted—that the farmers of America are applying better methods and getting better results from their labours than ever before. And in devising these better methods, in pointing the way for better results, the Department of Agriculture has been the undisputed leader, as it should be, and has thus beyond cavil or question derived from the money it has expended a percentage of profit to all the people which cannot be calculated."

THE PHYSIOLOGY OF SUBMARINE WORK.[1]

COMPRESSED air is used in all the great subaqueous works of to-day, in tunnelling, harbour works, shaft-sinking in wet soil, pier- and bridge-building, diving for pearl and sponges, salvage work, &c. The intercommunication of the great cities of the world depends on tunnels built with the aid of compressed air. All such works are limited to a certain depth by the pathological effects produced on the workers.

The Naked Diver.

The naked diver preceded the diver who uses compressed air. The body of the naked diver is pressed upon by the water, equally and in all its parts, by a pressure equal to one atmosphere (15 lb. per square inch) for every 33 feet (10·3 m.) of depth. He takes a deep breath or two, fills his lungs before, and holds his breath during, the dive. He places a foot in a stirrup attached to a heavy stone, and so is carried rapidly to the bottom. The air in his lungs, air passages, and middle ear must be compressed to half its volume at 33 feet (two atmospheres absolute), to one-third at 66 feet (three atmospheres absolute), to a quarter at 99 feet (four atmospheres absolute). The depths attained are usually not greater than 60 to 70 feet. The compression of the air in the lungs is rendered possible by the upward movement of the diaphragm and sinking in of the abdomen. Some of the air in the lungs must dissolve in the blood according to the law of partial pressures.

The amount of nitrogen dissolved from air at one atmosphere pressure and at body temperature is 0·85 per cent. This is the figure for the watery part of the body. The fat dissolves about 5 per cent., an important fact discovered by Vernon. At 66 feet (three atmospheres) the watery part can hold $0{\cdot}85 \times 3$ and the fat 5×3 per cent. Putting the fat against the solids of the body (bones, &c.), which do not dissolve gas, it may be assumed that the whole body dissolves about 1 per cent. of nitrogen per atmosphere. A man weighing 60 kgm., then, will dissolve when compressed from one to three atmospheres about 1200 c.c. of nitrogen, that is, if time were allowed for the blood to convey the nitrogen from the lungs to the tissues until saturation occurred. In the lungs there are about 4000 c.c. of air. Of course, far less than 1200 c.c. will be dissolved in the minute the diver is submerged. In addition to the solution of nitrogen, the blood will take up more oxygen, both in solution and chemically combined with the hæmoglobin; the diver working hard gathering pearl or sponge will use oxygen rapidly. It is clear, then, that the absolute volume of air must be reduced during the minute the diver stays submerged, but it is difficult to estimate by how much. To allow for the reduction of volume, both by compression and solution, in the body, it is clear that the diver must fill his lungs well, otherwise the diaphragm will be pushed up to such an extent that the action of his heart and the circulation of the blood become impeded. It is this, in part, which sets a limit to the depth to which the naked diver can go. The bleedings from mouth and nose which the unpractised naked diver suffers are due, no doubt, to both the congestion of the blood which results from holding the breath and to rarefaction of the air in the nose and middle ear during the ascent. Some time ago I put this question to Sir E. Ray Lankester: What happens in the case of the whale which sounds, perhaps, to a depth of 1000 feet? Does the whale allow the lungs to fill with water as the air becomes compressed to one-thirtieth of its volume? If not, what is the mechanism engaged which permits such compression? I fancy the whale allows water to enter, and blows this out again when it ascends to the surface. The naked diver can extend his stay under water by deep breathing before the plunge and filling the lungs with oxygen. The breathing is regulated by the concentration of acid (or the hydrogen ion) in the blood—carbonic acid is the natural end product of muscular metabolism; lactic acid is produced in the muscles when there is a deficiency of oxygen. Deep breathing before the dive will wash out much of the carbonic acid in the blood, owing to the increased ventilation of the lungs. The blood and muscles, too, will be better oxygenated, and thus less lactic acid will be produced during the submergence. If oxygen is breathed this will be still more the case, as Martin Flack and I have shown. After deep breathing air for two minutes we easily held our breath two or three minutes. After deep breathing oxygen five minutes one of our subjects held his breath more than eight minutes, and another just above nine minutes. Taking a deep breath and then holding it, J. M. pulled up a 60-lb. weight seventeen times in twenty-three seconds before he was compelled to take another breath. After deep breathing air for two minutes he held his breath while he pulled it up thirty times in fifty seconds, and after deep breathing oxygen for two minutes, seventy times in eighty-five seconds. Similarly, after a deep breath, R. A. R. held it while he ran 113 yards in twenty-nine seconds; 150 yards in $35\frac{3}{5}$ seconds after deep breathing air for two minutes; 256 yards in $62\frac{2}{5}$ seconds after deep breathing oxygen for two minutes. S. E. ran on one breath 470 yards in 110 seconds after deep breathing oxygen! At the end he ran blindly, having lost consciousness owing to the high concentration of CO_2 in his blood.

The high pressure of oxygen in the lungs enables one to hold one's breath until the pressure of CO_2 reaches 10 to 11 per cent., while if the pressure of oxygen is low a breath must be taken when that of the CO_2 reaches no more than half this amount. A balance is struck between the relative pressures of oxygen and carbonic acid. Mr. I. Feldman here has been breathing oxygen for some minutes; he will now put his face in a basin of water; you see he has now held his breath for three minutes without the least trouble.

It is clear, then, that the naked diver can stay longer and do more efficient work if he deeply breathed and filled his lungs with oxygen before each dive.

I will demonstrate my little apparatus by means of which oxygen can be generated from oxylithe (peroxide of sodium) and inhaled. Two blocks of oxylithe are put in the metal box—the generator—and a pint of water in the rubber bag. The mouthpiece of the bag is clipped, and the water allowed to enter the generator. Oxygen fills the bag, and a solution of caustic soda is formed. The man breathes in and out of the bag. This invention allows oxygen to be carried about, and has proved useful for mountain climbers who at high altitudes suffer from oxygen want.

Diving birds have double the normal volume of blood (Bohr), just as the llama and the human inhabitant of high altitudes have more red corpuscles and hæmoglobin. Observations on the blood of naked divers would probably show the same increase.

The Mechanical Effects of Pressure on the Body.

The body of the naked diver at a depth of, say, 66 feet is pressed upon equally on all sides by the water, and by a pressure of three atmospheres; for 33 feet of water = one atmosphere. The gas in his lungs (and intestines) is compressed into one-third of its volume, and that is the only effect of the pressure, for the pressure is transmitted equally and instantly by the fluids of the body to all parts, and as the fluids are practically incompressible the pressure has no mechanical effect.

The diver who uses gear, or the caisson worker, is surrounded with compressed air, and breathes freely in it. The body of either is pressed upon by the air, and the air pressure must always be just greater than that of the water to keep the latter out of the dress, bell, or caisson. I will demonstrate this on the model diver, diving bell, and caisson. Whether it be air or water that *uniformly* presses upon the body, the tissue fluids transmit the pressure equally; and thus, although it is computed that an extra atmosphere means an additional total pressure of 15,000 to 20,000 kilograms (40,000 lb.) on the body of a man, no mechanical effect is produced. Living matter is a jelly containing about 80 per cent. of water, and, like water, is practically incompressible. Since attention was first directed to compressed-air illness, the larger number of medical writers, ignorant of physical laws, have supposed that exposure to compressed air mechanically alters the distribution of the blood, forcing it inwards and causing a congestion, which is suddenly and dangerously altered on decompression.

[1] Evening discourse delivered before the British Association at Portsmouth on Friday, September 1, by Mr. Leonard Hill, F.R.S.

I have noted that the same false views are even now put forward in the daily Press to explain the symptoms, due to the rarefaction of the air, endured by aëroplanists. The sickness of high altitudes suffered by mountain climbers, balloonists, and aëroplanists has nothing to do with the mere mechanical effect of the lowering of barometric pressure. In an atmosphere enriched with oxygen U. Mosso has endured a lowering of barometric pressure until he could span the height of the column of mercury in the barometer with his hand. Oxygen want, due to the rarefaction of the air, is the prime cause of altitude sickness. At an altitude of 18,000 feet, where the barometric pressure is halved, a man, filling his lungs with air, takes in only half the *weight* of oxygen which he takes in at sea-level. His respiratory and circulatory organs can scarcely work hard enough for the body to get enough oxygen. The extra pulmonary ventilation washes the CO_2 out of the body, and produces a subnormal concentration of CO_2 in the blood and tissues. This is partly the cause of mountain-sickness. Individual variations in immunity to this sickness probably depend on variations in the chemical quality of the blood and power of the hæmoglobin to combine with oxygen.

That mere mechanical pressure, uniformly applied, is of no importance to living matter is shown by the existence of life in the greatest depths yet sounded, where the superincumbent pressure may equal two, three, and even five miles of water. By means of a small chamber and hydraulic pump and lantern I can project the shadow of the frog's heart beating in a suitable salt solution at a pressure of 2000 lb. (133 atmospheres), equivalent to a depth of nearly a mile of water. Regnard has compressed living aquatic animals, frogs' muscles, &c., to 500 and even 1000 atmospheres, and has found at the highest pressures the tissues become stiff and take up water, and life is destroyed. His experimental results and those of the deep-sea soundings (*Challenger* reports) are in contradiction. Regnard's experiments require repetition, with careful attention to the chemical composition of the water in which the living matter is compressed.

I refute the mechanical theories of compressed-air illness by this experiment: a frog's web is stretched over the glass window of the small pressure chamber, and is illuminated by the arc light, so that the circulation of the blood is projected on the screen. The circulation remains unchanged when the pressure is rapidly raised to twenty or even fifty atmospheres.

Manometric records of blood pressure taken from mammals enclosed in a pressure chamber, or from man, show no noteworthy change when the pressure is raised to three atmospheres. Similarly, I now show that a frog's heart or muscle contracts normally when suddenly submitted to a pressure of air equal to fifty atmospheres. After a time the contraction languishes; but that is not due to the pressure *per se*, but to poisoning by the high pressure (concentration) of oxygen. The pressure uniformly applied has no mechanical effect on the living protoplasm.

The Evolution of Diving Apparatus.

The use of compressed air for submarine work was a matter of slow development, owing, not to lack of invention, but to want of efficient air pumps and flexible tubes. The naked divers had a barrel, or bell-shaped vessel, standing on a tripod, lowered down to them full of air, to which they could return and breathe the air within every minute or two. They also chewed pieces of sponge dipped in oil, probably because swallowing inhibits the respiratory centre and checks the desire to breathe. One of the oldest inventions is that of a pipe conveying air from the surface to the mouth of the diver. Such a device cannot be used at any depth, because the body is pressed upon by the water plus the atmospheric pressure, while the lungs are exposed to the atmospheric pressure alone. This makes breathing difficult, and dangerously congests the lungs with blood, as I can demonstrate by this model. The cupping glass also demonstrates the congestive effect produced by lessening the atmospheric pressure at one part of the body only. Bernouilli (seventeenth century) formulated the correct theory that the diver must be supplied with air at the pressure of the water surrounding him. In the older inventions the air escaped from under the helmet, and only the head was dry. The air pressure in the modern diving dress (invented by Siebe), regulated by a valve in the helmet, keeps the water from entering at the wrist cuff, and the whole body is kept dry and warm and equally compressed. I demonstrate the modern diving dress which Messrs. Siebe, Gorman and Co. have lent me for this lecture. The pressure produced by the pump must keep up to that of the water as the diver descends, so long as he does not fall down. He can descend rapidly, *e.g.* 100 feet in two minutes; but it is dangerous to fall down, for if the pump does not keep up with the water pressure a cupping effect is produced, and the diver may suffer hæmorrhage from the lungs and mouth and nose.

By means of the escape valve the diver can adjust his specific gravity so that he is only slightly heavier than water, and can move easily along the bottom. He fills his dress more or less with air, just as the fish fills its swim bladder. If the dress becomes over-filled the diver is "blown up" to the surface; and in the old style of dress he may become helpless, arms and legs blown out stiff, unable to open his valve. You see how this happens in the case of the model diver. To prevent this accident the legs of the latest fashionable dress are laced up, as I now show you.

The Diving Bell and Caisson.

Anyone who pushed an inverted glass under water and saw it did not fill would conceive the idea of a diving bell. Sinclair (1665) fashioned a simple wooden bell to recover treasure from an Armada ship off Mull. At 33½ feet the air in such a bell is compressed to half its volume, and this, together with lack of ventilation, rendered such a bell of little use.

Halley, the astronomer, used a pipe and bellows for shallow work, while for deep work, when his bellows failed, he sank a cask full of air to a deeper level than the bell. From the cask to the bell passed a tube, and the water, entering the cask through a hole, displaced the air into the bell (model demonstrated). He descended to nine to ten fathoms with four others, and used up seven to eight barrels of air.

With the building of efficient air-pumps, Smeaton (1778) applied the bell to the important use of building the piles of bridges. Triger (1839) applied it to the sinking of coal shafts through quicksands, and the bell became thus evolved into the modern caisson—a steel chamber provided with a cutting edge below and an air-lock above for allowing the men to enter and leave without raising the bell. Finally, the caisson was applied to the purpose of horizontally tunnelling under rivers. To effect this a steel shield provided with cutting edge is driven forward by hydraulic jacks. Screens are placed in the shield to allow excavation of the soil in front of it. As fast as the shield is driven forward, segments of the iron tunnel are built into place. Water is kept out of the work by the use of compressed air. On entering, the men are "compressed" in the air-lock, *i.e.* the air pressure is raised to that in the tunnel, and on leaving the tunnel they are "decompressed," *i.e.* the air pressure is lowered in the lock down to the normal, so that the outer door of the lock may be opened.

A diver is "compressed" on descending into the water, as the pressure of his air-pump always keeps up to that of the water. On coming up he is "decompressed."

The Ventilation of the Diving Dress.

Divers in deep-sea water have in the past been unable to stay down long owing to a feeling of oppression, which they have ascribed to the pressure of the water. M. Greenwood and I have exposed ourselves in our compressed-air chamber to +92 lb. (seven atmospheres) and +75 lb. (six atmospheres) respectively, and found our breathing just as free and easy as at atmospheric pressure. Beyond the increasing nasal twang of the voice there are no symptoms produced, and there is no sense by which the pressure can be estimated. John Haldane has done great service in proving that the cause of the oppression is due to increased partial pressure of CO_2 in the helmet owing to deficient ventilation. The breathing is regulated by the pressure of CO_2 in the lungs, so that this is kept at 5 to 6 per cent. of an atmosphere. During work the amount of CO_2 given off is trebled or quadrupled, and during hard work it may be increased sixfold. The ventilation of the lung is increased *pari passu* so as to keep the percentage of CO_2 in the lung normal.

If the pressure of CO_2 in the inspired air is increased, the breathing is deepened so as to keep normal the CO_2 percentage in the lung. If the inspired air contain 3 per cent. CO_2, the volume breathed is about doubled, and moderate work in such air causes as much panting as hard work in pure air.

When the atmospheric pressure is altered it is not the percentage, but the absolute pressure of CO_2 which controls the breathing. Thus the percentage found in Greenwood's lungs was 5·4 at one atmosphere, 2·7 at two atmospheres, 0·9 at six atmospheres, and the partial pressure of CO_2—*i.e.* the percentage multiplied by the pressure in atmospheres—in each case was 5·4 per cent. of an atmosphere. This holds good also down to about two-thirds of an atmosphere in analyses taken at high altitudes. At lower atmospheric pressures than this oxygen want comes in, with the production of lactic acid in the tissues and blood as a disturbing factor. It is clear, then, that the effect of a given percentage of CO_2 in the diver's helmet varies with the depth. If air containing 5 per cent. CO_2 produces great panting at one atmosphere, air containing $5/7·4=0·68$ per cent. will produce the same degree of panting at 35 fathoms (7·4 atmospheres). It follows from this that whatever the pressure a diver is under, he requires the same volume of air measured at that pressure to ensure the ventilation of his helmet. At two atmospheres the ventilation must be doubled, at three atmospheres trebled, at six atmospheres increased sixfold. Under the old conditions of working, often with leaky pumps and tired men to pump, the ventilation has been actually less, not six times greater, as it ought to be, at a depth of 165 feet.

With a pressure of 2 per cent. of CO_2 in the inspired air the pulmonary ventilation is increased about 50 per cent., with 3 per cent. about 100 per cent., with 4 per cent. about 200 per cent., with 5 per cent, about 300 per cent., and with 6 per cent. about 500 per cent. If the diver is working hard the extra production of CO_2 will make him pant, and this, coupled with the effect of the excess in the helmet, which often reaches 3 to 4 per cent., makes breathing distressing and the feeling of oppression intense. Thus at a depth of 139 feet with a CO_2 pressure of 4·28 per cent. of an atmosphere, Lieut. Damant was unable to continue for more than eight minutes the exertion of lifting a weight of 56 lb. about 9 feet per minute. The Admiralty Committee found that the divers could continue work for long periods at depths of even 210 feet so long as the CO_2 pressure was kept below 3 per cent. of an atmosphere.

To keep the CO_2 down to this level a diver ought to have at least 1·5 cubic feet of air per minute when working, and he must have this volume of air pass through the helmet at whatever pressure he be at. Each cylinder of the regulation service pump ought to yield one-tenth cubic feet per revolution. Assuming an unavoidable leakage of the pumps of 10 per cent. at 100 feet and 24 per cent. at 200 feet, the Admiralty Committee ordered for 33 feet (depth) one cylinder, thirty revolutions per minute, and two men per spell, the work being estimated at 4440 foot-lb. per minute; while for 165 feet depth four cylinders, twenty-seven revolutions, and twelve men are required, the work being 34,000 foot-lb. per minute; for 198 feet (depth) six cylinders, twenty-three revolutions, eighteen men, the work being 43,000 foot-lb. per minute. Provision ought to be made to give a third more than this supply if the diver gets into difficulties.

At 210 feet thirty-six men were working very hard in alternate five-minute spells of rest and work, and were scarcely able to keep up the proper air supply. Long handles were supplied to allow three men on each side of the pump.

To avoid this excessive labour, R. H. Davis (of Siebe, Gorman and Co.) and I have added to the diving dress this metal box, containing trays of caustic soda. A mouthpiece is placed within the helmet, and a tube leads from this through the soda-box and back to the helmet. The diver when oppressed in the slightest degree can take hold of the mouthpiece with his lips and breathe through the caustic soda, and so lessen the concentration of CO_2. There is no risk of his suffering from want of oxygen so long as the pumps give him a moderate supply of air. This device ought to save a great deal of hard pumping work.

The Self-contained Diving Dress.

We have also contrived a self-contained diving dress fitted with cylinders containing compressed air enriched with oxygen (to 50 per cent.), and a caustic-soda chamber. The oxygen supply is delivered to the helmet by a reducing valve in constant supply (5 litres per minute), and the force of the oxygen stream is used, by means of an injector, to suck the air in the helmet through the caustic-soda chamber. No life-line or air-pipe is carried, only a light telephone cable, and this makes the dress suitable for exploration of flooded mines, tunnels, ships, &c., through which the heavy pipes and lines cannot be dragged. Air containing 50 per cent. oxygen is used in place of oxygen (Haldane), so that there is no risk of oxygen poisoning if used for an hour at depths of 70 to 80 feet, or even 100 feet, for half an hour.

Compressed-air Illness.

In all the great compressed-air works from first to last the men have suffered from illness and loss of life. There is no risk going into or staying in the caisson, as Pol and Watelle (1854) said, "On ne paie qu'en sortant." Out of sixty-four workers observed by them forty-seven remained well, fourteen had slight illnesses, sixteen more or less severe, two died. An absolute pressure of $4\frac{1}{4}$ atmospheres was reached. The men worked two shifts per diem of four hours each, and were decompressed in thirty minutes. At the St. Louis Bridge works, out of 352 workers there were 119 cases, fifty-six of paralysis, and fourteen deaths. The absolute pressure reached $4\frac{1}{3}$ atmospheres.

At the Nussdorf works 320 cases among 675 workers, and two deaths; the absolute pressure reached was $3\frac{1}{2}$ atmospheres.

In the East River tunnels (New York), under well-regulated conditions, the percentage of illness was 0·66, of death 0·0035 in 557,000 man-shifts, with a decompression rate of fifteen minutes from an absolute pressure of three atmospheres. Of the 320 cases at Nussdorf, v. Schrötter observed sixty-eight cases of ear trouble, 105 of pain in the muscles, sixty of pains in the joints, ten of girdle pains, seventeen of partial paralysis, twenty-six of paralysis of the lower half of the body, fourteen of vertigo and noises in the ear, two of sudden deafness, one of loss of speech, thirteen of asphyxial phenomena. Out of 3692 cases at the East River tunnels observed by Keays, 88·78 per cent. were pains in joints and muscles, "bends," 1·26 per cent. pains and prostration, 2·16 per cent. nervous symptoms, 5·33 per cent. vertigo, 1·62 per cent. dyspnœa and oppression, chokes, 0·46 per cent. loss of consciousness and collapse. There were twenty deaths. The trouble in the ear, which occurs during compression, is due to the inequality of air pressure on either side of the drum of the ear. It is relieved at once by opening the Eustachian tubes by swallowing, or by a forced expiration with the nose and mouth held shut. None of the other manifold symptoms come on while the men are under pressure. Mules were kept for a year in the Hudson Tunnel at three atmospheres absolute, and were healthy enough to kick and bite at all comers (E. W. Moir). The illness comes in after decompression, usually within a few minutes to half an hour, sometimes even later.

The Cause of the Illness.

The cause of the illness—so striking in its protean nature—was made clear by Paul Bert (1879), who showed by experiments on animals (1) that nitrogen gas is dissolved by the blood and tissue fluids in proportion to the pressure of the air (Dalton's law); (2) that the dissolved gas bubbles off and effervesces in the blood when an animal or man is decompressed too rapidly; the bubbles, by blocking up the capillaries and cutting off the blood supply here or there, produce the symptoms; (3) that during exposure to eight or nine atmospheres there is no ill-effect until the partial pressure of oxygen dissolved in the blood reaches such a point that it acts as a tissue poison; (4) that the illness which occurs on decompression is prevented by making the period of decompression sufficiently slow, by allowing time for the dissolved nitrogen to escape from the lungs. Looking through the works of Robert Boyle, I found that, after the invention of his air-pump, he "had a mind to observe whether when the air from time to time was drawn away, there would not appear some hidden swelling, greater or less, of the body of the animal by the spring and expansion of some air (or aërial matter) included in the thorax or the abdomen." He recorded that a viper's body and neck grew prodigiously tumid; that a bubble of air appeared in the aqueous humour of a viper's eye; that the heart of an eel grew very tumid and sent forth little bubbles; that blood boiled "over the pot" until the blood occupied only one-quarter of the volume of the whole, so great was the expansion of the bubbles given off from it. In the following surmise, concerning the death of animals submitted to rarefaction, Boyle forestalls Bert. "Another suspicion we should have entertained concerning the death of animals, namely, that upon the sudden removal of the wonted pressure of the ambient air, the warm blood of those animals was brought to an effervescence or ebullition, or at least so vehemently expanded as to disturb the circulation of the blood, and so disorder the whole economy of the body."

Hoppe-Seyler (1857) demonstrated bubbles in the blood-vessels of animals submitted to rarefaction. This was denied by Bert, but confirmed in the case of a rabbit by Greenwood and myself.

Out of thirty autopsies done on fatal cases of caisson illness, in nineteen gas-bubbles were visible in the blood-vessels; of the other cases most were old-standing lesions of the spinal cord.

The paralysis so often produced is due to a local death and degeneration of the spinal cord, produced by bubbles blocking the circulation there (v. Schrötter, Heller, and Mager).

Proofs that nitrogen gas dissolved in the body fluids and fat is the cause of the illness are the following. The blood collected from the artery of an animal while under pressure, and analysed with the gas-pump, shows that the amount of dissolved nitrogen varies with the pressure. Roughly, 1 per cent. per atmosphere is dissolved (Bert, Hill, and Macleod).

Exposed to one atmosphere at body temperature, blood dissolves just about 1 per cent. N, to two atmospheres 2 per cent., to three atmospheres 3 per cent., and so on. The tissue fluids take up the dissolved gas from the blood, and with time the whole body becomes saturated, according to Dalton's law. The saturation of the body fluids takes time, since the blood forms but 5 per cent. of the whole body weight, and it is the blood alone that comes in direct contact in the lungs with the increased atmospheric pressure. Probably about 5 kilograms of blood circulate through the lungs per minute, and this blood conveys the absorbed nitrogen to the 60 kilograms of tissues. The arterial blood saturated in the lungs yields the nitrogen to the tissues, and returns to be saturated again in the lungs. Those tissues which are plentifully supplied with blood will become saturated rapidly, while less vascular areas, and parts in a state of vasco-constriction, will saturate very slowly.

C. Ham and I exposed rats to ten to twenty atmospheres, killed them by instant decompression, and then, opening their bodies under water, collected and analysed the gas set free therein. We obtained in this gas CO_2 6·7 to 16 per cent., O_2 2·1 to 8·7 per cent., N 80 to 87 per cent., and a volume of N greater than that calculated according to solubility of N in tissue fluid. Some of the excess we found was due to air swallowed while under pressure, the rest to solution of N in fat.

M. Greenwood and I have tested upon ourselves the rate of saturation, using the urine as a test fluid. We were compressed in a large boiler, placed at our disposal by Messrs. Siebe, Gorman and Co. The chamber was fitted with electric light and telephone, and taps for slow decompression. The pressure was raised by means of a diving-pump driven by a gas engine. We drank a quart of water before entering, and collected samples of urine at varying pressures and times. The urine, collected in sealed bulbs, was evacuated by the blood gas-pump. We found the urine secreted in the next ten minutes after reaching any given pressure is saturated with N at that pressure.

To demonstrate the bubbling off of nitrogen on rapid decompression, I have spread the web of a frog's foot or wing of a bat over the glass window of a pressure chamber. The circulation of the blood is projected on a screen with aid of microscope and arc light. We can thus observe the circulation under twenty atmospheres of air, and watch the bubbles forming in the capillaries on rapid decompression. Recompression diminishes the size, and finally drives the bubbles again into solution.

When the larger mammals are exposed to high pressure, such as eight atmospheres, for an hour or so, and are then rapidly decompressed, they usually die in a few minutes. Small mammals, such as mice and rats, may escape, owing to the small bulk of body and rapid respiration and circulation. The young of rabbits, cats, &c., also escape more frequently than old animals. This is due rather to their smaller weight and more rapid circulation than to the youth of the body tissues. Paralysis in the limbs follows too rapid decompression, or the animals fall over and become unconscious. Noise of gas bubbles gurgling in the heart may be heard. Respiration becomes embarrassed, and the animals die. On dissection, the peritoneal cavity may be found distended with gas, or the stomach, and gas may be seen in the intestine. A part of this gas arises from the fermentative processes of digestion, and from air swallowed during compression. The veins of the portal system, the venæ cavæ, are seen to contain chains of bubbles; the heart is full of froth. Small hæmorrhages may be present in the lungs. The edges of the lobes of the lung are emphysematous, blown out by the rapid decompression. The fat often is full of small bubbles, so too are the connective tissues. Bubbles are seen in the joints, and may appear in the aqueous humour of the eye. On opening the skull, bubbles are seen in the veins of the brain. The bubbles are not restricted to the veins, but may also be seen in the arteries. The coronary vessels of the heart often show chains of bubbles. On microscopic examination the bubbles are seen in the capillaries; here and there they run together and form larger bubbles, sometimes rupturing the walls of the vessel and compressing the surrounding tissues. In the larger animals, decompressed from 100 lb. in four to seven seconds, we have found the cells of the liver, kidney, &c., vacuolated or even burst by bubbles. The gas set free in the heart can be collected and analysed; about 80 per cent. of it is found to be nitrogen (Bert, v. Schrötter, Hill and Macleod). Catsaras lowered dogs in a diving dress to depths of 43·7 m., and after about an hour rapidly drew them to the surface. He found bubbles set free in these dogs just as in those exposed in a pressure chamber.

In animals which escape without any severe symptoms, some gas bubbles may be found in the veins even six hours later. This shows how long it may take for nitrogen gas once set free as bubbles to escape from the lungs, and explains why caisson workers may suddenly be seized some half-hour or more after leaving the works. In such cases the bubbles may be swept from the abdominal veins—where they do no harm—into the heart, and impede the action of this organ, or they may penetrate the pulmonary circulation and enter the arterial system, and block up, perchance, the coronary arteries, or others in the brain or spinal cord.

The blood is a colloidal solution, and it takes time for the nitrogen to come out of solution and for the small bubbles to run together to form visible bubbles. The gas bubbles tend to collect in the veins, as the blood travels quickly through the arteries and slowly in the veins. It is only when the gas in the veins becomes sufficient in amount to produce foam in the heart, or when gas bubbles block up arteries of vital import, that grave symptoms arise. The place where bubbles in the arteries must always produce serious results is the central nervous system. In the liver, kidneys, muscles, fat, &c., bubbles may embolise small arteries and produce no grave effect, but in the spinal cord the interruption of the blood supply to any group of cells or tract of fibres is evidenced at once by pain and anæsthesia, spasm, and paralysis. In the medulla oblongata arrest of the circulation will stop respiration, and bubbles lodging there may produce immediate death. Lodging in the arteries of the great brain, bubbles may produce hemiplegia, aphasia, blindness, or mental disturbance.

Among men some are affected and others not. We can look for an explanation in the varying state of the blood, in fatness, in the varying vigour of the circulation and respiration and the effect of fatigue, in vaso-motor changes which alter the relative volume of circulating blood in viscera and muscles, and in the fermentative processes going on in the alimentary tract. The young man who is in perfect health, with powerful heart and deep respiration, can expel the dissolved nitrogen from his lungs far more rapidly than the old, the fat, the intemperate, or one who is over-fatigued by excessive labour. The records of caisson works seem to show that most men under twenty escape, while the percentage of cases increases with age, and is highest for men above forty; that long shifts increase the number of cases; that men who work the air-locks, passing material through, and undergoing frequent and short-lasting compression and decompression, are not affected. The longer the shift the more complete the saturation of the body; the higher the pressure the greater the risks and the graver the symptoms. The records show that practically no cases occur with a pressure below 2 to $2\frac{1}{2}$ atmospheres absolute, even though the decompression period be made only a minute or two.

At the Rotherhithe Tunnel the decompression period was three minutes, and the maximal pressure +22 lb. No cases of any gravity occurred. Nevertheless, we proved that the workers had excess of nitrogen in their bodies after decompression. We gave them a quart of beer to drink in the tunnel thirty minutes before decompression to provoke diuresis, and made them empty their bladders just before, and again ten minutes after, decompression. Their urine yielded more than the normal volume of N. The urine, passed immediately after their decompression, obviously effervesced.

Influence of Fatness.

As the fat holds five or six times as much nitrogen in solution as the blood, it saturates and desaturates slowly.

J. F. Twort and I have found 35·55 per cent. of nitrogen dissolved in olive oil which had been exposed to $7\frac{1}{3}$ atmospheres. The risk of exposure to compressed air varies with the fatness of the animal (Boycott and Damant). Greenwood and I have found fat pigs weighing 100 to 120 lb. are more susceptible than smaller pigs 50 to 60 lb. The bubbles once set free in the subcutaneous fat of pigs may stay there for days after decompression, as we have found to our cost, for it has seriously damaged the sale of the animals to the butcher, since the fat does not bleed white, but remains pink and mottled. All the results prove that fat men should be excluded from compressed-air work at pressures above two atmospheres absolute.

The varying percentage of fat in the blood, chyle, and liver must be an important factor in the evolution of bubbles in the blood. The less fat in the food eaten by caisson workers the better.

Ventilation and Illness.

Much has been made of the impurity of the air as a contributory cause of caisson sickness, in particular, of the percentage of CO_2. The ventilation of the tunnels built by the London County Council under the Thames have been carried out at enormous and needless expense in order to keep the CO_2 percentage down to a very low level. The work of the English physiologists is against this view. Divers generally work with 1, 2, or even 3 per cent. of an atmosphere CO_2 in their helmets. We have exposed ourselves to 3 to 4 per cent. of an atmosphere CO_2 without untoward results, beyond increased frequency of respiration, which prevents any increased concentration of CO_2 in the body.

Recently I have carried out many experiments on students sealed up in a small air-tight chamber, and found, as Haldane has, that it is the heat, moisture, and stillness of the air which cause discomfort and fatigue, and not the excess of CO_2 or deficiency of oxygen in the air breathed. The putting on of powerful electric fans, by whirling the air and cooling the body, gives very great relief, even when there is 4 to 5 per cent. of CO_2 in the chamber.

In open-air treatment the coolness and movement of the air are the essential qualities which promote health by stimulating the activity, the metabolism, and nervous well-being of the body.

Hot, moist, still air causes fatigue by taxing the cooling mechanism of the body; blood is sent to the skin to be cooled which ought to be going to muscle and brain. Fatigue increases the danger of decompression by making the circulation and respiration less efficient. The heat causes more blood to come to the skin and a more complete saturation with nitrogen there. The cold in the decompression chamber—due to expansion of the air—causes vaso-constriction and repels the blood from the skin, and so stops its desaturation. We have lost pigs by taking them from the warm caisson into the cold air.

Over-hot and moist—that is, under-ventilated—caissons have, therefore, a higher morbidity. To secure efficient work, the wet-bulb temperature must be kept below 75° F. (Haldane). The men should not pass from a warm caisson to a cold air-lock and a cold outside world. They should go through a warm lock to a warm room.

Hot, moist atmospheres are very disadvantageous to health and work. If the wet-bulb temperature is high in the caisson, the current of air should be increased or electric fans used to cool the workers. Electric fans have enormously increased the efficiency and health of Europeans in the tropics. An excess of CO_2 in the air-lock, or diver's helmet, during decompression is favourable, as it increases the pulmonary ventilation and the outbreathing of nitrogen. Haldane advises the air-pump to be slackened purposely. There is no harm in breathing 1 or even 2 per cent. of CO_2.

Methods of Decompression.

The safety of compressed-air workers depends on the relation of the period of decompression to that of compression.

The period of the saturation or desaturation of the body with nitrogen depends on the relation between the circulating volume of the blood and the volume (1) of the tissue fluid (2) of the body fat which dissolves the nitrogen—remember the fat dissolves five or six times as much as the tissue fluid. The more often the whole volume of the blood circulates round the body, the quicker will be the saturation or desaturation. The smaller the body, the more often does the volume of blood course round it. A mouse's heart beats six hundred or seven hundred times a minute against a man's seventy (F. Buchanan). The circulation and rate of respiratory exchange are twenty times faster in the mouse. In the case of a man, the smaller man, the leaner and harder the man (less fat and tissue fluid), the quicker will his body saturate and desaturate. The rate of the circulation and percentage of fat vary in different organs. There are parts quickly and parts slowly saturated or desaturated. The joints, tendons, subcutaneous fat, abdominal fat depôts, are relatively slow parts. The white matter of the brain and spinal cord has much fat in it, while the grey matter has little fat and a more active circulation. In the white matter of the spinal cord bubbles commonly form and lead to a stoppage of the circulation there, death of the tissue, and paralysis. Bubbles in the subcutaneous fat, or fat depôts of the belly, may be compared to stones scattered in the fields, and bubbles in the spinal cord to rocks thrown down on the main railway lines of London.

Muscular work increases the circulation and pulmonary ventilation five or six, even ten, times if the work is very hard. In warm, moist caissons the cutaneous vessels are dilated, and the circulation accelerated, and this makes the saturation of the peripheral parts quicker than in the case of the diver, who is surrounded with cool water. The diver also does not work so hard and so long as the caisson worker. Therefore the caisson worker suffers far more from "bends." The diver goes to much greater pressures for short times, and after a quick decompression may suffer from asphyxia, symptoms of paralysis—arising from bubbles in the heart and pulmonary vessels, or in the spinal cord. The caisson worker when decompressed stands quiet, and is subjected to the cooling effect of the expanding air, and this constricts his cutaneous vessels and prevents desaturation of the peripheral parts. The caisson worker ought to be decompressed in an air-lock which is comfortably warmed, and he ought to exercise himself hard in order to keep up the circulation and pulmonary ventilation, and so hasten desaturation.

Haldane thinks that the body of man is about half-saturated in one hour, and about saturated in four hours. Bornstein says six or seven hours are required for saturation of the fat. Greenwood and I found that the urine secreted by the kidney is about saturated after ten minutes' exposure to four atmospheres. About twenty minutes were occupied in reaching this pressure. On decompression of a saturated animal the viscosity of the colloidal blood prevents the formation of bubbles under a certain difference of gas pressure. It is found by experience that it is safe to decompress men in a minute or two from two atmospheres to one. Since the volume of a gas is halved at two atmospheres, made one-fourth at four atmospheres, one-eighth at eight atmospheres, and the volume of a bubble is doubled on lowering the pressure from eight to four, six to three, four to two, or two to one, Haldane concluded it was safe to come rapidly from four to two, six to three, or eight to four atmospheres. The supersaturated tissues then give nitrogen to the blood, and the blood to the lungs, and the nitrogen escapes without bubbling at the half-pressure stage, where a long pause is given. Successive stages may be given when required to secure the desaturation of the body, each stage by producing a safe degree of supersaturation accelerating the outgiving of the dissolved nitrogen. The stage method of decompression initiated by Haldane, and adopted by the Admiralty, has an advantage over the uniform in that it prevents the further, and perhaps dangerous, saturation of the slow parts. Supposing a diver had been for half an hour at six atmospheres pressure; if he were decompressed on the old plan, slowly and uniformly, his fat would become further saturated up to five atmospheres while he was being decompressed from six to five atmospheres. On the other hand, if he is decompressed rapidly from six to three, the further saturation of the fat at pressures above three atmospheres is altogether prevented. The stage method is of value to divers, who go down for short periods and do not work very hard, as it prevents the saturation of slow parts and hastens the period of decompression.

Caisson workers who do four to eight hours' shift are practically saturated; but they, too, are best decompressed by the stage method, because it accelerates the outgiving of the nitrogen by producing a safe degree of supersaturation of the blood. The safety is greatly enhanced if hard muscular work is done during the pauses. This can be effected by having a series of air-locks, and making the men walk, or better, climb, between each. In the East River tunnels this method was tried with good results—(1) +40 to +29 lb. in five minutes; (2) ten minutes walking in +29 lb.; (3) +29 to $+12\frac{1}{2}$ lb. in eight minutes; (4) ten minutes walking in $+12\frac{1}{2}$ lb.; (5) $+12\frac{1}{2}$ to +0 in fifteen minutes. Lengths of tunnel were arranged between locks for walking in. Total time, forty-eight minutes. The Admiralty table enforces ninety-seven minutes for this pressure.

As there were 1·60 per cent. cases of "bends" and no serious ones, the Admiralty time is demonstrated to be unnecessarily long. This is particularly so if *hard work* is done during decompression, for the same amount of nitrogen would be expelled in about one-fifth of the time as during rest.

Greenwood and I have tested the stage method on pigs, which are more like men in shape, diet, and habit than goats—the animals used in the investigations conducted for the Admiralty Committee. It appears from our results fairly safe to decompress even fat pigs from six atmospheres to $2\frac{1}{3}$ atmospheres in about ten minutes, and then after a pause of $1\frac{1}{2}$ hours from $2\frac{1}{3}$ to one atmosphere in twenty minutes. The pigs slept quietly in the warm caisson and never moved, and, being fat, were very unfavourable subjects. One death and no severe case of illness occurred among forty-seven pigs weighing 50 to 100 lb.: one severe and three slight cases among nineteen goats weighing 30 to 57 lb. A similar decompression of fat pigs from seven atmospheres, allowing 105 to 120 minutes interval at $2\frac{1}{3}$ atmospheres, gave unfavourable results, seven deaths and one severe case—among twenty-seven pigs weighing 81 to 115 lb. Only one pig out of all showed any symptoms after reaching the stage at $2\frac{1}{3}$ atmospheres. At these very high pressures there is great risk unless time enough is given, and plenty of exercise taken during the pause.

For pressures up to four atmospheres the method employed by Mr. Yapp at the East River Tunnel is evidently a very good one. For pressure two to three atmospheres it is an advantage to do work immediately after decompression, supposing work cannot be provided between two air-locks (Bornstein). At the Greenwich Tunnel, now being built, the men climb the shaft, 60 feet high, after decompression, and since I made the suggestion, and the engineer, Mr. E. H. Tabor, carried it out, the number of cases of "bends" has dropped from 1 in 94 to 1 in 240 man-shifts. For higher pressures it would not be safe to take exercise after; it ought to be taken during decompression and the pauses between the stage decompressions. The importance of this cannot be insisted on too much. Exercise during decompression is the simplest means of rendering compressed-air work safe and of keeping the period of decompression of a reasonable length.

The question of the length of shift desirable has been much discussed. Long shifts of eight hours are found to give more illness than shifts of, say, one to two hours. Every practical caisson engineer agrees to that. Divers are decompressed in a few minutes from high pressures (five to six atmospheres) with comparative immunity if they have been down for only a few minutes. Cases of illness occur when they exceed their stay, or after a succession of dives, each of which helps to saturate slow parts and increases the fatigue of the diver. The Admiralty table fixes the period spent at the bottom so as to prevent saturation of "slow" parts and shorten the period of decompression. The descent is hastened for the same reason. It is quite safe to descend to 200 feet in two minutes; slow descents only increase risk by increasing the saturation of the body. In the matter of the caisson workers at the East River Tunnel, two three-hour shifts per diem, with three hours' rest between, gave 1·07 per cent. cases, and one eight-hour shift 0·62 per cent. cases. The men are so far saturated in three hours of hard work that doubling the decompressions is worse than extending the shift to eight hours. As bubbles may persist for a long time in the tissues, and may act as starting points for the formation of other bubbles, it is wise to give long intervals of time between shifts; also in a short interval slow parts may not become desaturated. Haldane has suggested the men should return to a "purgatory" chamber, say at two atmospheres, and eat their dinner and rest there in the mid-period of an eight-hour shift, and again at the end of the shift, when, while waiting for decompression to one atmosphere, they could wash, change their clothes, and have some hot coffee to stimulate the circulation. In any large tunnel works such a chamber could be easily constructed out of a section of the tunnel. This would suffice for stage decompression, and would give excellent results if the men could be persuaded to take exercise in it, or be given oxygen to breathe before decompression to one atmosphere.

The quickest method of desaturating the body is to "wash" the nitrogen out by breathing oxygen for a few minutes before and during decompression. The only question is the safety of this proceeding, for high concentrations of oxygen act as a poison.

Oxygen Poisoning.

(1) I have found that all kinds of animals, worms, snails, flies, spiders, frogs, &c., are instantly convulsed and killed by exposure to fifty atmospheres oxygen. (2) The frog's heart beats, nerve conducts and muscle contracts for some time in fifty atmospheres oxygen, but there is evidence of progressive diminution in functional power; the muscles behave like a fatigued muscle. (3) Mice exposed to ten atmospheres oxygen are thrown into tetanic spasm, and on being decompressed continue to be convulsed by a touch. Bubbles of oxygen are to be then found in the central

nervous system compressing the nerve cells. As the bubbles are oxygen, the cells do not die, and the animals may recover, the oxygen being absorbed by the tissues and the circulation re-established. (4) +3 atmospheres oxygen convulsed animals in thirty to sixty minutes (Bert and Lorrain Smith), and the poisonous effect, depending as it does on the partial pressure of oxygen in the blood, comes on just as soon in larger animals as in small, *e.g.* cats, rats, and mice. (5) Fatal inflammation of the lung is produced by exposure to high partial pressures of oxygen, *e.g.* after twenty-five hours' continuous exposure to +7 atmospheres of air = 170 per cent. atmospheric oxygen (Lorrain Smith). This can be prevented by using nitrogen to dilute the air, and so lowering the partial pressure of oxygen. (6) It is quite safe to breathe one atmosphere oxygen, or five atmospheres air, for three to four hours. The men who wear the Fleuss apparatus for rescue work in mines have breathed it day after day for this period. I have spent much time with Mr. R. H. Davis in perfecting this apparatus on physiological lines, and so have studied particularly the effect of oxygen on man. In very hard work there may be a deficiency of the oxygen supply in the body, and then breathing oxygen helps the working power of the man.

If the body is getting enough oxygen the breathing of it has no effect on the metabolism. The man at rest cannot be fanned into a greater rate of activity by breathing oxygen. Poisonous pressures of oxygen lower the metabolism and diminish the carbonic acid output of animals. Martin Flack and I showed that the breathing of oxygen just before a race may help an athlete, because during his great effort he uses up oxygen quicker than his respiration and circulation can provide it. A shortage of oxygen leads to the production of acid products in the tissues and blood, which causes breathlessness and stiffness of the muscles.

Lactic acid appears in the urine after a short period of hard running (Ruffel). Feldman and I have found that breathing oxygen by means of the Fleuss dress during the run prevents the excretion or lessens the amount of lactic acid excreted. Thus the pressure of oxygen helps the caisson worker to do his work more easily. During decompression the pressure of oxygen is lowered, and this is of no advantage to him.

Bornstein at the Elbe Tunnel works has breathed oxygen (90 to 95 per cent.) for forty-eight minutes at a pressure of three atmospheres. Two other engineers breathed it for thirty minutes. Bornstein freed himself from "bends" by this means. These periods are the outside limits of safety. Bornstein began to have slight convulsive movements.

For every atmosphere the body dissolves nitrogen to about 1 per cent. of its mass—for a 60 kgm. man, say, 600 to 1000 c.c. per atmosphere. Von Schrötter calculates that oxygen plus exercise would turn out 1000 c.c. in five minutes, probably more.

Oxygen can be breathed economically by means of the Fleuss apparatus, which was used so effectively in the last great colliery disaster at Bolton. The apparatus can be put on and oxygen breathed for ten minutes before and during decompression. The breathing-bag must be washed out several times with a current of oxygen, from the emergency valve provided, to accelerate the output of nitrogen.

J. F. Twort and I have investigated the effect of breathing oxygen on the volume of nitrogen dissolved in the urine. Precautions were taken to collect the urine without contact with the atmosphere. About three pints of water were drunk thirty minutes before collection of urine, so that samples could be obtained every seven minutes or so. The samples were pumped out by means of the Gardner and Buckmaster gas-pump, in which there are no taps, and leakage of air is practically nil.

I cite the results of two experiments.

(1) Breathed air at three atmospheres. After fifteen minutes emptied bladder. Sample I. collected seven minutes later at three atmospheres. Decompressed to $1\frac{2}{3}$ atmospheres in three minutes. Sample II. collected six minutes later at $1\frac{2}{3}$ atmospheres. Decompressed to one atmosphere in three minutes. Sample III. collected three minutes later at one atmosphere.

	Nitrogen	Oxygen	Pressure atm.	Nitrogen calculated (0·85 per atm.)
Sample I. ..	3·054	0·152	3	2·55
,, II. ...	2·859	0·144	$1\frac{2}{3}$	1·416
,, III. .	1·609	0·081	1	0·85

(2) At three atmospheres for forty-four minutes. Emptied bladder and breathed oxygen for nine minutes, then took Sample I. Decompressed to $1\frac{2}{3}$ atmospheres in two minutes. Took Sample II. four minutes later. Decompressed to one atmosphere in $1\frac{1}{2}$ minutes. Took Sample III. five minutes later.

	Nitrogen	Oxygen	Pressure atm.	Nitrogen calculated
Sample I. ...	2·091	0·297	3	2·55
,, II. ...	0·8835	0·1985	$1\frac{2}{3}$	1·416
,, III. ...	0·5751	0·0941	1	0·85

The results show that the urine is supersaturated with nitrogen after decompression in the first case, and undersaturated after breathing oxygen in the second case.

The ideal method, then, for safe decompression from high pressure is (1) oxygen breathing for five minutes and rapid decompression to two atmospheres; (2) pause during which oxygen is breathed and exercise taken; (3) rapid decompression to one atmosphere while oxygen breathing and exercise are continued.

The period of decompression can be notably shortened by such means, how far further experiment will show. We want to know, in particular, how the fat of the spinal cord is desaturated under these conditions. The "quick" parts are evidently put right in a few minutes. Further experiments on fat pigs should give the required information.

Recompression.

Recompression is the one method of cure for the illness. Pol and Watelle (1854) recorded the benefit of this. Men with "bends" went back under pressure. A. Smith suggested the use of a recompression chamber at Brooklyn. E. W. Moir instituted it at the Hudson Tunnel. All caisson works are now provided with such. Men at the East River Tunnel works have truly been raised from the dead by its means.

In the frog's web experiment I have observed the bubbles shrink up on recompression. Experiments on animals show that recompression must be applied at once in dangerous cases, before vital parts are killed by the interference with the circulation. "Bends" may be relieved by compression long after they have come on.

Recompression relieved 90 per cent. of the cases at the East River Tunnel, and all but 0·5 per cent. were partly relieved by its means. Oxygen breathing can be employed with advantage in the medical lock. Decompression from the lock must be slow, for some of the bubbles, having run together to form larger ones, only shrink up on recompression, and do not quickly go into solution. These expand again on decompression. J. F. Twort and I have observed this happening, and measured the bubbles under the microscope.

For deep-diving work a recompression chamber should always be at hand. I have contrived a double-chambered diving bell, one chamber open to the sea, the other closed, save for a manhole communicating with the first. The divers after completing their work enter the inner chamber and close the manhole. The bell is raised on deck, and the men decompressed by the stage method. Such a contrivance prevents exposure to cold during, or risk of storm preventing, gradual decompression in the ordinary way by the diver climbing the shotted rope.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BRISTOL.—The annual Congregation for the presentation of degrees was held on Friday, October 20. After the deans had presented the graduands in the various faculties, the following honorary degrees were conferred:—*Doctor of Letters:* Prof. Alfred Marshall; *Doctor of Science:* Mr. Arthur Prince Chattock, Prof. Julius Wertheimer, and Sir William Ramsay. The recipients of the science degree were introduced by Prof. Francis, and described as follows:—

Mr. Chattock.—For twenty-one years professor of physics in University College, Bristol, and late Henry Overton Wills professor of physics in this University. A distinguished authority in those realms of physics which he made his own. A teacher who sacrificed himself to his students, and whose wide sympathies and varied knowledge were always at their disposal.

Prof. Wertheimer.—Officier de l'Académie, B.A. and B.Sc. of the University of London, principal of the Merchant Venturers' Technical College, dean of the faculty of engineering in this University. A man who by his energy and conspicuous talent for organisation has made the Merchant Venturers' Technical College one of the leading institutions in the kingdom, and has played no mean part in the formation of this University.

Sir William Ramsay.—K.C.B., Commander of the Crown of Italy, officier de la légion d'Honneur, Ritter of the order Pour le Mérite, D.Sc. of the Universities of Oxford, Cambridge, Dublin, Columbia, Liverpool, and Sheffield; LL.D. of the Universities of Glasgow and Birmingham; M.D. of the Universities of Heidelberg and Jena; Ph.D. of the Universities of Tübingen, Cracow, and Christiania; Nobel prizeman in chemistry (1904); F.R.S.; professor of chemistry in the University of London; and late professor of chemistry and principal of the University College, Bristol. Famous for all time for his discoveries of fundamental importance in physics and chemistry, and for his marvellous realisation of the transmutation of the elements.

PROF. MICHAEL E. SADLER has been appointed Vice-Chancellor of Leeds University, in succession to the late Sir Nathan Bodington.

IT is announced in *Science* that the class of 1886 has presented to Harvard University 20,000*l.*, the income of which is to be used for the benefit of the college. From Mr. W. J. Riley, of Boston, the University has received 5000*l.* for the establishment of scholarships in memory of his nephew.

THE dissolution of the City Polytechnic in 1907 rendered a new scheme for the management of the Northampton Polytechnic Institute, Clerkenwell, necessary, and this scheme has now been sealed by the Charity Commission. The principal matter of public interest arising out of it is that it gives the governors power to appoint a president of the polytechnic; in accordance with these powers H.R.H. the Duke of Connaught, K.G., has been offered, and has accepted, the new office.

THE first issue has appeared of a new educational periodical, published in Calcutta under the title of *The Collegian*. It is described as "an all India journal of university and technical education," and will appear fortnightly, with the object of keeping its readers in touch with the work of the five Indian universities and of higher education generally throughout India. Among a very varied table of contents we find an illustrated description of the College of Agriculture at Sabour, Bengal, by Mr. D. N. Mitra. The detailed information provided about the Indian universities will prove popular among the students in them.

IN response to the appeal to raise the sum of 15,000*l.* as a building fund for the Galton Laboratory for National Eugenics, the following sums, amounting to a total of 2260*l.*, have been given, promised, or promised conditionally on the buildings being commenced within two years:—Mr. W. E. Darwin, 500*l.*; Prof. Pearson, F.R.S., and Mrs. Pearson, 500*l.*; Prof. Arthur Schuster, F.R.S., 250*l.*; Mr. E. G. Wheler (first contribution), 250*l.*; the Earl of Rosebery, 100*l.*; Lord Iveagh, 100*l.*; Major Leonard Darwin, 100*l.*; Major E. H. Hills, F.R.S., 100*l.*; Institute of Actuaries, 52*l.* 10*s.*; Mr. C. B. Edgar, 50*l.*; Mr. W. H. Macaulay, 50*l.*; Dr. E. H. J. Schuster, 50*l.*; Mr. Alfred Tyson, 50*l.*; Mr. J. Archer, 25*l.*; Mr. H. R. Beeton, 21*l.*; the Master of Trinity, 10*l.* 10*s.*; Lord Avebury, 10*l.*; total, 2219*l.* An amount of 41*l.* 16*s.* has been received in smaller sums.

THE Calcutta correspondent of *The Times* states that the Government of India is understood to be prepared to sanction the scheme of a Mahommedan University provided that the funds actually collected are adequate and that certain changes are made in the draft charter. With regard to finance, the condition laid down is that an annual income of 33,000*l.* must be secured. So far, an income of 21,400*l.* has been obtained. In this sum are included the receipts of Aligarh College, which represent a capitalised value of 446,000*l.* The campaign led by his Highness the Aga Khan has resulted in promises to the amount of 240,000*l.*, which will undoubtedly be realised, though the sum in hand is as yet only 99,000*l.* To the estimated income of 21,400*l.* must be added an annual grant of 6600*l.* which has been promised by the Government of India, leaving an additional income of 5000*l.* to be raised by the Mahommedan community.

THE council of the Zoological Society arranged last year with the Education Committee of the London County Council for a series of demonstration lectures to school teachers. The society arranged the courses, provided the lecture-room and lantern, and allowed the teachers free admission to the Zoological Gardens, while the education authority made a grant towards the expenses. The course, which was repeated three times last session to three separate sets of 150 school teachers, consisted of three lectures, illustrated by lantern-slides, and a demonstration in the gardens. This year the number of demonstrations in the gardens is to be larger, and the Education Committee has increased its grant. The first lecture for the present session took place on October 21, and was attended by nearly 150 teachers, while four parties of twenty-five teachers were taken for a demonstration tour in the gardens by the lecturer, Mr. J. L. Bonhote. To suit the convenience of teachers, all the lectures and demonstrations are given on Saturday mornings. The syllabus has been made very simple, and it is devised to cover only such subjects as are likely to interest school children and to be understood by them.

THE current issue of *The Oxford and Cambridge Review* contains an article signed "Tu ne cede malis" on "The Education of Study." The conditions of life and work at Oxford and Cambridge are criticised very frankly. At Oxford, the writer says, it is urged "that collegiate life, with all its various activities, is the main thing; that such a life moulds character, and that academic study is a secondary affair." The complexion of the universities is reflected, says the writer, in the life of the nation. "An extraordinary obsession has attacked the minds of most classes of Englishmen. It is to the effect that book-learning of any kind—apart from the three *r*'s and the like—is of very little value." The author knows men "who maintain even violently that anything like academic study is ruinous to all practical efficiency." In another place we are told: "The chief mischief is that the great world has ceased to regard professional eminence as a substantial asset, unless it be accompanied and certified by a display only possible to a man of considerable pecuniary means." The writer's conclusion is "that an educational commission of the most extensive scope is absolutely necessary"; though "our educational system stands in need of nothing more than sensible reform, not of root and branch upheaval."

THE arrangements for the Congress of the Universities of the Empire, 1912, are making progress. The Home Universities Committee, consisting of the Vice-Chancellors or other representatives of the universities of the United Kingdom, is engaged in preparing the programme of subjects to be discussed at the congress, and has had before it communications on the matter received from some of the overseas universities. The preliminary Conference of Canadian Universities, held on June 6 in view of the congress, proved a very successful gathering. Seventeen of the nineteen Canadian universities accepted invitations to appoint representatives. Dr. R. D. Roberts, secretary of the congress, was present at the conference on behalf of the London Congress Committee; and we learn from the interesting and suggestive report which he submitted to the committee that the subjects which the Canadian universities regarded as amongst the most important for discussion at the congress are the increase of facilities in the universities of the United Kingdom for post-graduate and research work, and some plan for the interchange of university teachers. It appears that the majority of Canadian post-graduate students go to the American and German universities, and not to the universities of the United Kingdom. Reasons for this are set out in Dr. Roberts's report; and it may be confidently expected that the deliberations of the congress next year will lead to some combined action to remedy this state of things, for it is clearly of supreme importance, both from the university and the imperial points of view, that able students from the King's dominions overseas should be encouraged to pursue their post-graduate studies in the Mother Country.

A copy of the annual report, for the year ended May 31, 1911, of the Rhodesia Scientific Association, has reached us. It contains, among other interesting particulars of the work of the association, the address of the retiring president, Mr. F. P. Mennell, who took education in Rhodesia as his main subject. Dealing with scientific and technical training, the president pointed out that he had exceptional opportunities of coming into contact with the men who desire technical and scientific instruction, and proceeded to propose the following plan. In the first place, he said, a building would have to be hired or erected, which might be known as the Bulawayo Technical Institute. The expenditure of 2000*l*. would probably meet all requirements in the building line, provided, of course, that the convenience of the users was given first consideration and not the fancies of architects. In the next place it would be desirable to engage a man to act as organiser and principal, in addition to teaching one or more subjects. For other teachers it would be necessary to ask the cooperation of the museum, the Geological Survey, the Government mining engineer, and even local professional men. There might thus be secured, without great expense, the services of specialists, who would each conduct a particular course. The feature of the scheme would be the shortness of the courses. Each subject would be limited to a month, every morning and afternoon being devoted during that time to the same subject, until the course was finished. Practical, that is, experimental, work would necessarily be an essential feature of each course. As subjects Mr. Mennell suggested inorganic chemistry, physical geology, agricultural chemistry and geology, determinative mineralogy, theory of ore deposits, principles of sampling and opening up mines, metallurgy of gold. Possibly, in addition, it might be found practicable to teach gold assaying and simple methods of surveying. It need scarcely be said that most of these subjects could not be effectively taught in so short a period as a month. A great deal, however, could be done in that time. In the event of more extended courses being established, the president continued, Rhodesia would only be competing unavailingly with Johannesburg, whereas the people it is desired to attract are those who cannot afford either the time or the money to go there.

SOCIETIES AND ACADEMIES.

LONDON.

Institution of Mining and Metallurgy, October 19—Mr. H. Livingstone Sulman, president, in the chair.—H. Standish **Ball**: The economics of tube milling. The investigation, of which this paper is a report, was undertaken by the author at the McGill University, Montreal, for the purpose of determining the most efficient working conditions of the tube-mill on metal-bearing ores. An experimental tube-mill was constructed, with all necessary accessories, and a series of test runs was made under various conditions of feed, moisture, pebble load, and speed, the system adopted being that in each series of tests one of the above factors was varied whilst the others were maintained as constants. Taking the experimental mill as a standard, the result of the tests was to establish certain conditions for each of the four factors mentioned as those most conducive to efficiency; and the author believes that there is a possibility of estimating from the curves obtained from the different tests the probable results that would be derived from running the mill under different conditions. He deduces from this the rather startling theory that in any mill it would be possible by a similar series of tests to obtain the necessary information for running it to the best advantage. Among other results of his experiments he was able to ascertain the duration of time required by a mill to assume a uniform condition following a change of adjustment of its various component factors, and to test the efficiency of the mill during the transition periods. Having ascertained by tests the several conditions under which the mill worked at its best, a trial was made during which the critical factors were all complied with, and the resultant mechanical efficiency was found to show an increase of 14 per cent. above all previous tests, thus seeming to bear out the utility and value of experimental work in determining the proper conditions of working.—Eugene **Coste**: Fallacies in the theory of the organic origin of petroleum. The author sets out to show that the supporters of the organic theory founded their arguments on erroneous premises, and ignore the obvious facts presented by the petroleum occurrences and deposits, which point to a volcanic origin. In proof of his own theory he directs attention to the abundance of hydrocarbon emanations noted in connection with volcanic phenomena, as showing that the sources of carbon are not confined to the organic kingdom alone. The conclusion at which he arrives is that the constant recurrence of hydrocarbons in volcanic and igneous rocks, in volcanic emanations, in metallic and other veins, in meteorites, in comets and other stellar bodies, clearly demonstrates that petroleums are not organic, as if they were their distribution could not possibly resemble the actual occurrences which are met with. The petroleum deposits are not everywhere associated with rocks of a particular age, but are found in strata of all ages, and only along some of the tectonic disturbances; where there are no such disturbances the strata are barren. These occurrences are therefore, he claims, due to dynamic disturbances accompanied by magmatic emanations from the interior, which must be held to be of solfataric volcanic nature, and unlike anything else known to be to-day in the active process of formation in nature.

PARIS.

Academy of Sciences, October 9.—M. Lippmann in the chair.—L. **Mangin**: *Peridiniopsis asymetrica* and *Peridinium Paulseni*. These two species are currently known under the name of *Diplopsalis lenticula*. By the use of a boiling solution of 5 per cent. potash the nitrogen compounds are removed, and the structure can be more easily made out. The supplemental apical plate has either been missed by previous investigators or else its presence has been considered as an anomaly. This plate, however, is always present, and indicates a separate genus.—A. **Laveran**: Are trypanosomes latent in their vertebrate hosts? An account of some experiments undertaken with a view to verify facts put forward by Salvin, Moore and Breinl, Fantham, and Hindle. The conclusion is drawn that for the trypanosomes studied, especially *T. gambiense*, there is no non-flagellated stage of evolution in the vertebrate organism, and that the elements described under the name of latent bodies correspond to different stages of involution of the trypanosomes.—G. A. **Tikhoff**: The variable star of the Pleiades. Observations for the last sixteen years of the magnitude of this star have been plotted as a curve, magnitudes as ordinates, and the time as abscissæ. The period between a maximum and minimum is shown to be 565 days, the last maximum being on January 10, 1911.—P. **Chofardet**: Observations of the Quénisset comet (1911*f*) made at the Observatory of Besançon with the 33-cm. bent equatorial. Positions are given for September 26 and 29. The comet was estimated as of the eighth magnitude, with a round head 3′ in diameter. There is no well-defined nucleus, and the tail is absent.—Paul **Lévy**: A generalisation of the theorems of Picard, Landau, and Schottky.—A. **Blondel**: The reception of periodic trains of damped waves in radio-telegraphy.—F. **Croze**: The spectrum of the negative pole of oxygen. The group of bands shown in Sturbing's photograph cannot be represented by the ordinary formula or band spectra, and the number is too small to establish a regularity with certainty. The author has discovered a new less refrangible band, and shows that the differences are analogous to the nitrogen bands.—Félix **Robin**: Pitch in alloys and its variation with temperature. In steel tuning-forks chromium raises the pitch, whilst nickel lowers it. For a nickel steel containing 30 per cent. of nickel the pitch increases with rise of temperature up to 90° C. Four alloys are suggested as suitable for standard tuning-forks, the composition being such that the pitch is practically independent of the temperature.—Mlle. E. **Feytis**: The magnetic *rôle* of water in the constitution of some solid hydrates. The additive law cannot be considered as applicable with certainty when dealing with salt molecules containing strongly electropositive metals.—G. **Charpy** and S. **Bonnerot**: The cementation of iron by solid carbon. From their experiments, published in January, 1910, the authors concluded that solid carbon could not cause cementation in iron in a vacuum; since then, new experiments by M. Weyl have led to the opposite conclusion. The results of fresh experiments are now given, and it is concluded that the cementation of solid iron by carbon at about 950° C. is absolutely *nil* in the absence of gases capable of reacting on the carbon and metal.—Robert **Pers**: An equilibrium between chloropentaminecobaltic chloride and aquopentaminecobaltic chloride in aqueous solution.—Paul **Bary** and L. **Weydert**: The apparently reversible character of the vulcanisation reaction between indiarubber and sulphur. Reasons are put forward for the view that the vulcanisation of indiarubber by sulphur is accompanied by a process of depolymerisation.—Etienne **Boismenu**: The hypobromous amides. The reaction between hypobromous acid and amides has been found to take place according to the equation

$$R-CO-NH_2+BrOH=R-CO-NH-Br+H_2O$$

in the cases of the amides of propionic, benzoic, and formic acids. The bromo-acetanilide could not be isolated owing to its instability.—A. **Behal** and A. **Detœuf**: A new derivative of urea, monochlorurea. If chlorine is passed over urea at the ordinary temperature in the proportion of one atom of chlorine to one molecule of urea, a mass is obtained which gives reactions corresponding to a mixture of monochlorurea and urea hydrochloride in equal molecules, but these two substances could not be separated by organic solvents. By modifying the conditions of the experiment, the authors have been able to isolate pure monochlorurea and to study its reactions.—P. **Gaubert**: Helicoidal structures.—R. **Souèges**: The development of the embryo in *Mysorus minimus*. For demonstrating how the first cells in a dicotyledon are formed, *M. minimus* is a better example than *Capsella Bursa-pastoris* or any other Crucifer.—C. L. **Gatin**: Experimental reproduction of the effects of the tarring of roads on the neighbouring vegetation.—Raphaël **Dubois**: New researches on the physiological light in *Pholas dactylus*. The light is the result of an indirect oxidation of an albuminoid substance (luciferine) by a peroxydase (luciferase).—G. **Faroy**: Proof of the treponeme in tertiary syphilis of the kidney with amyloid degenerescence.—Foveau **de Courmelles**: The identification of charred bodies by the X-rays. Peculiarities of the bone structure could lead to the identification of bodies so burnt as to be otherwise unrecognisable.—Ch. **Gravier**: The polychætal annelids collected by the second French Antarctic Expedition (1908–1910).—Ph. **Négris**: The importance of the Eocene in eastern Greece and the discovery of the Trias.

DIARY OF SOCIETIES.

THURSDAY, October 26.

The Concrete Institute, at 8.—Fire-proofing: R. L. Humphrey.

FRIDAY, October 27.

Physical Society, at 5.—Further Observations on the After-glow of Electric Discharge and Kindred Phenomena: Hon. R. J. Strutt, F.R.S—Homogeneous Fluorescent X-radiation of a Second Series: Prof. C. G Barkla and J. Nicol.

SATURDAY, October 28.

Essex Field Club (at Essex Museum of Natural History, Stratford) at ·.—The Natural History of British Fresh-water Leeches, with Notes on their Occurrence in Essex: Henry Whitehead.—On the Remains of Vertebrate Animals found in recent excavations at Rayleigh Castle, Essex: Martin A. C. Hinton.—Report of Club's Delegate at Portsmouth Meeting of British Association: W. Whitaker, F.R.S., and D. J. Scourfield.

MONDAY, October 30.

Aristotelian Society, at 8.—The Relations of Universals and Particulars: Hon. Bertrand Russell, F.R.S.

WEDNESDAY, November 1.

Society of Public Analysts, at 8.—Notes on Shrewsbury and Knapp's Process for Estimating Cocoanut Oil: H. S. Shrewsbury and A. W. Knapp.—Note on a Counterfeit Gold Coin: H. S. Shrewsbury.—Note on the Examination of Finnish Turpentine: L. Myddelton Nash.—Note on the Approximate Estimation of Starch by Iodine: Lester Reed.—Note on the Gravimetric Estimation of Phosphorus in Milk: E. H. Miller.—Kobert's Reagent as a Test for Salicylic Acid: J. McCrae.—Precipitation of Nickel Compounds and Preparation of Spongy Nickel: W. H. Low.

Entomological Society, at 8.—The Effect of Temperature on Animal (especially Insect) Life: Dr. A. G. Butler.—Parthenogenesis in Worker Ants: W. C. Crawley.

THURSDAY, November 2.

Royal Society, at 4.30.—*Probable Papers*—Colour Blindness and the Trichromatic Theory of Colour Vision. Part III. Incomplete Colour Blindness: Sir W. de W. Abney, K.C.B., F.R.S.—Note on the Iridescent Colours of Birds and Insects: A. Mallock, F.R.S.—The Behaviour of the Infusorian Micronucleus in Regeneration: K. R. Lewin.—An Inquiry into the Influence of the Constituents of a Bacterial Emulsion on the Opsonic Index: A. F. Hayden and W. P. Morgan.—The Morphology of *Trypanosoma gambiense* (Dutton and Todd): Colonel Sir David Bruce, C.B., F.R.S.—Preliminary Report upon the Injection of Rabbits with Protein-free (tuberculo-) Antigen and Antigen-Serum Mixtures; Factors in the Interpretation of the Inhibitive and Fixation Serum Reactions in Pulmonary Tuberculosis: A. H. Caulfeild.

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