THURSDAY, SEPTEMBER 5, 1907.

MARIGNAC'S COLLECTED PAPERS.

Œuvres complètes de Jean-Charles Galissard de Marignac. Edited by E. Ador. In two vols. Vol. i. (1840–1860), pp. lv + 701, with a portrait; vol. ii. (1860–1887), pp. 839. (Geneva: Ch. Eggimann et Cie.; Paris: Masson et Cie.; Berlin: Friedländer und Sohn.)

AMONG the great chemists of the nineteenth century, and especially those engaged with inorganic chemistry, Jean-Charles Galissard de Marignac takes high rank, and in the notable advances which were made in chemical science during his lifetime he played a conspicuous part. The pride which his native city felt in his long and fruitful career has found expression in this sumptuous edition of his published papers, a worthy monument to the untiring energy that characterised him all his life so long as strength remained. It has been issued under the auspices of the Société de Physique et d'Histoire naturelle. The editing has been entrusted to the capable hands of his son-in-law and, for a time, colleague, Prof. E. Ador, who has executed what was evidently a labour of love with reverent care, and has contributed the interesting sketch of the life and works of Marignac which prefaces the first volume.

Marignac's personal life seems to have been singularly uneventful. Sprung from a French family which had settled in Geneva early in the eighteenth century, he was born in that city in 1817. With the view of entering the French service as a mining engineer, he underwent the course at the École polytechnique at Paris, and in accordance with the enlightened custom that prevailed in that country was dispatched at the end of his training on a scientific mission to foreign countries in order to study their methods. While at Stockholm he made the acquaintance of Berzelius, and there can be little doubt this meeting had a profound influence on the course of his life and turned his bent more definitely towards chemistry. At any rate, when, soon after his return to France, he was offered the chair of chemistry at the Academy of Geneva, he, despite the, from a worldly point of view, far better prospects that awaited him in France, accepted the offer without hesitation; and, as it turned out, he filled the post for thirty-eight years, until in 1878 failing health compelled him to tender his resignation.

It is pleasant to note the sympathetic consideration which Marignac experienced from the French Government. He was permitted to vacate his post and yet to retain the title of Ingénieur des Mines, and in the course of his letter the Minister of Public Works remarked:—

"Le gouvernement français ne peut voir qu'avec faveur que le gouvernement de Genève vienne chercher en France les hommes auxquels il confie le soin de répandre les lumières de la science, et, en remplissant avec distinction le poste qui vous est confié, ce sera encore un service indirect que vous rendrez à la France."

Shy and retiring by nature, he seemed to find happiness only in his laboratory; indeed, it was with considerable reluctance that he tore himself away for a few days at the time of his marriage. To quote Prof. Ador:—

"Marié en 1845, c'est à peine s'il consent à s'éloigner pendant quelques jours de son laboratoire; il emporte chaque matin un petit pain qu'il dévore à la hâte, ne pouvant se décider à interrompre ses travaux au milieu du jour";

a picture of a thinker, absorbed in his work and almost oblivious of every-day life. He shunned any position which brought him before the public gaze, and to the end found it irksome to lecture before a fresh generation of students.

The conditions under which most of Marignac's work was performed would be rather a shock to those accustomed to the greater luxury of these latter days. His laboratory is described by Prof. Ador thus:—

"Cette méchante cuisine enfouie dans le sous-sol, sombre en plein midi, avec ses cornues de grès ou de verre qui lui donnaient l'air d'une officine d'alchemiste."

Yet amid such forbidding surroundings were carried out elaborate researches with a care and completeness such as would be with difficulty surpassed at the present day even with the advantage of the improved apparatus now available. More commodious premises were eventually provided in 1873 when the academy was transformed into the university; but not long afterwards he was compelled to retire, and, although for a few years he continued work in his private laboratory, his strength at length failed so completely that he was practically confined to his couch. He died in 1894. The excellence of his work was recognised by the numerous honours conferred upon him; among them we may note that he was elected in 1881 a corresponding member of the Royal Society, and received in 1886 the Davy medal.

At the time when Marignac went to Geneva, the atomic weight of few of the elements had been at all accurately determined, and although some confidence might be felt in the numbers obtained by such a master as Berzelius, it was imperative that they should be confirmed by independent investigators and by other methods. There was at the time considerable speculation as to the question of the rigid application of Prout's law. Perceiving the pressing need for further trustworthy determinations of these fundamental data, on which the whole fabric of chemical science is based, Marignac resolved to devote his scientific energy to this important investigation. As was pointed out by Stokes, the president of the Royal Society, when bestowing on him the Davy medal, his work was the more important since he gave so much of his attention to the atomic weights of the more common elements on which the determination of new atomic weights is generally made to depend. In the whole of his researches he exercised the greatest care in considering the possibilities of error which might have occurred in the operations of

previous workers, and displayed more than ordinary ingenuity in devising new methods to avoid such errors, and at the same time he paid particular attention to the necessity of employing the purest material in such work. He was never satisfied with even repeated experiments on different amounts by the same method, and always, whenever practicable, adopted two or more independent methods. If we include those elements which he did not completely study, he determined the atomic weights of no fewer than twenty-nine of the elements, and in nearly every case his numbers differ little from those now adopted —a remarkable feat for one man working without any assistance. In the course of his investigations he analysed certain of the minerals containing the rare earths, and succeeded in separating two new elements, ytterbium from gadolinite and gadolinium from samarskite.

The process of time has brought it about that much of his work begins to have mainly historical interest, and probably at the present day most chemists will feel more vivid interest in researches which were to some extent incidental to the principal investigation. Prominent among these is his elaborate work relating to the intricate and puzzling problem in analysis presented by titanium, niobium, and tantalum. So difficult is the separation of these three elements, when occurring together in the same substance, that many eminent chemists have imagined the existence of other elements; for instance, Hermann strongly insisted on the presence of ilmenium in samarskite, but Marignac showed it to be really a mixture of niobium and tantalum. Although it cannot be said that he solved the problem with complete success, yet Marignac was the first to devise a method—the differing solubilities in hydrofluoric acid of the double fluorides of the three elements with potassium—which effected any real separation, and which to this day has not been superseded by any more satisfactory. The problem is one that still awaits solution, and is occupying the attention of many chemists. It is of interest to note that, in recognition of the method devised by him, the name marignacite was recently assigned by Mr. Weidman and Mr. Lenher to a variety of pyrochlore from Wausau, Wisconsin. Of little less vivid interest is his comprehensive investigation relating to the formula of zirconia and the atomic weight of the element. He made use of the law of isomorphism propounded by Mitscherlich, of which he was early a keen advocate, and undertook a complete chemical and crystallographical examination of a large number of fluozirconates. None of his experiments lent any confirmation to the idea put forward by Svanberg that zirconia contains three distinct metallic oxides. Nevertheless, the question is one deserving of further consideration. Prof. Church and other observers have noted a remarkable range in the density of zircons, 4·0 to 4·7, and an even more remarkable alteration in the density effected in certain stones of low density by the application of heat, and the conclusion has been drawn that there are three varieties of zircon. Further, the crystallised native zirconia, baddeleyite, presents almost as wide a range of density, which is even more difficult to understand in the case of an apparently simple oxide. It is possible that zirconium has never been completely isolated; it is well known that a satisfactory method for separating it from titanium has yet to be found.

Marignac found time to examine the chemical and crystallographical characters of a large number of minerals, and also of artificial salts prepared by him in the laboratory. The sentence with which he opens one of his elaborate papers is indicative of the thoroughness characterising his work, and embodies a maxim which even now is by no means universally appreciated by chemists:—

"L'intérêt que présente l'étude des formes cristallines des divers composés chimiques, m'a engagé à ne jamais négliger de déterminer exactement les formes de ceux qui s'offraient à moi, en cristaux déterminables, dans le cours de mes travaux de laboratoire."

Towards the end of his career his attention was attracted to the physical side of chemistry, and he carried out with his customary skill and care a lengthy series of thermochemical determinations; unfortunately, the complete collapse of his physical vigour brought his work to a premature close. To his other investigations—for instance, on ozone—space will not permit us to allude.

As regards the appearance of the volumes, the quality of the paper and the style of the printing are beyond criticism, and care has been taken to indicate the original pagination. Most of the papers were published in the *Bibliothèque Universelle de Genève* or the *Annales de Chimie et de Physique*; those dealing with mineralogical subjects appeared in the *Annales des Mines*.

THE BLOOD-SUCKING GNATS.

A Monograph of the Culicidae or Mosquitoes. Mainly Compiled from Collections received at the British Museum. Vol. iv. By F. V. Theobald. Pp. xix+639; 16 plates. (London: Printed by order of the Trustees, 1907. Sold by Longmans and Co., B. Quaritch, Dulau and Co., and at the British Museum [Natural History].) Price 1*l.* 12*s.* 6*d.*

THIS work forms the second supplementary volume to Mr. Theobald's original monograph of the Culicidæ of the world, in two volumes, published by the trustees of the British Museum in 1901. The present volume deals very largely with the new species which have been added to the national collections, and besides these it also embodies the descriptions of one hundred and sixty species which have been described by various authors since the issue of the first supplementary volume in 1903.

It would be difficult to overestimate the great scientific value of Mr. Theobald's most exhaustive faunistic work on these insects. It is a model of painstaking scientific accuracy, and we congratulate him on its issue.

With the exception of the adoption of a few characters in an admirable scheme of general

classification drawn up by Dr. Lutz, no changes have been made in this volume. The Corethrinæ have, however, been excluded from the Culicidæ and raised to family rank, partly on account of the asiphonate character of the larvæ, but mainly by the absence of piercing mouth-parts and of scales in the adults.

Felt's[1] new method of classification, based upon the genital armature of the males and the wing venation, is discussed at some length, but abandoned as unpractical on the grounds (1) that the majority of known mosquitoes are females only, and thus we should not be able to place many of our well-known species in any genus; and (2) that the cross-veins in the venation of the wings are subject to so great a variation that generic characters cannot be fixed by them. The author also points out that Messrs. Dyar and Knab's[2] unusual classification of the Culicidæ by larval characters only cannot be admitted. We need scarcely point out that any radical changes in the classification of these insects will result in endless confusion, especially so if based mainly upon local knowledge; and as practically all British, French and South American doctors and entomologists have adopted the Theobaldian classification, anything more than a modification of this system would be followed by somewhat disastrous results, especially among the students of the medical profession who are engaged in the study of the Culicidæ in connection with tropical diseases.

In the general notes we find a reference to Major Adie's evidence as to the benefit of *Lemma minor*, L., as a means of preventing mosquitoes from laying their eggs on water. He states that "tanks covered with this flat weed never contain larvæ of Culicidæ, whilst others at the same time of year are full of them." This genus of plants has apparently the same marked effect upon the frequency of both Anopheles and Culex in this country.

The natural reservoirs formed by the flowers of *Heliconia brasiliensis*, Hook., in Ceylon, the leaves of Nepenthes and various Bromeliaceous plants and the cut ends of bamboo in South America, are given as the breeding places of both Anophelines and Culicines. Mr. E. E. Green, of Ceylon, has contributed some notes on *Myzomyia rossii*, Giles, which he found breeding in the brackish lake at Batticaloa. There are also some interesting notes on the bionomics of *Nyssorhynchus fuliginosus*; but apart from these and a few other references to the habits of mosquitoes, very little is known of the earlier stages of a large proportion of the Culicidæ, so that those who have the opportunity of observing these insects have the pleasure of discovery before them.

In a work which has been so admirably performed, it is invidious, perhaps, to direct attention to any errors either of omission or commission, but we note that Patton's[3] important paper in which he describes five new species of Anophelinæ has been quite overlooked, nor do we find any reference to Grünberg's[4] new Anophelines described in 1905.

[1] Bull. 79, Ent. 22. New York State Museum. (1904.)
[2] "The Larvæ of Culicidæ classified as Independent Organisms." Journ. New York Ent. Soc., vol. xiv., pp. 169-230. (1906.)
[3] Journ. Bombay Nat. Hist. Soc., 1905.
[4] Zool. Anzeiger, Bd. xxix., No. 12, September, 1905.

Myzomyia hebes, Dönitz (p. 42); *Cellia punctulata*, Dönitz (p. 109); and *Howardina chrysolineata*, Theob. (p. 218), are all omitted from the synoptical tables; while *Pyretophorus pitchfordi*, Power (p. 72), and *Nyssorhynchus indiensis*, Theob. (p. 98), are omitted both from the synoptical tables and the lists of species given under the respective genera.

Myzomyia listoni, Liston, is given priority on pp. 41, 43, but is sunk to the position of a synonym of *M. christophersi*, Theob., on p. 51. Under *Culicada fitchii*, Felt and Young (p. 321), Fig. 112 is described as *Grabhamia fitchii*; there are also some minor errors in the text, evidently printer's. R. N.

COMMERCIAL ORGANIC ANALYSIS.

Commercial Organic Analysis. By A. H. Allen. Vol. ii., part iii. Pp. xii+547. Third edition, re-written and revised by the Author and A. R. Tankard. (London: J. and A. Churchill, 1907.) Price 20*s*.

WITH the publication of this volume, the whole of this standard work on the analysis of organic materials occurring in commerce is again available in a revised form. The preparation of this portion was undertaken by Mr. Allen so long ago as 1898, but, owing to his ill-health, little progress was made, and after his untimely death in 1904 the completion of the book was undertaken by Mr. Tankard.

The recent considerable additions to our knowledge of volatile oils, rubbers, gutta-perchas, and resins, the four principal groups of products now dealt with, have necessitated extension of the space devoted to these subjects in previous editions. As regards resins and volatile oils the author was assisted by Mr. E. J. Parry, and in the preparation of the article on oil of turpentine Mr. Archbutt was consulted, whilst Dr. Leffmann, of Philadelphia, contributed a portion of the section on aromatic acids and their hydroxy-derivatives.

The method of treatment adopted is to give a short critical *résumé* of the present position of the chemistry of each product, followed by a summary of the analytical methods available for its examination, one or more of these being finally recommended as giving trustworthy results in the author's own experience.

In spite of the care which has evidently been taken to secure accuracy in the information given, the specialist will be able to find here and there in the sections in which he is particularly interested statements requiring emendation or amplification. Thus the important matter of the botanical sources of rubber should not have been dismissed in the statement that it is "obtained from the latex of trees growing in S. America, Africa, India, &c.," supplemented by the inaccurate footnote, "A *new* source of caoutchouc has been recently discovered in the root-bark of *Landolphia thrallonii*, a plant growing in Lower Guinea and the French Congo." The statement that gutta-percha occurs in the latex of various trees belonging to the Sapotaceæ (*e.g. Palaquium pustulata* and other species) is all the information vouchsafed regarding the source of this important product, and is misleading since the best gutta is obtained from *Palaquium gutta*, *P. pustulata* yield-

ing an inferior product of little commercial value. There is a reference on p. 384 to "Spanish oil of hops" or "Cretan oil of marjoram," described as obtained from *Origanum hirsutum* and *O. creticum*. This appears to refer to the material better known in this country as "Cretan origanum" or "red thyme" oil, which is generally believed to be obtained from *Origanum hirtum*. The tabular statement of the constituents of volatile oils is incomplete in some respects; thus, under "basil oil," there is no reference to the terpene ocimene isolated by van Romburgh from this source in 1901; and the information given under the head of "applications" in these tables is in some cases rather inadequate.

There is a reference in the list of "errata and addenda" to the recent confirmation by the Philippine Bureau of Science of Trimen and Bentley's statement that "elemi" is obtained from *Canarium luzonicum*, but, curiously enough, the generic name is wrongly given as Conarium.

The arrangement of the subject-matter adopted facilitates reference to the information given regarding most of the products described, but it would have been an advantage if a fuller index had been provided.

As a guide to the analysis of commercial vegetable products this book fully maintains the high standard set in previous editions, and those concerned in its revision are to be congratulated on the satisfactory way in which they have accomplished their work.

T. A. H.

SCIENTIFIC ASPECTS OF PHOTOGRAPHY.

Investigations on the Theory of the Photographic Process. By Dr. S. E. Sheppard and Dr. C. E. Kenneth Mees. Pp. x+342. (London: Longmans, Green and Co., 1907.) Price 6*s.* 6*d.* net.

DURING the last four years the authors have been working with the object of preparing theses for their degrees according to the regulations of the University of London, and in this volume they present in order the records of their work by republishing together their communications to several scientific societies. That particular branch of photography that the authors refer to as *the* photographic process is the exposure, development, fixation, and sensitometry of gelatino-bromide plates—in short, negative making as now understood, but without reference to the after-treatment of the fixed plate by such processes as intensification, or to such collateral matters as the production of developer stains.

As indicated by the title, the volume is theoretical rather than practical, though the results often have an important practical significance. The subjects are dealt with from the point of view of what is now understood as physical chemistry, and the work is described in the language of that branch of science. This will make the volume probably more acceptable to students interested in photography who have devoted themselves specifically to physical chemistry, but it imposes a serious difficulty in the way of those who have not. This difficulty is increased by the constant use of symbols instead of words in the text. We would suggest the addition of a glossary giving the exact meaning of each of the symbols used.

Some of the apparatus used appears to be disadvantageously complex. For measuring opacities a spectrophotometer is employed, though dispersion of the light is unnecessary, and appears to be undesirable, for it must add sources of error. The authors use the bright green part of the spectrum, but do not say why they throw away the rest. They recognise the fact that the light transmitted by the silver deposits in films is largely scattered, and that their instrument takes very little cognisance of scattered light. They apparently assume that the scattered light generally bears a constant proportion to the whole, but it is very doubtful whether such an assumption is well founded. On certain occasions the authors endeavour to obviate the error due to scattering by making the film itself the practical light-source by means of a diffusing medium, placed in contact with it. Opal glass, which they use, is probably the best diffusing medium available, but the present writer does not call to mind any proof that it is thoroughly effective for such a purpose. Other methods of measurement are well known that do not suffer from these drawbacks.

The authors deal with many questions that are of a very debatable character, and it in no sense belittles their work to say that they remain debatable. They adopt the "germ" theory of the developable image, but limit the effect of each germ to the grain or nodule of which it forms a part. The "suspicion of a vicious circle in the argument" that the authors refer to in connection with the "molecular strain" theory is, we fear, much more widely applicable than they appear to realise. The authors remark that "it may be said of the physical theories that they shirk a real explanation by treating the phenomena to be explained as a quality of the physical modification of the halide"; to which one might reply that those who advocate the chemical theories assume a decomposition of which there is no evidence. And so it remains a matter of opinion as to which is the safer and more useful hypothesis. We make only one other observation, namely, that it seems undesirable to speak of the *law* of constant density ratios, when, as the authors themselves admit, it is "frequently not followed." When this "law" was first propounded by Messrs. Hurter and Driffield they maintained that it was really a *law*, which it was very difficult, if possible, to get away from.

This volume will find a place, which it will worthily fill, in the libraries of all who are interested in the scientific aspects of photography, because it contains the record of a series of carefully conducted experiments under stated conditions, and gives copious references to the literature of the subject. C. J.

OUR BOOK SHELF.

Surgical Instruments in Greek and Roman Times. By Dr. John Stewart Milne. Pp. xii+187; illustrated. (Oxford: The Clarendon Press, 1907.) Price 14*s.* net.

BOTH the author and the Clarendon Press are to be congratulated on the issue of this very valuable work—Dr. Milne because it represents work well done, and the Press on account of the successful manner in which

the fifty-four plates of surgical instruments have been reproduced.

The book has grown out of a thesis written by Dr. Milne for the degree of doctor of medicine at the University of Aberdeen. It shows him to be a scholar of no mean capacity, and a fit member of a profession which used to be a great deal more learned and much less practical than it is at the present time. Knowledge about ancient surgical instruments is singularly scattered. There are descriptions of them in the medical and surgical writers of classical times, and there are remains of the instruments themselves in most of the national museums of Europe and America. But in modern times very little attention has been devoted either to the instruments or to their descriptions, and those who still read descriptions of the operations in the classical authors have either been contented to imagine the instruments with which they were performed or have had to draw upon their recollection of what they saw at Naples. Dr. Milne has now removed this reproach, and any intelligent surgeon, even though he be ignorant of Greek and should know but little Latin, can follow easily the manipulations of the older surgeons. Some day, perhaps, a surgeon with an archæological bias will do for Egyptian surgery what Dr. Milne has accomplished for Greece and Rome. Dr. Milne describes the instruments under the general headings of knives, probes, forceps, bleeding cups and clysters, cauteries, bone and tooth instruments, bladder and gynæcological instruments, sutures, and the portable outfit which was necessary for the surgery of so migratory a race as the Romans. In an appendix is an inventory of the chief instruments which Dr. Milne has seen in the various European museums, and a bibliography of the subject, short but apparently complete. There are no less than three indices, the first an index of subjects, the second a Latin index, and the third in Greek. Dr. Milne has done his work so well and so accurately that as this monograph is the first dealing with the subject it must remain for a long time the standard authority until further finds prove or disprove some of the disputable conclusions drawn by the author. The monograph presupposes a considerable amount of knowledge on the part of the reader. He must in the first place be skilled in the practice of his profession, he must be interested in its antiquities, and he must be a fair classic. These qualifications being granted, the book is most excellent reading, and throws abundant light, not only on the subject of which it treats, but also on many collateral points.

Diptera Danica. Genera and Species of Flies hitherto found in Denmark. Part I. By William Lundbeck. (Copenhagen: G. E. C. Gad; London: William Wesley and Son, 1907.) Price 4*s.* 6*d.* net.

THIS work is expected to be completed in about ten parts; and the first part is accompanied by a portrait of R. C. Stæger, an eminent Danish dipterist. The book is written in English, and as it appears to be very carefully done will prove very useful to English entomologists who take up the study of Diptera, which has been more neglected in England than any other order of insects, and respecting which we possess no complete work at present; though most European countries possess good monographs of Diptera in their own languages. The introduction relates chiefly to structure, illustrated by figures of structure and neuration. The other text-illustrations represent details of structure, such as heads, wings, palpi, &c. One term is new to us—the "yowls," which from the context seems to apply to the lower part of the face. The English is very good, but somewhat stilted, and occasionally rather unfamiliar words are used, such as "kinks" and "kneeformed."

There is no general table of families, which we regret; but detailed tables are given of subfamilies, genera and species. The descriptive part of the book appears to be very good, as well as the accounts of habits, transformations, and localities. There is even a table of the larvæ of the genera of Stratyomiidæ, the first family included in part i., the others being Xylophazidæ, Cœnomyiidæ, Tabanidæ, Leptididæ, and Acroceridæ.

It appears that the last estimate of the number of Danish Diptera was given by Zetterstedt in 1855 as 1439, to which Prof. Lundbeck will doubtless be able to add considerably by the time that his work is completed. The number of British species is probably somewhere between 2500 and 3000; and a considerable proportion of the Danish species probably also occur in the British islands, though the latter may be expected, when the Diptera of both countries are fully known, to possess a richer fauna than Denmark, owing to the greater extent and more varied character of the country.

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.*]

Radiation of Meteors.

THE shower of November Andromedids which occurred in 1885 exhibited a very large area of radiation, the flights being directed from a region variously estimated from 7° to 15° diameter. The Draconids of August, with a radiant near *o* Draconis and centre at about 290°+60°, appears to exhibit a similar feature, for the rich shower this system presented in 1879 had a very ill-defined radiant. An active shower of Taurids seen on November 2, 1886, also formed a very dispersed or scattered radiant.

The Draconids alluded to above returned rather plentifully this year between August 15 and 28, and they exhibited the same indefiniteness of radiation as in 1879. The feature is an interesting one, but it is very difficult to investigate it properly because of the errors of observation and mistakes in attributing meteors to their correct systems.

As a rule, it may be accepted as a general fact that showers of slow meteors have more diffused radiants than the swift meteors. I have often found the radiant points of the Perseids, Orionids, and Leonids very contracted and exact centres, while certain displays of slow meteors have proved rather puzzling to me in fixing their correct positions owing to the evident diffuseness in the intersections of the paths. W. F. DENNING.

Bishopston, Bristol, August 30.

Experiment on the Rusting of Iron.

IN view of recent work on the rusting of iron, the following simple experiment will be of interest. It is the result of a number of attempts to devise a simple method —for class-demonstration purposes—of showing that carbon dioxide is necessary for the rusting of iron.

A 500 c.c. flask was taken, and into it were put about 100 c.c. of 15 per cent. caustic potash solution. A partially bored sound cork was inserted in the neck, and the flask shaken occasionally for two days. Then a piece of bright iron wire (a long nail is suitable) was, after boiling in distilled water, pushed through the unbored portion of cork, leaving about an inch outside. After four months the iron inside shows no sign of rust, whilst that outside was rusted in as many days. GEO. A. WATSON.

Grammar School, Cork.

THE EXPLOSION OF GASES.

THE earliest work on the explosion of gases was that of Humphry Davy, who in 1817 published those celebrated experiments on "the propagation of flame through small tubes and orifices" which led him to the construction of the miner's safety-lamp.

More than half a century later Bunsen devised the non-luminous gas burner, observing that unless the flow of the mixture of coal-gas and air exceeded a certain rate the flame became unsteady and passed down the tube. Bunsen believed that this rate represented the velocity with which an explosion would travel in the combustible gases in a closed tube, and he obtained definite values for a number of mixtures by leading the gases through an orifice at the end of a tube, igniting the jet, and determining the minimum speed at which the gases must be forced through the tube to prevent the flame passing back through the opening. The rates of explosion measured in this way were comparatively slow, the fastest observed being about thirty-seven yards a second.

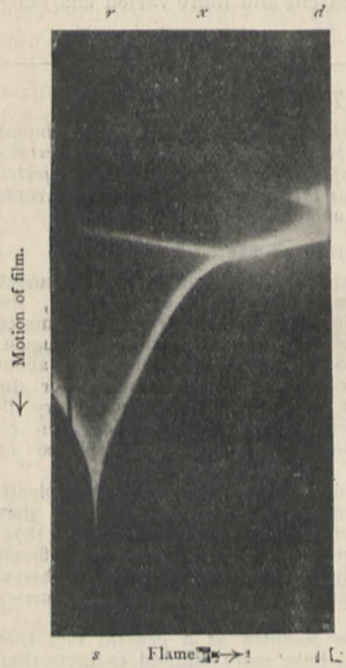

FIG. 1.

But in 1881 Berthelot and Vieille discovered that when an explosive mixture is ignited at the end of a long pipe, the velocity of the explosion rapidly increases from its point of origin until it reaches a maximum velocity, which remains constant however long the column of gas may be, and which greatly exceeds the speeds of combustion measured by Bunsen; this discovery was confirmed by the independent investigations of Mallard and Le Chatelier, published at the same time. Berthelot gave the name "l'onde explosive" (detonation-wave) to the flame travelling with its maximum velocity, thus distinguishing it from the variable progressive combustion which precedes its development. The velocity of the explosion-wave constitutes a physical constant which has a specific value for each inflammable mixture; measurements by Berthelot and H. B. Dixon have shown that it is approximately equal to the velocity of sound in the burning gases at the temperature of the explosion. For a mixture of hydrogen and oxygen in equivalent proportions the velocity is about 3000 yards a second.

Mallard and Le Chatelier succeeded in recording the slow movements of the flame of progressive combustion by photographing the flash on a piece of sensitised paper fixed on a revolving cylinder. They found that when the gases are ignited at the open end of a long tube, the flame travels for some distance with a uniform slow velocity of the order measured by Bunsen; the flame next begins to vibrate, swinging backwards and forwards with oscillations of increasing amplitude; then it either dies down or sometimes the gas detonates. If the gas is fired near the closed end of the tube, the movement of the flame is uniformly accelerated until the detonation is set up. Le Chatelier's apparatus was not fast enough to analyse the wave of detonation itself.

The apparatus used by Prof. H. B. Dixon consists of a drum carrying a narrow strip of Eastman film, which can be rotated at the rate of 100 metres a second. The explosion tube is fixed horizontally, and the image of the flame is focussed on to the vertically moving film. The photographs show an inclined line of light compounded of the two motions. Fig. 1 is a photograph of the explosion of cyanogen with oxygen. The mixture was fired near the middle of a tube by an electric spark *s*. The flame moves slowly in both directions; to the left it passes out of the field of view, to the right its speed increases until at *x* the detonation-wave is set up. The detonation-wave, moving with constant velocity, is represented by a straight line (*x*, *d*), while the slower movement of the progressive combustion preceding it is shown as a curve (*s*, *x*), the steepness of which diminishes as the motion of the flame accelerates—the speed of the drum being uniform. The duration of the flash was less than 1/100 second. The period before the detonation is distinguished not only by the slow movement of the flame, but also by slow and incomplete combustion and feeble luminosity.


FIG. 2.

The initiation of the detonation-wave is marked by certain characteristics—(1) a sudden increase in intensity of the flame, accompanied by an instantaneous rise in pressure; it is found that glass tubes are most often fractured at the point where the detonation originates; (2) rapid and complete combustion; (3) the setting up of a strongly luminous backward wave (*x*, *r*)—the so-called "retonation-wave"—which under certain conditions travels as rapidly as the detonation-wave itself. The sudden rise in pressure is due to the increase of chemical action, and this pressure not only produces the forward detonation, but also sends a backward wave of compression into the slowly-burning gases behind it; this compression-wave raises the temperature of the combining gases and increases the luminosity. It should be observed that the light produced by the explosion is chiefly due to particles knocked from the glass and raised to incandescence; the small particles suspended in the burning gases glow by the heat imparted to them by the hotter but invisible gaseous products of combustion.

The detonation-wave is set up only after the flame has run some distance, which depends on the nature of the mixture and on the size of the spark.

Fig. 2 shows the explosion of hydrogen and oxygen in a closed glass tube too short to allow of the detonation being set up. The gas is fired in the middle of the tube, and the flame spreads right and left with faint luminosity. The flame is preceded by an invisible compression-wave which travels with the

velocity of sound through the unignited gas, and is reflected from the ends of the tube. The flame is checked while these two compression-waves pass through the burning gases, and is then helped forward by the waves moving in the same direction. The movement then becomes unsymmetrical; the flame to the left is checked a second time before it reaches its end of the tube, that to the right reaches the end of the tube and sends back a strong retonation-wave. The wave from the right is of greater intensity and moves more rapidly than that started a little later from the left, and, although the reflections of these waves at first run nearly parallel, the stronger gradually overtakes the weaker and coalesces with it, and the single wave continues to traverse the tube from end to end. As many as one hundred reflections have been counted in an explosion of this kind. Fig. 3 shows in outline the movements of the flame and compression-waves.

The flame in its initial stage is only very feebly luminous, a fact which has led to erroneous beliefs in regard to the mechanism of explosion. Von Oettingen and von Gernet, failing to photograph the flame itself, introduced finely-divided salts into the tube, and obtained brilliant pictures of the explosion showing a series of parallel waves. They believed that the explosion itself was *quite invisible*, the movements shown in the pictures being compression-waves rushing through the burning gases after the explosion was completed. These parallel waves, following each other in close succession, were supposed to be due to "successive partial explosions" proceeding from the spark, in accordance with Bunsen's theory of discontinuous step-like combustion.

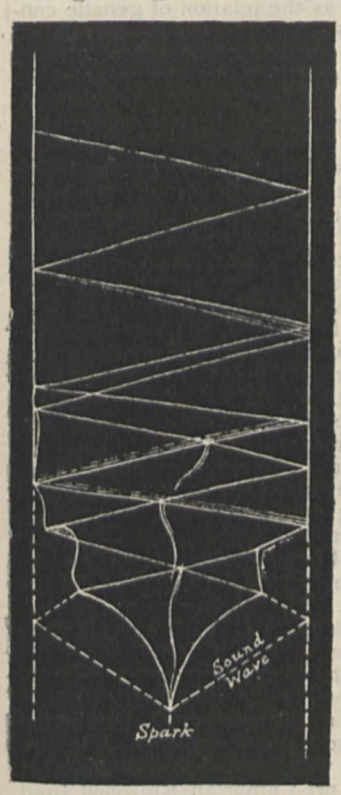

FIG. 3.

The influence of water vapour on the combustion of hydrogen with oxygen has formed the subject of much recent research. Some years ago Dixon showed that an electric spark would fire ordinary electrolytic gas whether in the dried or moist condition, and that the velocity of detonation was practically unaffected by the presence of aqueous vapour. The experiments of Baker with very pure hydrogen and oxygen have, however, shown that the initiation of the flame is largely influenced by the purity of the mixture. It might be expected that the initial phase of the explosion (before detonation is set up) would be modified if the interaction of the gases depends on the presence of previously formed water molecules. Dixon and Bradshaw have shown by photographs that this is not the case; the flame, once it has been started by a spark, spreads with the same velocity in the dry as in the moist gases, and undergoes the same changes in intensity. So far as the development and movements of the flame are concerned, the presence of water-vapour appears to make no difference in the union of hydrogen and oxygen.

In a recent paper Dixon and Bradshaw have shown that the compression-wave which travels in front of the flame in the initial stage of the explosion may, under certain conditions, bring about the spontaneous inflammation of the gases in a region of the tube some distance from the spark. Fig. 4 shows the explosion of hydrogen and oxygen in a tube one end of which has been drawn off in the blowpipe flame in the manner of a Carius bomb-tube, so that the end has the form of a funnel followed by a short capillary. The explosion is started in the middle of the tube (*s*); almost simultaneously the gas inflames in the capillary (*c*). The flames meet midway between the fine dark vertical lines, which are reference marks produced by fastening narrow strips of black paper outside the explosion tube to eclipse the flame as it passes. The broad band is due to the clamp which held the tube in position. The firing of the gas in the capillary is caused by the sudden increase of pressure in the funnel, the heat of compression raising the gases to the temperature of ignition. The wave produced is analogous to the tidal "bore" in a funnel-shaped estuary. L. B.

FIG. 4.

THE SEVENTH INTERNATIONAL ZOOLOGICAL CONGRESS.

THE meeting of zoologists at Boston was formally convened on Monday, August 19, in the Jordan Hall. Prof. Alexander Agassiz, as president, welcomed the members and delegates, and gave a short but vivid address on the recent progress of oceanographical research, especially in its zoological aspects. He directed attention, for instance, to the extremely interesting facts which he has discovered in regard to the relations of the deep-sea faunas on the two sides of the Isthmus of Panama. In a country where the stranger cannot but be impressed with the amount of public and private money which seems to be placed at the disposal of scientific institutions, it was interesting to hear Prof. Agassiz's complaint that the Government had not taken any steps to publish an account of the treasures of the *Albatross* expedition. It was one of those touches of nature which make the whole world kin.

Vice-presidents were appointed, such as Mr. Bateson (England), Prof. Hubrecht (Holland), Prof. H. F. Osborn (United States), Dr. Watase (Japan); and, on the report of Prof. Blanchard, the Czar Nicolas prize was awarded to Prof. Cuénot, of Paris, for his research on hybrids. Special mention was also made of theses by M. Loisel, of Paris, and M. Standfuss, of Zürich, which did not arrive in

time to be considered in making the award. Prof. R. Hertwig, of Munich, gave a long address on the most recent researches on cytology. He spoke in German, and it was not always easy, in spite of his lucidity and illustrative charts, to follow his discussion of the intricate relations between the nucleoplasm and the cytoplasm. Of particular interest was the account of his observations on the influence of temperature on the size and rate of division of the chromosomes.

The meetings of the sections were held in the truly magnificent buildings of the Harvard Medical School, which stand like five marble temples on the three sides of a quadrangle, and are admirably designed for internal re-adjustment or for external extension outwards as future circumstances may demand. The internal equipment of the various departments, *e.g.* Prof. C. S. Minot's embryological laboratories, called forth universal admiration. Great praise is due to the organisers of the congress for the way in which they secured the orderly accomplishment of the scientific business and for the embarrassingly tempting arrangements for excursions. For creature comforts most thoughtful care was taken, from the providing of *al fresco* luncheons to the presence of a nurse!

The intellectual bill of fare—a metaphor which cannot be avoided amid so much hospitality—was all too full. Never can the zoologist of good appetite and digestion have wished more ardently that he could be, as Sir Boyle Roche's bird, "in two places at once." For in spite of clever arrangements, there was no avoiding the simultaneous occurrence of interesting events. This holds especially true in regard to the sectional addresses, which included the following:—The problem of the vertebrate head, by Prof. J. P. McMurrich; the chemical aspect of fertilisation, by Prof. Jacques Loeb; cytology and taxonomy, by Prof. C. E. McClung; facts limiting the theory of heredity, by Mr. William Bateson; fœtal membranes, by Prof. A. A. W. Hubrecht; operative factors in development, by Prof. W. Roux; economic entomology, by Dr. L. O. Howard; the relations between North American and European Hemiptera, by Dr. Geza Horvath; the problem of organic development, by Prof. C. O. Whitman; migrations of Tertiary faunas, by Prof. C. Depéret; the scope and promise of systematic zoology, by Dr. T. Gill; the evolution of continents as illustrated by the geographical distribution of animals, by Dr. R. F. Scharff.

One of the most striking of the sectional addresses delivered at the congress was that on the chemical character of fertilisation, by Prof. Jacques Loeb, of Chicago, delivered before an audience of about three hundred. He began by distinguishing between the function of the spermatozoon as a bearer of hereditary qualities and its function as an instigator of development. In connection with the latter the foremost effect is the enormous synthesis of nuclear matter. To attain to some understanding of the hydrolytic and other processes which the spermatozoon sets up in the egg, the most promising path at present is to study the phenomena of artificial parthenogenesis. By adding to "hypertonic" sea-water a small quantity of a monobasic fatty acid, Prof. Loeb has been able to induce in sea-urchin ova the formation of an egg membrane and perfectly normal development in the great majority of the eggs of a given female. The effects of the spermatozoon were thus more perfectly imitated than by the previous purely osmotic methods. Prof. Loeb's results lead him to the general conclusion that the membrane-formation is connected with the solution of a layer of fatty material underneath the surface-film of the egg. It seems that the essential feature of the process of fertilisation consists first in a liquefaction or hydrolysis, or both, of fatty compounds in the egg, and second, in starting the processes of oxidation in the right direction. The lecturer ended his discussion by making a very suggestive comparison between the chemical processes in the germination of oily seeds and those in the early development of the animal ovum. The general idea to which the experiments on the artificial parthenogenesis (of sea-urchins, Lottia, Polynöe, and Sipunculus) point is that the spermatozoon acts as a catalyser.

Sir John Murray gave a general afternoon address on the progress of oceanography, and another was given by that genial iconoclast, Prof. W. K. Brooks, who calmly asked, "Are Heredity and Variation facts?" If philosophy is a criticism of categories, the latter address was certainly philosophical, for its aim was to show that specialisation—none the less dangerous because often unconscious—necessarily leads to partial abstractions. Such, according to Prof. Brooks, are heredity and variation. The former means likeness between offspring and their parents; the latter means divergence of the offspring from the likeness of their parents. But these two aspects in isolation are not facts; they express our artificially abstracted realisation of *one* fact—kinship and individuality are inseparable. It might be suggested that heredity is more correctly definable as the relation of genetic continuity between successive generations—a relation which presents, on the one hand, the aspect of continuity, persistence, or hereditary resemblance, and, on the other, the aspect of divergence, novelty, or variation; but the lecturer would not accept this suggestion.

Much of the lecture, which was enlivened by a fine humour and by epigrams condensing much reflection, was in great part an apologia for the individuality of the living creature. "Like never does produce like, but only something like." "The sheep which the morphologist finds to be all alike, are all unlike, as the shepherd's dog knows. Each ewe knows its own lamb." (Is even this a fact?) "One never meets the average man, the normal man of the statistician." "Statistics of mortality are very useful, but they have no bearing on your death or mine." "We speak of *the* struggle for existence, but every struggle is private and particular in every respect."

If we follow Prof. Brooks's line of argument, we are led to the conclusion that since we cannot think of a living organism without an environment in which it lives, then the living organism is not a fact—it is only a scientific abstraction of one side of a fact; and so far as we understand, the Berkeleyan biologist did not hesitate to take this step. "The being is not in itself, but in its reciprocal relations." It is therefore illusory to speak of a material substratum of inheritance; the real creature is not in the idioplasm, or the chromosomes, or the determinants, or the vital units; it is to be sought and found in the reciprocal interaction between the organism and its environment. A luminous section of the lecture was devoted to showing that supposing one knew the pre-Cambrian Rhizopod from which all animals are descended, and knew it thoroughly, yet one would not be able to foresee from such knowledge all that was to follow. The history was not really in the pre-Cambrian ancestor, for living creatures, as they have evolved, have, so to speak, worked time into their being, and evolution is continual creation.

The last days of the formal meetings of the congress were overcrowded with remarkable communications, too numerous even to mention in a brief notice, but we cannot refrain from remarking on the addresses given

by Mr. Bateson, on facts limiting our theories of inheritance; by Prof. C. O. Whitman, on orthogenesis in pigeons and on the relations of ontogeny and phylogeny; by Dr. L. O. Howard, on the recent progress of economic zoology; and by Prof. H. F. Osborn, on evolution from a palæontologist's point of view—all of them very remarkable and memorable expositions.

At the formal close of the congress it was announced that the 1910 meeting would be held at Graz under the presidency of Prof. von Graff. A welcome announcement was made that the committee on nomenclature had at last arrived unanimously at a code of rules which would cover 90 per cent. of all possible difficulties. Dr. Stiles further said that the committee would continue to sit in judgment on the remaining 10 per cent. of intricate difficulties, and that they had resolved to prepare a check-list of some thousands of common animals the names of which were not henceforth to be changed on any pretext whatsoever. As Prof. Agassiz remarked, the only difficulty remaining was the cheque. Prof. Blanchard announced that a third prize had been offered by Russia for adjudication by the congress and by representatives of the Zoological Society of St. Petersburg. It was offered to perpetuate the memory of the great Russian zoologist, Alexander Kowalewsky. In a very neat speech Prof. Hubrecht, of Amsterdam, thanked the local committee, the organisers, and the president for their indefatigable labours in making the congress a conspicuous success, and Prof. Blanchard, of Paris, eloquently expressed the gratitude of the ladies for the hospitality which had been shown them by the ladies of Boston.

NOTES.

THE weather conditions for the three summer months, June to August, have proved very disappointing, and the principal characteristic has been the entire absence of warm days. At Greenwich there have only been forty days during the whole period with a temperature of 70° and above. This is precisely the same number as in the phenomenally wet summer of 1903, but it is very greatly below the average. In 1860 there were only twenty-three days with a temperature of 70° or above, and in 1879 twenty-six such warm days, so that the past summer is not unique. There has not been, however, a single day this summer with a temperature of 80°, whilst in 1903 the thermometer touched that reading on six days. The aggregate rainfall at Greenwich for the three months was 5·29 inches, which is 1·37 inches less than the average of the past sixty years. In 1903 the aggregate for the corresponding three months was 16·17 inches, which is the wettest summer on record. At the London observing station of the Meteorological Office the aggregate rainfall for the three months was 4·76 inches, which is 2·13 inches below the normal, and the only month with an excess so far this year is April. June was generally wet over nearly the whole country, July was mostly dry, whilst in August the rainfall varied considerably in different parts of the kingdom. At Jersey the total measurement in August was 0·60 inch, whilst the average is 2·48 inches; at Valencia the measurement was 5·67 inches. The sunshine has not varied much from the average. In London there was a slight deficiency in each month, but in the aggregate for the three months it only amounts to thirty-eight hours. September has commenced with exceptionally cold weather, and the thermometer for the first four days has averaged about 30° lower than at the corresponding time last year.

A REUTER telegram from Rome states that it is expected that ratifications will be received by the end of the present year from all the Powers of the convention of June 7, 1905, for the establishment of the proposed International Agricultural Institute. If the expectations are realised the committee of the institute will be able to meet early in 1908, enabling the institute itself to assemble in the autumn of that year, and to be in working order in 1909. In connection with the new institute, the Italian Government is taking steps for the scientific organisation of a system of agricultural statistics which existed until about ten years ago, when it was abolished by Count Guicciardini, Minister of Agriculture, on the ground that it did not afford sufficient guarantees of correctness. By way of experiment, agricultural statistics will be collected this year in fifteen provinces of Italy, with the view of extending the new system to the whole of the country, with any reforms that may be suggested by the experiment. At the same time a count will be taken of the livestock in the country, which has not been done for a considerable time. In this way Italy will in 1909 appear before the International Institute with complete agricultural returns.

THE installation of the first electric irrigation system in southern British Columbia has just taken place. It is considered that by this means the problem of the irrigation of several thousand acres of fruit lands will in a great measure be solved.

AN organisation to be known as the Universal Society of the White Cross of Geneva has been formed at Geneva. It has for its object the coordination of the work being carried on throughout the world in combating tuberculosis, cancer, epidemic and infectious diseases, and social evils such as alcoholism, &c.

ACCORDING to the *Engineer*, an Inter-Ministerial Technical Commission has been appointed by the French Minister of Public Works to organise the whole system of wireless telegraphy in all its branches in the country, and it is expected that the commission will be able to arrive at results which will furnish France with a very complete and properly coordinated service of wireless telegraphy for land and sea service, both in peace and war.

IN 1859 Mr. U. A. Boyden, of Boston, deposited with the Franklin Institute the sum of 1000 dollars, to be awarded as a premium to any resident of North America who should show by experiment that light and other rays travel with the same velocity. According to the August number of the Journal of the Franklin Institute, the premium has just been awarded to Dr. P. R. Heyl, who has taken photographs in the blue and ultra-violet of the variable star Algol in the neighbourhood of its minima, and has shown that the time of minimum intensity of the blue photographs is so nearly identical with that of the ultra-violet that the speeds of the two radiations across the space between Algol and the earth cannot differ so much as one part in a quarter of a million.

THE following arrangements have been made for the opening of the winter session of certain of the London medical schools:—at the Guy's Hospital Physical Society, on October 4, Dr. G. A. Gibson will read a paper entitled "Past and Present"; at King's College, on October 1, Dr. W. H. Allchin will give "Some Observations on the Present State of Medical Education in London"; at the Middlesex Hospital Mr. A. G. R. Foulerton will, on the same date, speak on "The Development of Preventive

Medicine in Relation to the Welfare of the State"; at University College Hospital, on October 2, the inaugural address will be given by Sir R. Douglas Powell; and at the Seamen's Hospital Society, on October 21, Sir Lauder Brunton will give the inaugural address. The session of the Pharmaceutical Society will be opened on September 30, when Prof. R. Meldola will speak on "The Scientific Training of the Pharmacist."

PRELIMINARY particulars of the ninth International Geographical Congress, to be held at Geneva from July 27 to August 6, 1908, are given in the September number of the *Geographical Journal*. Ten scientific excursions, some of which will take place before, others after, the congress, have been arranged for, each being conducted by an expert. Dr. J. Früh, of Zürich, will lead a party, of not more than twenty, for the study of the morphological phenomena of the Alps and their foothills. Another party, conducted by Dr. Lugeon, will study the phenomena of inverted folding in various parts of the Alps. An excursion will be devoted to high-level forestry, and will be led by M. Ernest Muret. The structure of the Jura, the plateau, and the Alps will be studied under the direction of Dr. H. Schardt. A botanical excursion will be made under the direction of Dr. C. Schroeter, the well-known authority on the flora of the Alps. A study of vegetation contrasts and the technique of botanical distribution will be undertaken under the guidance of Dr. J. Briquet, and one of glacial morphology under the guidance of Prof. Brückner. Prof. J. Brunhes and others will direct attention to the contrasts between fluvial and glacial erosion, while Prof. Schardt will explain the structure of the southern portion of the crystalline Alps. Lastly, a party under the guidance of Prof. E. Chaix will study the phenomena of chemical erosion, especially as displayed in the surface forms known as *lapiés*, or *Karrenfelder*, and in the Karst. The place of meeting is particularly favourable for the arrangement of instructive excursions, and these may be expected to be one of the most prominent features of the congress.

THE *Philippine Journal of Science* for June (ii., No. 3) is entirely occupied with a paper by Dr. Richard Strong on studies in plague immunity. The author concludes that general vaccination in endemic centres would be a valuable means in accomplishing the extermination of this pestilence, an important pronouncement at the present juncture, when plague is rampant in India.

PREVENTIVE inoculations against hydrophobia were received at the Pasteur Institute of Paris in 1906 by 773 persons, only two of whom died from the disease, and as one of these may be excluded for statistical purposes, seeing that hydrophobia manifested itself in less than a fortnight after the conclusion of the treatment, the results show the low mortality of 0·13 per cent. Only one of the patients came from England. The person who died in less than fifteen days after treatment had received a severe penetrating wound on the face; the other fatal case had been severely bitten on the nose on August 3, was treated at the institute from August 5 to 26, and died from hydrophobia on October 12.

THE second report of the Natal Government Museum—covering the year 1905—has just been published by Messrs. Adlard and Son, and tells of progress in all departments. In the period under review the following additions to the specimens in the museum were made:—in ethnology, 145; mammals, 98; birds, 81; anatomy, 82; reptiles and fishes, 19; invertebrates, 425; palæontology, 4; geology and minerals, 1445. A native blacksmith's complete outfit, including a good specimen of skin-bellows, has been acquired by the ethnology department of the museum through the misbehaviour of its former owner, the police authorities of the colony having acted on the request made to them to forward to the museum all native articles which have been confiscated for wrongdoing.

IN a letter to the *Times* of August 28, Mr. James Brand states that intravenous injections of a mixture of aqueous solutions of methylene blue and corrosive sublimate cure trypanosome infections in horses, and suggests that this may be found to be a remedy for sleeping sickness, a Trypanosoma infection, in man. Prof. Moore and his co-workers have found that corrosive sublimate enhances the curative value of atoxyl, another anilin dye, in experimental infections with the human trypanosome, but it does not follow that methylene blue would be of service in sleeping sickness, since Nicolle and Wenyon have found that an anilin dye which is curative for an infection with one trypanosome is not necessarily curative for other trypanosome infections.

THE fifth annual report of the Imperial Cancer Research Fund, which has been recently issued, contains the reports of the executive committee, of the general superintendent, Dr. Bashford, and of the honorary treasurer. The fund now possesses a capital sum of 118,275*l.* for the purposes of the work, including the munificent gift of 40,000*l.* by Mr. and Mrs. Bischoffsheim on the occasion of their golden wedding. Dr. Bashford gives a *résumé* of the experimental and other researches carried out during the past year. Attention has been given to testing various alleged cancer cures; unfortunately, it is impossible to assign a curative value to any of them. The much-vaunted trypsin is incapable of curing inoculated cancer in mice, or even of influencing the progressive growth of the tumours. The only means capable of freeing the inoculated mice from cancer is the surgical removal of the tumours.

IN an illustrated pamphlet published at La Plata ("La Reforma" Press, 1907), under the title of "El Origen del Hombre," Dr. Florentino Ameghino reiterates his opinion that South America was the birthplace of the human race. Man is traced back to the supposed Cretaceous family Microbiotheriidæ—in other words, to Miocene opossums!

AMONG numerous articles in part i. of the fiftieth volume of Smithsonian Miscellaneous Collections, attention may be directed to a description, by Dr. Leo Walter, of Prague, of the structures by means of which the fore and hind wings of hymenopterous insects are linked together. After pointing out that homologous structures exist in the wings of certain other insects, such as many Lepidoptera, Cicadidæ, and Thricoptera, the author observes that in none of these is the development so full and so complicated as in the Hymenoptera. Strange to say, these structures in the latter group appear never to have been worked out in full detail—an omission which Dr. Walter has endeavoured to supply. Facts of considerable interest have been discovered during the investigation, and it has been found that these organs possess much importance from a systematic point of view. Their object is, of course, to enable the two wings to act during flight as a single unit, and, as might have been expected, it turns out that the strongest flyers among the Hymenoptera are those in which the connection between the wings attains its fullest development. The halting and uncertain

flight not infrequently noticeable in individual humble-bees is attributed by the author to damaged wing-connections.

THE rapidly advancing study of spirochætes is at once of practical and scientific interest, of practical interest because these parasites occur in those "gustatory flashes of summer lightning," as Huxley said, which mortals call oysters, and because *Spirochaeta pallida* is believed to be the active cause of syphilis; of scientific interest, because it remains uncertain whether these protists are protozoa or bacteria. In a recent paper (Ann. Nat. Hist., xix., 1907, pp. 493–501), Mr. H. B. Fantham points out that the diffuse nuclei and transverse fission of spirochætes suggest bacteria, while, on the other hand, the presence of an undulating membrane, longitudinal fission, and even definite "chromosomes" suggest protozoa. It is to the latter interpretation that he inclines. Mr. Fantham has made a careful study of living spirochætes—*Spirochaeta balbiani* (Certes) from the oyster, and *S. anodontae* (Keysselitz) from the fresh-water mussel—and gives an interesting account of their puzzling movements. Their motion is resolvable into at least two components:—(1) a vibratory motion of flexion of the body, mainly for progression, and (2) a spiral or corkscrew movement of the body as a whole, due to the spirally wound membrane, which is composed of longitudinally arranged "myoneme" fibrillæ. The myonemes set up transverse movements on the surface of the body, manifested as waves passing down the body in a direction opposite to that in which the organism moves. The spirochætes seem to move more quickly than even trypanosomes, and with an added cork-screw motion. While flagella are present in the case of true Spirilla, they do not occur in spirochætes. What have been described as flagella or cilia by some investigators are really "myoneme" fibrils split off from the membrane during its rupture.

A DOUBLE number of *Le Bambou*, the first issue of this year, comprising Nos. 7 and 8, has been received. It contains a descriptive article on the aërial vegetative structures of bamboos, also notes on their cultivation and resistance to frost.

THE third number of vol. iii. of the Records of the Botanical Survey of India is appropriated to the determinations, by Dr. L. Radlkofer, of new species belonging to the order Sapindaceæ, based on material from India and Malaya.

THE results obtained by de Vries have led botanists to examine closely the so-called variable species, as from such species special modifications or new characters may most reasonably be expected. In the *New Phytologist* (February) Dr. L. Cockayne refers to a New Zealand plant of this type, *Leptospermum scoparium*, with regard to colour modification. Ordinarily the flowers are white, but a pink-flowered form was introduced to cultivation as *Leptospermum Chapmanni*, and recently another plant, bearing rich crimson flowers, has been discovered growing wild. Seedling plants of the latter have been raised, so that from the next generation some idea as to the origin of the plant, whether a mutant or hybrid, may be obtained. In *Science* (April 12) Dr. G. H. Shull notes that he can distinguish four elementary species in the numerous specimens of *Capsella bursa-pastoris* he has cultivated, all of which breed true, and that without geographical or complete physiological isolation they maintain themselves distinct.

AN account in the *Kew Bulletin* (No. 7) of the proceedings in connection with the Linnean bicentenary celebrations at Upsala, Lund, and Stockholm accords with other descriptions in testifying to the enthusiastic and impressive nature of the ceremonies. Correspondence connected with the award of the special Linnean gold medal to Sir Joseph Hooker is also published. An article on new or little-known algæ from eastern Asia is contributed by Mr. A. D. Cotton, in which a new alga from Ceylon, *Euptilota Fergusonii*, is described and figured. Dr. Otto Stapf communicates notes on two rubber plants, *Mascarenhasia elastica*, belonging to the order Apocynaceæ, that grows in British and German East Africa, and *Euphorbia fulva*, a tree known in Mexico as "Palo Amarillo." From the former balls of fair-quality rubber, known as "Mgoa," are prepared; the latex obtained from the latter contains a large percentage of resin, but a process of separation is said to have been devised. Mr. J. M. Hillier has collated information on Guayule rubber, the product of *Parthenium argentatum*, a shrubby composite of Mexico.

ACCORDING to the second part of the *Bergens Museum Aarbog* for the current year, Norway experienced an unusually small number of earthquake shocks in 1906, namely, thirteen, against twenty-three in 1905 and thirty-three in 1904. Mr. C. F. Kolderup, the author of the paper referred to, is of opinion that the comparative frequency of earthquakes in Norway is due to subsidence in the bed of the adjacent sea. In another article in the same issue Mr. J. Rekstad discusses ancient terraces and beach-lines in western Norway, illustrating his account with a number of reproductions from photographs.

IN the *Physikalische Zeitschrift* for August 15, Prof. F. Paschen gives the results of some careful measurements made by his pupil, Miss Stettenheimer, of the Zeeman effect in known magnetic fields for the lines Zn 4680 and Cd 4678 which behave normally. From the results he calculates by the theory of Lorentz the quotient of the electric charge on the ion by its mass, and obtains $1{\cdot}79\times10^{7}$. This agrees very well with the value $1{\cdot}77\times10^{7}$ given by Messrs. P. Weiss and A. Cotton in the June number of the *Journal de Physique* as the result of their measurements. The values which have been obtained by different experimenters for the above quotient in the case of the kathode rays differ so much from each other that it is difficult to fix on a representative one for comparison with the above numbers. Prof. Paschen takes the value $1{\cdot}88\times10^{7}$ given by Profs. Kaufmann and Simon, and is disposed to think that the difference between the values of the quotient in the two cases is due to some difference in the ions.

THE uncertainty as to the melting point of platinum, to which we referred a few weeks ago, is leading to corresponding uncertainties in all high-temperature determinations. Profs. C. E. Mendenhall and L. R. Ingersoll, in their paper on the melting points of rhodium and iridium in the July number of the *Physical Review*, are compelled to give two sets of values, one based on 1745° C., the other on 1789° C., as the melting point of platinum. They use the Nernst glower as a meldometer, place a very small particle of the metal on it, and observe through a microscope for what current through the glower the particle melts. The temperature of the glower is determined by measurement of the isochromatic radiation, assumed to follow a law similar to Wien's, with constants determined from the melting points 1065° C. and 1745° C. or 1789° C. of gold and platinum. With 1789° C. as

basis, they give the following melting points:—silicon, 1452° C.; palladium, 1576° C.; rhodium, 1968° C.; indium, 2388° C.; the temperature of the glower at normal brilliancy 2480° C., the melting point of the glower material 2490° C.

THE atomic weight of radium was determined five years ago by Mme. Curie on about 0·09 gram of a highly purified radium chloride. Large quantities of Joachimsthal pitchblende residues have since then been worked up, and from these 0·4 gram of pure radium chloride has been obtained. The method of purification adopted was re-crystallisation from weak hydrochloric acid and fractional precipitation of the aqueous solution by alcohol, the progress of the purification from barium being followed by means of the spectroscope. It seemed desirable to repeat the determination of the atomic weight on the larger quantity now available, and Mme. Curie gives an account of the method adopted in the current number of the *Comptes rendus* (No. 8, August 19). Difficulties were encountered owing to the presence of traces of impurities in the reagents, leading to a gradual loss of radium during the purification, and a detailed account is given of the elaborate precautions found to be necessary for the preparation and preservation of the reagents used. The atomic weight deduced from the ratio radium chloride: silver chloride is 226·2 (Ag=107·8, Cl=35·4), or 1·2 units higher than the value found on 0·09 gram in 1902. It is shown that the slight increase of purity of the 1907 over the 1902 preparation is not sufficient to account for the rise of 1·2 units in the atomic weight, the difference being most probably due to the loss of accuracy on the determinations with the smaller quantity and the use of reagents not properly purified.

THE August number of the Journal of the Institution of Electrical Engineers (No. 185, vol. xxxix.) contains, amongst others, a paper on the technical training of electrical artisans, read by Mr. C. P. C. Cummings before the Dublin local section of the institution. The subject is one which is very rarely treated in papers read before the Institution of Electrical Engineers or the branch sections, but, at the same time, it is one which is very important to the future development of electrical work. The term electrical artisan, as referred to by Mr. Cummings in his paper, deals almost entirely with those electrical artisans who are generally classified as "wiremen," and the paper treats of the possibilities of improving the existing methods by which such men are trained at the present day, so that more efficient workmen may be obtainable. Mr. Cummings very rightly points out that there is a very large majority of the "so-called wiremen" obtaining the maximum rate of wages per hour which the highly trained and competent workman is fully entitled to, who cannot be placed in the same class with him, and can obtain this rate without any trouble. This in itself is evidence of the serious defect in the method by which electrical artisans are produced. So long as these methods continue, they will produce a considerable number of men who cannot be considered fully competent, but very few first-class artisans, and from this very fact the really competent men consider themselves so strong by virtue of their minority that their demands upon employers and their general independence greatly reduce their utility. Mr. Cummings describes the present method of training electrical artisans, and points out the faults of the system and propounds a scheme which is well worth the consideration of educational authorities and employers—especially the latter—for until the employers take a practical interest in this matter they cannot hope to obtain the man most suited to their requirements.

MESSRS. JOHN J. GRIFFIN AND SONS, LTD., of Kingsway, have just issued a new edition of "Chemical Handicraft," giving particulars (in many cases illustrated) of the chemical apparatus and reagents manufactured and sold by them. Science teachers will find the volume very handy for reference.

THE lectures delivered under the Silliman foundation at Yale University in March, 1905, by Prof. E. Rutherford, F.R.S., which were afterwards issued in book form under the title of "Radio-active Transformations," have now been translated into German by Dr. Max Levin, of Göttingen, and published by F. Vieweg and Son, Brunswick. Brief reference is made in the volume, in the form of footnotes, to the more important advances in the subject which have taken place since the first appearance of the work in English.

OUR ASTRONOMICAL COLUMN.

DANIEL'S COMET, 1907*d*.—The following is a continuation of the ephemeris for comet 1907*d* given in No. 4196 of the *Astronomische Nachrichten* (p. 337, August 23):—

Ephemeris 12h. (M.T. Berlin).

1907	α (true) h. m.	δ (true) ° ′	log *r*	log Δ	Brightness.
Sept. 9 ...	9 41·5 ...	+11 5·7 ...	9·7250 ...	0·1139 ...	13·7
,, 11 ...	9 53·3 ...	+10 26·0			
,, 13 ...	10 4·7 ...	+ 9 45·9 ...	9·7495 ...	0·1408 ...	10·8
,, 15 ...	10 15·7 ...	+ 9 5·5			
,, 17 ...	10 26·3 ...	+ 8 25·1 ...	9·7818 ...	0·1654 ...	8·3
,, 19 ...	10 36·5 ...	+ 7 44·9			

It will be noticed that the brightness of this object is declining rapidly, and, as the comet rises nearer and nearer to sunrise, it is becoming increasingly difficult to observe. At present it rises about two hours before the sun, and on September 19 it will precede the sun by about 1½ hours, rising about 12° north of east.

Comptes rendus, No. 8 (August 19), contains the results of observations made by M. E. Esclangon at Bordeaux. The head of the comet was extraordinarily bright and of about 5′ diameter on August 1. Seven tails were seen, the extreme streamers being much shorter than the median. A reproduction of the observer's drawing shows the disposition of the tails.

SOLAR OBSERVATIONS AT CARTUJA, GRANADA.—In an extract from No. 3 (1907) of the *Bulletin de la Société belge d'Astronomie*, M. J. Mier y Terán, S.J., publishes an account of the solar observations and reductions now carried on at the Observatory of Cartuja-Granada (Spain).

Solar observations were commenced at the beginning of 1905 for obtaining statistics relating to sun-spots and faculæ. In January, 1906, photography was substituted for eye observations for the purpose of obtaining more precise measures, and photographs have since been secured on each clear day. A more suitable photoheliograph has recently been erected having an objective of 94 mm. (3·7 inches) aperture and 1·50 m. focal length, and fitted with a direct enlarger giving a solar image of about 10 cm. (4 inches) diameter. The areas and positions of the spots, &c., are measured with a Hilger micrometer, the positions afterwards being reduced to heliocentric coordinates in the usual manner, and it is hoped that the results will be found sufficiently precise to supplement the Greenwich measures. As it is proposed to publish these results in the tri-monthly numbers of the observatory bulletin, it may be expected that solar workers will find them available without having to wait for the Greenwich annual publications. Spectroscopic observations of the sun and the stars are also being carried on at Cartuja, and it is hoped that ere long the apparatus for spectrophotography with a large dispersion will be installed.

DISCOVERY OF SEVENTY-ONE NEW VARIABLE STARS.—The wholesale discovery of new variable stars from photographic plates is proceeding at Harvard, and in Harvard College Observatory Circular, No. 130, Prof. Pickering announces the discovery of a further batch of seventy-one new variables. These were found by Miss Leavitt on the Harvard maps Nos. 9, 12, 21, 48, and 51. Prof. Pickering gives a table showing the proportion of newly discovered variables to the total number now known to exist in each region examined, and arrives at the general deduction that about one-third of all the variables in the three northern regions examined, and about one-half of those in the two southern regions, yet remain to be found. The designations, positions, and magnitude ranges of the newly discovered variables are given, and the list includes thirteen probable Algol and seven long-period variables, the proportion of the former being remarkable, as in the case of Region 50 discussed in Circular No. 122.

THE ELECTRICAL ACTION OF THE SUN.—In these columns for March 14 we referred to a discussion, by Dr. Albert Nodon, of the nature and effects of the sun's electrical charge. The whole discussion is now published as an extract from the *Revue des Questions scientifiques* for April and July, and will be found to be of great interest by all workers on solar physics and the allied terrestrial phenomena. In the first part of the paper Dr. Nodon discusses the observations, the apparatus used in making them, and the theories deduced from them. The second part contains a discussion of the application of the results to the explanation of cometary, planetary, and terrestrial phenomena, whilst in the third part of the paper the author discusses the deductions relative to terrestrial physics. The paper is published by J. Polleunis, 45 rue Sans Souci, Brussels.

MICROMETER MEASURES OF DOUBLE STARS.—In No. 4193 of the *Astronomische Nachrichten* (p. 277, July 26) Dr. H. E. Lau publishes a further list of Struve double stars measured by himself, and discusses the mean probable errors of his measurements. In addition to the eighty measures made by Dr. Lau, the list also contains twenty-eight measures made by Herr Luplau-Jannsen.

THE MAY OR GORSEDD YEAR IN ENGLISH AND WELSH FAIRS.

SIR NORMAN LOCKYER has taught us to call the year indicated by alignments of stone monuments in Britain the May year. The quarter days of that year are astronomical, being the half-way stations of the sun between the solstices and equinoxes. In fixing these dates, of course, the solar quarter days were marked as well, which year is conveniently called the solstitial year. It will clear the way for the discussion of some figures bearing on the subject if the two series of quarter days are presented here side by side, as given in "Stonehenge Astronomically Considered," p. 23 :—

MAY YEAR ... Feb. 4	May 6	Aug. 8	Nov. 8
SOLSTITIAL YEAR ... March 21	June 21	Sept. 23	Dec. 23

The quarter in both series is of the same length, ninety-one days, and the distance from a solstitial quarter day to a May-year one is roughly forty-five days.

Though the name May year is a very happy one, as the May festival was certainly the most popular, it is really the Gorsedd year, the very *raison d'être* for that institution which, in form, purpose, and ritual, is the temple-observatory brought up to date. We know now for what purpose the megalithic monuments were raised, and that knowledge has been acquired by working from the known to the unknown. By assuming that the Welsh Gorsedd is a much truer representation of ancient Druidism than the manifestly inaccurate, second-hand observations of Cæsar and other classical writers, we are able to see at the Welsh National Eisteddfod in this twentieth century the actual use to which the temple-observatory was put. If such a broad assertion causes surprise, that surprise is considerably lessened by what seems to me to be an incontrovertible fact, that, instead of having one Gorsedd, and that in Wales, a true survival from late Neolithic times (to fix an indubitable downward limit), we have in Britain more than one thousand Gorsedds the pedigrees of which are as unimpeachable as that of the Welsh institution. I refer to fairs still held on the quarter days of the May year. To a student of the Welsh Gorsedd this fact at once dispels any *a priori* doubt as to the antiquity of that institution. It is only one among a thousand, though, I would maintain, it is the only one that shows what all the others were at first.

The Gorsedd and the popular fair are one and the same, constituting a true monument as ancient as a temple-observatory in stone. A better way of putting it is, the temple-observatory has survived in (1) stone, in (2) tradition, and in (3) festival. The Welsh Gorsedd presents this triple evidence.

There is, I think, no need for a formal proof of the prevalence of the May year in Ireland, Scotland, and Wales, or the "Celtic fringes." It reigns supreme over still purely Celtic ground. It is when one comes to England proper that even one accustomed to mark time in May-year terms must confess to a feeling of surprise. The evidence from the Celtic fringes is, of course, indispensable to understand and explain the English May-year fairs, but a brief presentation of the English case may be helpful by way of enlisting the cooperation of English archæologists to make that case as strong as possible.

I take Owen's "New Book of Fairs" for 1824 as source. The book was published by Royal licence, but as regards Wales it is incomplete, and I would infer as much as regards England. The following figures, except those given by counties, include the Welsh fairs as given in the list. That inclusion cannot affect seriously the English case, as will be seen.

The relative popularity of the May and of the solstitial years may first be ascertained by comparing the number of all fairs in May with those in June. May fairs, 510; June fairs, 250; 2 to 1 for May.

There are two lists of fairs in Owen's book, one by counties and the other by dates. I take the latter first. The figures in every case are my own. As the book is incomplete, and all lists of fairs I have consulted are so, I have thought it sufficient for the present purpose to make only one rapid reckoning of the fairs. The chief fair days can be easily noted by large groups of fairs. The fairs corresponding to the May-year festivals are to be looked for under several dates. The astronomical day is in many cases observed eleven and twelve days later. Generally, that day has given way to the first of the calendar month. In both cases new and old style dates must be noted. Then there are fairs depending on such dates. All fairs held during the first twelve days of the month should be numbered. In the case of November, the inclusion of Martinmas fairs needs no comment, as November 11 is a Scottish quarter day, and the Scottish quarter days, with the fact that in Gaelic-speaking Scotland the months, as well as the seasons, are still reckoned in the true May-year order, is sufficient formal proof of the predominance of that year on Celtic ground.

February	Fairs	May	Fairs	August	Fairs	Novyember	Fair
2 ...	8	1 ...	32	1 ...	18	1 ...	10
5 ...	7	4 ...	42	2 ...	29	6 ...	13
13 ...	20	6 ...	38	5 ...	53	8 ...	43
14 ...	12	8 ...	14	10 ...	16	11 ...	17
D. ...	21	12 ...	81	12 ...	26	12 ...	26
—		13 ...	11	15 ...	13	13 ...	14
—		14 ...	42	D. ...	50	17 ...	18
—		17 ...	16	—		22 ...	43
—		18 ...	12	—		D. ...	57
—		D. ...	71	—		—	
	68		359		205		241

D. = Dependent fairs.

Thus we have 873 plain May-year fairs. I claim now the Church-year fairs, which are plainly the old May-year festivals. For February 4 I claim 28 fairs between Candlemas and the beginning of Lent; for May 6, 358 Whitsun and Ascension fairs; and for November 8, 53 fairs at Michaelmas, 71 on October 10 (Old Michaelmas), and 32 on December 11 (Old St. Andrew's Day). Though Michaelmas and St. Andrew's Day are both a month away from November 1, they constantly occur as half-year

days corresponding to May Day. It is very likely, however, that some of the August fairs have been absorbed into Michaelmas. As that day occurs so near to the autumnal equinox, some concession must be made also to the solstitial year. There is no need, however, to decide these points at present.

We can now add 542 to our list of May-year fairs, altogether 1415 fairs which may reasonably be claimed as so many Gorsedds or prehistoric monuments, 96 in February, 717 in May, 205 in August, and 397 in November. It is curious to note that the number of plain May fairs and of Church-year May fairs is the same. The ratio for November seems to be too high, and the number for that month has grown evidently at the expense of August. Dividing the total for August and May, we get 301 for each of those months to match the figure for May, which is always at least twice as high as the corresponding figures. For obvious reasons February is a poor time for fairs, and the intrusion of Lent has very generally broken up that end of the May year. A more thorough scrutiny will be the means of recovering many February 4 fairs.

If the above estimate is considered too generous, my estimate of the solstitial-year fairs must err more in that pleasing direction, for I include, against strong reasons, all the Easter fairs in that estimate.

	Fairs		Fairs
March 21	2	June 22	29
April 5...	37	,, 24	35
	39	July 5	54
			118
Easter	231	Trinity	59
	270		177

	Fairs		Fairs
Sept. 19	31	December 21	7
,, 21	20	,, 25	8
Oct. 2	53		
	104		15

There are, then, 276 true solstitial fairs and 347 Church-year fairs to bring the total up to 623; but the figure for Easter shows evident borrowing from February, the vernal equinox, and May. A fair ratio would be obtained by counting sixty Easter fairs for the vernal equinox and the remainder for February.

In claiming the Easter fairs for the May year, I have a larger number of fairs to add to the solstitial estimate. Beside the May year, with the portions of the Church year which are evidently based on it, and the solstitial year as such, there are two other series of dates to consider. The one I would call the Roman year, being important dates in the old Roman year, which were early associated with the names of Christ, St. Mary, and at least six of the Apostles. I refer to groups of fairs on the 25th of the month. There are 25 fairs on March 25 and 43 on September 25, 68 fairs which I would add to the solstitial estimate.

The other series of dates I would call the Petrine year, with groups of fairs on the 29th of the month. When the old Celtic saints of Llandaff Cathedral, Teilo and Dyvrig, May-year saints, were superseded in Anglo-Norman times by SS. Peter and Paul, June 29 was fixed as the beginning of the year in that cathedral. The canons there still mark their time of residence as from that date. The Petrine year is fairly general, though it is altogether subsequent to the middle of the twelfth century A.D., at any rate in South Wales. There are 18 fairs on March 29, 35 on June 29, 45 on July 10 (O.S.), 53 on September 29, and 71 on October 10 (O.S.), in all 251 fairs which I would add to the solstitial estimate, which now stands at 948 fairs.

The May year is still 467 ahead, and the May-year figures are certainly much more satisfactory than the large figures I have juggled for the solstitial estimate. If the latter is fairly correct, I must now add it in a lump to that of the May year, and say that we have still in England and Wales 2363 fairs, relics of festivals held at the same spots or thereabouts when the dates were obtained by direct solar observations by means of aligned monuments. Several capable archæologists have expressed the opinion, anent the astronomical theory, that they admit the solstitial alignments, while doubting the very existence of the May year in connection with the monuments. Such admission is substantially complete. The solstices and equinoxes were of little direct practical use to the ancient farmer as dates to commence farming operations. The Welsh farmer of to-day is finely indifferent to the almanac statements that spring begins on March 21 and winter on December 23. He knows better. The solstitial quarter days were observed as points from which the infinitely more practically important May quarter days could be correctly marked.

So far I have made only a rough preliminary reconnaissance of the list of fairs. I now take up Owen's list of fairs by counties, not to learn more about the relative prevalence of the May and the solstitial year so much as to learn more concerning the May year itself. Except May 6 and November 8, I have counted all fairs in February, May, August, and November. From the Church year I have borrowed only some pre-Lenten fairs for February and the Whitsun fairs for May. The total is just the same, but the analysis is much more to the point. The Welsh fairs are included, though the list is very defective. The letters F.M.A.N., variously grouped, represent May-year quarters:—

	Feb.	May	Aug.	Nov.	May 6	Nov. 8	Fu year	F. M.	F. M. A.	F. A.	M. A.	M. A. N.	M. N.	A. N.	F. A. N	F. N.	F. M. N.
Bedford ...	3	8	3	7	—	1	2	—	—	—	—	—	1	—	—	—	—
Berks	2	7	2	4	—	1	—	2	—	—	1	—	—	—	—	—	—
Bucks ...	3	11	3	3	3	1	—	1	—	1	—	—	1	—	—	—	—
Cambs ...	—	3	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—
Cheshire ...	1	9	5	7	2	1	—	—	—	—	2	—	5	1	—	1	—
Cornwall ...	7	27	11	17	2	3	—	—	—	—	2	—	9	1	—	1	—
Cumberland	1	7	5	2	—	—	—	—	—	—	2	—	2	—	—	—	—
Derby ...	4	9	4	8	1	1	1	1	—	—	—	1	—	—	1	2	1
Devon ...	8	25	15	11	2	1	—	1	—	2	4	—	4	1	—	—	—
Dorset ...	2	11	7	5	1	1	—	—	—	1	—	—	1	—	—	—	—
Durham ...	—	8	1	4	1	—	—	—	—	—	—	1	3	—	—	—	—
Essex	—	30	10	8	2	1	—	—	—	—	2	—	2	—	—	—	—
Glouc. ...	1	19	4	8	2	2	—	—	—	1	2	—	5	—	—	—	—
Hants ...	4	21	2	7	2	2	—	—	—	—	—	—	3	—	—	—	1
Hereford ...	5	12	4	6	1	1	—	1	2	—	1	—	3	—	—	—	1
Herts ...	—	10	3	2	—	1	—	—	—	—	2	—	1	—	—	—	—
Hunts ...	5	12	4	6	—	—	—	—	—	—	1	—	1	—	—	—	—
Kent	5	40	20	7	3	2	—	1	—	1	—	—	1	1	—	—	—
Lancashire	2	16	7	11	1	—	—	—	1	—	2	—	3	2	—	1	—
Leicester ...	3	4	3	4	—	—	—	—	—	—	1	—	—	1	—	2	—
Lincoln ...	1	16	11	9	2	2	1	—	—	—	1	2	1	2	—	—	—
Middlesex ...	—	4	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—
Norfolk ...	3	24	11	13	1	2	—	1	—	1	2	—	4	—	—	—	—
Northamptn.	6	11	5	3	—	—	2	—	2	—	—	—	—	—	—	—	—
Northumberland ...	—	9	7	7	—	1	—	—	—	—	2	—	3	2	—	—	—
Notts ...	1	6	2	3	—	1	—	—	—	—	—	—	2	—	—	—	—
Oxford ...	1	7	7	5	1	1	1	—	—	—	1	—	2	2	—	—	—
Rutland ..	—	1	—	1	—	1	—	—	—	—	—	—	1	—	—	—	—
Salop	5	18	9	6	1	—	1	1	2	—	2	—	2	1	—	—	1
Somerset ...	5	27	25	13	2	3	—	1	—	—	5	1	2	—	—	—	1
Stafford ...	8	14	5	10	3	—	—	—	1	—	1	—	3	1	—	—	2
Suffolk ...	2	16	12	4	—	1	—	1	—	—	2	—	1	—	—	1	—
Surrey ...	1	16	5	6	—	—	—	—	—	—	—	1	1	—	—	—	—
Sussex ...	—	51	12	12	2	2	—	—	—	—	8	—	6	—	—	—	—
Warwick ...	4	9	4	4	1	2	3	1	—	—	—	—	—	—	—	—	—
Westmorland ...	—	6	1	1	—	1	—	—	—	—	1	—	—	—	—	—	—
Wilts	1	17	10	2	6	—	—	—	—	—	—	—	—	1	—	—	—
Worcester ...	2	4	4	1	—	—	1	1	—	—	2	—	—	—	—	—	—
Yorks ...	15	42	22	26	5	2	—	6	—	—	1	6	4	1	1	—	3
	111	587	266	254	18	38	12	19	8	7	51	12	77	17	2	8	10

	Feb.	May	Aug.	Nov.	May 6	Nov. 8	Full year	F. M.	F. M. A.	F. A.	M. A.	M. A. N.	M. N.	A. N.	F. A. N.	F. N.	F. M. N.
Anglesey ...	3	2	3	5	1	—	—	1	—	—	—	—	1	3	1	—	—
Brecknock...	—	5	2	3	—	—	—	—	—	—	1	1	2	—	—	—	—
Cardigan ...	4	2	2	2	—	—	1	—	—	—	—	—	—	—	—	—	—
Carm. ...	—	7	6	10	1	1	—	—	—	—	—	—	3	1	—	—	—
Carn.	1	7	8	6	—	1	—	—	1	—	—	1	2	—	1	—	—
Denbigh ...	2	12	9	9	2	1	1	—	—	—	—	3	4	—	—	1	—
Flint	3	5	4	3	—	—	1	—	—	—	1	—	—	—	1	—	—
Glam. ...	2	7	7	5	1	—	1	1	—	—	2	1	1	—	—	—	—
Merion. ...	1	5	7	5	—	—	—	—	—	—	—	1	2	—	—	—	—
Monmouth	—	6	4	3	1	—	—	—	—	—	1	2	1	—	—	—	—
Montgomery	—	5	1	3	—	—	—	—	—	—	1	—	2	—	—	—	—
Pembroke	—	5	1	5	—	—	1	—	—	—	—	—	1	1	—	1	—
Radnor ...	1	5	2	2	1	—	—	—	—	—	—	—	1	—	—	—	1
	17	73	56	61	7	3	5	2	1	—	6	9	20	5	3	2	1
England and Wales ...	128	660	322	315	55	41	17	21	9	7	57	21	97	22	5	10	11

It is curious to note that the total of fairs in February, May, August, and November, with pre-Lenten and Whitsun fairs, is 1425, just ten less than the total of true May-year fairs *plus* all the Church-year fairs which I would claim for that year. I can, therefore, add the Michaelmas and St. Andrew fairs to the last total obtained and make it 1571, or a round fifteen hundred May-year fairs, nearly two-thirds of the total number of solar, as distinguished from mere calendar, fairs.

Wales makes but a very poor show in Owen's list. Instead of five complete May-year series, I have noted ten in North Wales alone; but it serves the present purpose to keep Wales in the background.

It is satisfactory to find seventeen complete series. The case of Weldon, Northamptonshire, is eloquently put as follows:—"First Thursday in February, May, August, and November." There are, however, ten other combinations of May-year quarter days, each of which tells the same tale, and there are 277 places where the May-year seasons are observed by fairs, that is, where more than one May-year fair is held. The relative prevalence of the eleven combinations may be shown as follows:—

	Feb.	May	Aug.	Nov.
17	1	1	1	1
10	1	—	—	1
21	1	1	—	—
9	1	1	1	—
7	1	—	1	—
57	—	1	1	—
21	—	1	1	1
97	—	1	—	1
5	1	—	1	1
22	—	—	1	1
11	1	1	—	1
277	7	7	7	7

Each May-year quarter day enters into seven combinations, which reminds me of the story invented, I believe, to account for the popular name of the parish from which I write, *Yr Hên Blwyv*, the Old Parish. The story goes that a stone-cutter carved the figure 7777 on a gravestone intended to commemorate a man whose age was twenty-eight. By the way, multiplying the May-year sevens together would be a good way to remember the number of solar fairs we have made out, 2303 for 2363, leaving a margin of sixty for possible errors in such a large estimate.

No combination of figures affects the supremacy of May Day. February enters into combination with other quarters at 80 places, May at 230, August at 139, and November at 183. Generally, the ratio seems to be:—February = 1, May = 3, August = 2, November = 2.

But in the two most decisive factors there is not much to choose between May and November. These two factors are the prominence of the summer half of the May year and the fact that the astronomical dates are still observed at ninety-six places in remarkably even numbers—May, 55; November, 41. May 6 is associated with St. John the Evangelist. Such association may have helped to preserve the date; but no such Church sanction, favour, or support has been given to November 8. There are four places in England where both dates are still observed. In several instances where the astronomical dates have been preserved I note a startling parallelism between the dates and the prominence acquired by those places in tradition and archæology.

List of Places where Fairs are held on May 6 and November 8.

Bedfordshire ...	Nov. 8 ...	Biggleswade.
Berkshire	May 6 ...	Abingdon, Aldermaster.
	Nov. 8 ...	Newbury.
Buckinghamshire	May 6 ...	Buckingham, Ivinghoe, Risborough.
	Nov. 8 ...	Buckingham.
Cheshire	May 6 ...	Macclesfield, Frodsham.
	Nov. 8 ...	Knutsford (or Knotsford).
Cornwall	May 6 ...	Treganotha, West Looe.
	Nov. 8 ...	Helstone, Newlyn, Stratton.
Derbyshire ...	May 6 ...	Pleaseley.
	Nov. 8 ...	Ripley.
Devonshire ...	May 6 ...	Chawley, Tavistock.
	Nov. 8 ...	Hatherleigh.
Dorsetshire ...	May 6 ...	Stalbridge.
	Nov. 8 ...	Blandford.
Durham	May 6 ...	Walsingham.
Essex	May 6 ...	Dunmow, Halstead.
	Nov. 8 ...	Dunmow.
Gloucestershire	May 6 ...	Dursley, Winchcomb.
	Nov. 8 ...	Cirencester, Lydney.
Hampshire ...	May 6 ...	Liss, Southampton.
	Nov. 8 ...	Blackwater, Rumsey.
Herefordshire ...	May 6 ...	Wigmore.
	Nov. 8 ...	Leominster.
Hertfordshire ...	Nov. 8 ...	Hertford.
Kent	May 6 ...	Ashford, Groombridge.
	Nov. 8 ...	Biddenden, Chilham.
Lancashire ...	May 6 ...	Newton.
Lincolnshire ...	May 6 ...	Bourn, Holbeach.
	Nov. 8 ...	Alford, Stamford.
Middlesex ...	May 6 ...	Brentford.
Norfolk	May 6 ...	Rudham.
	Nov. 8 ...	Diss, Massingham.
Northumberland	Nov. 8 ...	Hexham.
Nottinghamshire	Nov. 8 ...	Bingham.
Oxfordshire ...	May 6 ...	Chipping Norton.
	Nov. 8 ...	" "
Rutland	Nov. 8 ...	Oakham.
Shropshire ...	May 6 ...	Wem.
Somersetshire ...	May 6 ...	Pensford, Stoke-Gomer.
	Nov. 8 ...	Dulverton, Pensford, Somerton.
Staffordshire ...	May 6 ...	Uttoxeter, Wednesbury, Longnor.
Suffolk	Nov. 8 ...	Newmarket.
Sussex	May 6 ...	Lewes, Bolney.
	Nov. 8 ...	Billinghurst, Forest Row.
Warwickshire ...	May 6 ...	Coleshill.
	Nov. 8 ...	Sutton, Warwick.
Westmorland ...	Nov. 8 ...	Kendal.
Wiltshire	May 6 ...	Amesbury, Colne, Maiden Bradley, Chippenham, Mere, Purten.
Yorkshire	May 6 ...	Hunmanby, Knaresborough, Pocklington, Askrig, Burton in Bishopdale.
	Nov. 8 ...	Leeds, Keighley.
Wales	May 6 ...	Langharne, Llannerchymedd, Nantglyn, Hay, Penrice, Knighton.
	Nov. 8 ...	Aberconway, Llanedi, Llanrhaiadr.

From other sources I find six more May 6 fairs in Wales and three November 8 fairs, in all twelve of the former and six of the latter. Only in one place, Llanfynydd, Carm., I find both days observed.

Pensford, where both dates are retained, is near Stanton Drew, where Sir Norman Lockyer has made out a May alignment. At Lydney, Gloucestershire, a Roman inscription has been found to the Celtic Neptune, *Nudd* or *Lludd*. At Hexham a similar inscription equates Apollo with the Celtic god Maponos. Dunmow's flitch of bacon should be carefully studied.

I think all will admit that the phrase "startling parallelism" is no exaggeration when the case of Wiltshire is considered. When Sir Norman Lockyer ascertained the age of Stonehenge from the alignment of the avenue, he found evidence there of an earlier May-year temple. Geoffrey of Monmouth fixes the earliest festival he mentions as having been held at Stonehenge on the Kalends of May. That must have been against his liking as an ecclesiastic, and the next festival, held shortly after the first, he fixes at Pentecost, the Church equivalent of the May festival; but Geoffrey never fixes a Church festival where and when such a festival was an historical impossibility. Therefore it is practically certain Stonehenge was a May temple pure and simple in the fifth century A.D.

Now Wiltshire heads the record with six fairs on May 6 and its equivalent May 17. So the astronomical, historical, and ferial evidences point clearly to the preeminence of Stonehenge as a May temple. No wonder the Welsh bards claim it as one of the three chief Gorsedds.

But what of the manifestly solstitial character of the present ruins at Stonehenge? In Wiltshire seventeen out of thirty May-year fairs are held in May, but the May year as such is nearly *non est*. May and August combine in one place, that is all. On the other hand, the solstitial year in the county is a fairly well-balanced year. There are five fairs held on the vernal equinox, five on the summer solstice, eleven on the autumnal equinox, and three on the winter solstice, the last figure being quite significant, as definite winter solstice fairs are very rare, though, of course, as Christmas, it has no rival.

Now, the local fairs connect the two series of facts in the most striking manner. "Amesbury, May 17, June 22." So does Owen solve the riddle of Stonehenge. Chippenham, May 17, June 22. Maiden Bradley, May 6, October 2 (O.S. for September 21). Mere, May 17, October 10 (O.S. for September 29, here very likely September 21 at first). Ignoring the date May 6, we have many other like combinations, February 14—October 2, May 14—September 25, July 10—August 1, May 14—October 10, May 12—October 2, May 20—September 23—December 23, May 7—October 8. At Laycock we have only the two solstices July 7—December 21.

Since the foregoing tables were compiled, I have discovered that the estimates for both the May and the solstitial years are much too low, even on the incomplete showing in Owen's list. The astronomical date is to be looked for not only eleven days later, as, for instance, May 17 at Amesbury for May 6, but also eleven days earlier. When immediately before 1752 A.D. the solstice was the eleventh, the date corresponding to our May 6 would be April 26. In 1824 there was a remarkable series of fairs eleven days before the May-year quarter-days proper. This came out while I was searching for some explanation of the strange fact that there is not a single fair on February 4. I find them under January 25. August 5 is the most popular survival of the old August quarter day, and the equivalent of that date is July 25, and that of November 8 is October 29. As the tables given above are sufficient to show the distribution and relative prevalence of May-year fairs, it may suffice to add only the places where the overlooked series of fairs is found.

January 25 (February 4).—Bentham, Bingley, Bodmin, Chesterfield, Churchingford, Derby, Kington (Warwickshire), Weasenham, Whittlesea in the Isle of Ely. (Nine fairs.)

April 23 (May 4).—Bewdley, Billesden, Bruton, Campden, Downton, Finchampstead, Great Bedwin, Hatfield, Hinton St. George, Holywell, Manhineot, Methwould, Norlease, Oakingham, Sawbridgeworth, Stanaway, Tenbury, Yetminster. (Eighteen fairs.)

April 25 (May 6).—Ashover, Bracknell, Brigstock, Burnham (Essex), Crowborough, Dronfield, Great Oakley, Holt (Norfolk), Iron-Acton, Llandegla, Llannerchymedd, Llanrwst, Limpsham, Loughborough, Medhurst, Methwould, Parkgate, Stoke-under-Hampden, Toddington, Warkworth. (Twenty fairs.)

April 25 and 26 (May 6).—Kendal, Penrith. (Two fairs.)

April 26 (May 6).—King's Norton, Ovingham, Settle. (Three fairs.)

April 27 (May 6).—Axminster, Boroughbridge, Cerrig y Druidion, Dorston (Heref. There is a cromlech there), Holdsworthy, Keynsham, Mortimer, Spalding, South Molton. (Nine fairs.)

April 28 (May 6).—Boroughbridge, Cerne-Abbas, Keynsham, Malmesbury, Soham. (Five fairs.)

I claim April 23 because of the popularity of May 4. The two-days' fairs at Kendal and Penrith connect April 25 and 26 with May 5 and 6. I claim April 27 and 28 for a similar reason, namely, that both at Boroughbridge and Keynsham there are two-days' fairs held, which must have been old May festivals. We have the first and the last day of the three-days' festival in the fairs at Methwould on April 23 and 25.

There are only two fairs on August 8, Rhuthin and Shepton Mallet, and there are only two fairs on the equivalent date, July 29, Mountsorrel and Wivelsfield. Mountsorrel is an interesting name, as, I believe, some authorities hold that the wood-sorrel was the original shamrock, which we have reason to claim as a May-year emblematic plant. The great August fair day is the fifth, which we are sure was one day of the August festival because it is coupled with the sixth in two-days' fairs at Ewhurst, Goldsithnay, Louth, and Trowbridge.

July 25 (August 5).—Acle, Alresford, Ashton-under-Lyne, Barnard Castle, Billesdon, Blackboys, Castle-Acre, Little Clacton, Derby, Dunwich, Earith, Gissing, Great Wakering, Hockwold, Ipswich, Leigh (Kent), Lindsey, Liverpool, Middlewich, Milverton, North Down, Reading, Saltash, Seaford, Shoreham (Sussex), Southrepps, Staple, Tiptree Place, Totnes, Tregony, Trew, Wisbech (Isle of Ely), Wells, Yarmouth (Isle of Wight). (Thirty-four fairs.)

July 26 (August 8).—Bewdley, Clare, Great Bedwin, Hastings, Horsemonden, Kirby, Lewes, Llanelian, Llansawel, Leighton Buzzard, Malpas, Mattingley, Newnham (Kent), Portsdown, Sherborne, Tamworth (Staff.), Twyford. (Seventeen fairs.)

July 28 (August 8).—St. Kenelm's, Leek, Manhineot, Week St. Mary, Winchcomb. (Five fairs.) (I claim this date on the strength of the correspondence of the Manhineot July fair with that on April 23.)

The fairs in October are very numerous. From the 20th to the 29th I recognise familiar May-year places, such as Cerrig y Druidion, Sawbridgeworth, and Wells on the 20th; Boroughbridge and Llansawel on the 23rd; Leighton Buzzard on the 24th; Bentham and Wells on the 25th.

October 26 (November 8).—Appletreewick (an excellent name), Grantham, Edwinstone, Llandegla, Llansannan, Ovingham, Pen y Bont (Radnor), Spalding, Warminster, Whittlesea in the Isle of Ely. (Ten fairs.)

October 27 (November 8).—Abergwili, Appletreewick, Caergwrle, Cleobury-Mortimer, Darley-Flash, Daventry, March in the Isle of Ely, Nantglyn. (Eight fairs.)

October 28 (November 8).—Alnwick, Askrig, Bangor, East Dean, Llanidloes, Lifton, Linfield, Milbourne-Port, Needham, Plympton, Radnor, South Harting, Thirsk, Totnes, Warminster, Whitchurch (Salop), Wigan. (Seventeen fairs.)

October 29 (November 8 strictly).—Abbey-Holm, Ambleside, Askrig, Bourn, Little Brickhill, Bridgenorth, Broadwater, Burton, Chaford, Charing, Chippenham, Clay, Ely, Ewell, Farringdon, Halstead, Hampton (Gloucestershire), Henley-in-Arden, Highworth, Hindon, Holt (Denbighshire), Horncastle, Hunmanby, Kidwelly, King's Cliff, Kirkby Stephen, Saint Lawrence (Cornwall), Marlow, Midhurst, Mongham, Newcastle-upon-Tyne (nine days), Pamphill, Pleasley, Radnor, Sedburgh, Tenby, Thirsk, Tidswell, Towcester, Tunbridge, Uphaven, Usk, Wellingborough Wigan. (Forty-four fairs.)

Without making any further attempt at estimating the number of May quarter-day fairs, we must count nine fairs on January 25 as February 4 festivals; add 57 to the 38

on May 6, in all 95 fairs which are strictly May 6 fairs; add 56 to the 53 on August 5, and regard them all as strictly August 8 fairs; and add 79 to the 43 on November 8, though there are more fairs in October claiming such recognition.

Our lowest possible estimate of true May-year fairs is now as follows :—

	Feb.	May	Aug.	Nov.	
	77 ...	416 ...	261 ...	321 ...	Total 1074
Astronomical	35 ...	96 ...	109 ..	122 ...	,, 362

The table of the quarter-day groups must likewise be corrected, only to strengthen materially the whole case for the May-year. (Only in a few cases have I been able to correct Owen's spelling of place-names.)

The Bardic Mystic Sign. (Reproduced from "Barddas." "Morien" quotes Payne Knight's "Symbolical Language of Art and Mythology," pp. 69, 70, where it is stated that the same sign, with a small circle or ring at the converging point of the three lines, is a very ancient emblem in Asia Minor. The angles in Knight's sketch, as reproduced by "Morien," are also exactly 28° each.)

George Meredith makes one of his Welsh characters "think in triads." Here is a new triad :—"The three interpreters of the riddle of the stones: the Sun, the Gorsedd, and the Popular Fair." I have already shown (NATURE, May 2) that the May year is the true basis of the Gorsedd. The bardic *Nôd Cyvrin*, Mystic Sign, which Mr. A. L. Lewis (NATURE, June 6) associates very naturally with the "broad arrow," is really a miniature Gorsedd. I have tested several printed cuts of the sign and find the angles to be 28°, that is, regarding the middle line as an east-west line, the right line points to N. 62° E. and the left to S. 62° E., the only possible emblematic representation, in the simplest form, of the May year in the Gorsedd country. JOHN GRIFFITH.

KATHODE RAYS AND THE AURORA.[1]

THE idea that kathode rays play a part in aurora has been advanced by several physicists. Prof. Kr. Birkeland ("Expedition Norvegienne," 1899–1900, Christiania, 1901) has described a number of phenomena produced by kathode rays in the neighbourhood of a magnetised sphere, which resemble various types of aurora. He supposed the sun to be a primary source for kathode rays, which might set up secondary rays in the earth's atmosphere. Mr. C. Störmer has carried out elaborate calculations as to the possible ways in which electrified particles coming from a great distance can approach a magnetised "earth"; his

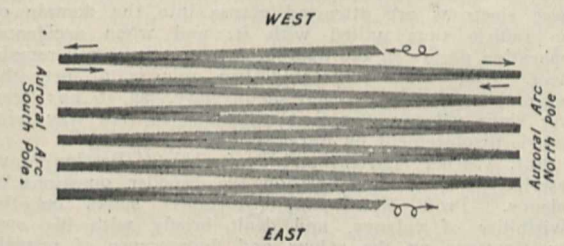

FIG. 1.

results tend to limit the approaching particles to the space near the magnetic poles. Prof. S. Arrhenius has supposed electrified particles to be driven from the sun by the repulsion of light and to reach the earth's atmosphere in about two days, originating aurora and magnetic storms.

M. Villard refers to Arrhenius's theory, but seems somewhat sceptical as to the supposed solar origin of the electrified particles. His own views appear to be a combination of theory and observation as to what happens to ions or electrified bodies of any kind moving in a magnetic field. In a uniform field the ion, when travelling with uniform velocity, describes a regular helix on a cylinder the axis of which is parallel to the lines of magnetic force. The radius of the cylinder varies directly as the component of the velocity perpendicular to the lines of magnetic force, and inversely as the intensity of the field. Suppose, however, that the magnetic field is not uniform, but increases in intensity in the direction in which the ion travels; then, as has been shown by Poincaré, the path forms a curve with diminishing spirals on a cone, and before actually reaching the summit of the cone the particle ceases to advance, and retires, the spirals gradually opening out. If, for instance, the field is that due to two elongated parallel poles, then if the particle gets under weigh between the poles, travelling obliquely to the lines of force, there is a regular game of battledore and shuttlecock, the particle zigzagging to and fro slantwise, reversing its direction whenever it gets within a certain distance of either pole.

M. Villard supposes ions to get in motion somewhere in the earth's atmosphere. As to exactly how this comes about he is not prepared to dogmatise. He is inclined to think that cirrus clouds—which he believes to consist of ice particles negatively electrified—under the influence of ultra-violet light, or less probably under a solar bombardment such as Arrhenius postulates, are probable sources. He also thinks that not improbably a part is played by cosmical dust encountered in the earth's movement through space. Ions starting, say, from a cirrus cloud, and moving obliquely to the lines of magnetic force in the earth's atmosphere, will travel each in a spiral, the whole together forming a sort of luminous spindle, which on getting within a certain distance of, say, the south magnetic pole, turns as if reflected, makes for the north pole, suffers a second reflection there, and so on. Fig. 1, copied from M. Villard's paper, represents the idea diagrammatically. The particles are supposed to come in at the top (answering to the west) and first to travel south. The movement may be supposed to be set up by ultra-violet light from the sun falling on cirrus. The first band or two will thus be in the still illuminated hemisphere, and so invisible; succeeding bands will be overhead in the unlighted hemisphere, and will be visible. Passing further to the east, the energy will be gradually dissipated and the aurora cease to be visible, thus explaining why the late evening, and not the morning, is normally the time of most brilliant aurora.

To fit the theory, the charge carried by the particles must be negative. If it were positive, the motion would be from the east, and the principal aurora would be in the early morning. Fig. 2 reproduces a photograph showing the actual appearance near a magnetic pole from one point of view, in one of M. Villard's experiments. He regards the intensifications of brightness, due to the superposition

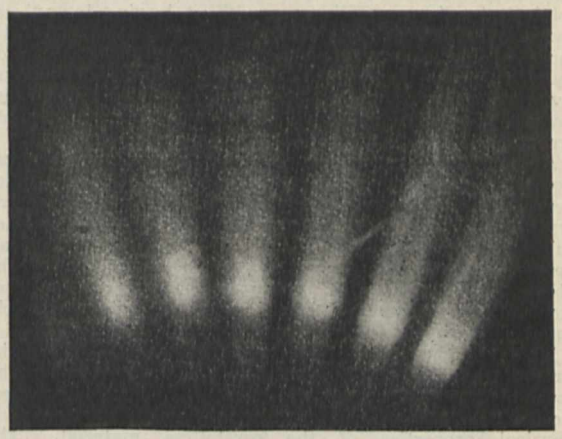

FIG. 2.

of the direct and return paths, as answering to an auroral arc. Below the arc there would, he says, be total darkness—answering to the "dark segment" of the ordinary aurora—but for a special form of discharge which he terms "magneto-kathodic" rays; these rays require, he says, a very steep potential gradient, and do not exist in the earth's atmosphere. Changes in the magnetic field or

[1] "Les Rayons cathodiques et l'Aurore boréale." By M. P. Villard. (*Bulletin de la Société d'Encouragement pour l'Industrie nationale*, May, 1907.)

in the velocity of the particles alter the distance between the bright patches in Fig. 2, giving the effect of changes of luminosity running round a circle, a well-known auroral phenomenon. Other phenomena analogous to the "dancing" of auroral rays are easily produced by advancing or withdrawing a bar magnet. M. Villard seems to regard magnetic disturbances rather as agents causing auroral phenomena than the converse, but his theory seems still in a somewhat uncrystallised state. Those actually familiar with auroral phenomena will think of a number of points requiring explanation to which M. Villard does not refer; but his researches, like those of Prof. Birkeland, are at all events highly interesting and suggestive.

C. CHREE.

CHEMISTRY AT THE BRITISH ASSOCIATION.

THE proceedings of this year's meeting were largely influenced by the number of foreign visitors, most of whom made lengthy communications to the section. The latter part of the president's address in particular elicited the warmest approval; it was felt that his warning against the danger we now run into of neglecting to cultivate manipulative skill in the young chemist was most timely. The discussions ranged over an unusually wide field; that on valency came first in importance; in its course the new doctrine of Barlow and Pope was subjected to searching criticism, although the general tone was far from hostile. Of deep significance, as illustrating the importance of maintaining the very closest connection between science and industry, was the discussion on the quality "strength" in flour; it was felt by those concerned in the debate that this did much towards establishing clear ideas on this controversial subject.

Prof. Pope opened the discussion on valency with an account of the theory put forward by Mr. W. M. Barlow and himself. Combining chemical with crystallographic data, it is possible to show that the fundamental valency of an element represents, very approximately, the number of units of volume contained in the polyhedral cell which constitutes the domain of its atom in any molecular assemblage. Valency, from this point of view, is primarily a simple volume relation. If the atoms are regarded as centres of attraction and repulsion, a crystalline structure may be considered to be an equilibrium arrangement of such centres. If each atom be allotted its own polyhedral cell or sphere of influence, the simplest assumption that can be made as to the shape of these spaces is that they depart as little as possible from sphericity. The polyhedral cells must fill space without leaving interstices, and the centres of the identical polyhedral cells will be those of the centres of a closest packed assemblage of equal spheres. There are two varieties of homogeneous arrangement of equal spheres in closest packing, distinguished as the cubical and the hexagonal closest packed arrangements.

A crystalline element, in which no molecular aggregation of the single atoms occurs, should thus exhibit holohedral cubic or hexagonal symmetry. Of the forty known crystalline forms of the elements, only six are neither cubic nor hexagonal; in the rest the axial ratios all approximate to the theoretical values calculated on the above hypothesis. The binary compounds can be constructed from spheres of two kinds, but of approximately equal size, present in equal numbers.

This hypothesis has been worked out in detail in the case of the alkali haloid salts and of silver iodide. The assemblages thus constructed present geometrical properties which are entirely in harmony with corresponding physical properties of the crystalline material. The cleavage, twinning, and gliding of the cubic alkali haloid salts and the dimorphism of silver iodide are precisely paralleled by corresponding properties of the assemblages suggested as representing the crystalline structures of these salts.

Each crystalline substance is to be regarded as a close-packed homogeneous assemblage of the spheres of atomic influence.

Prof. Sollas criticised the form of close packing put forward by Messrs. Barlow and Pope, and objected to the structure suggested for silver iodide on the grounds that it did not explain the sudden contraction in volume of this substance when heated to a certain temperature. He described and showed models to illustrate an alternative system. Prof. Miers agreed that the fact that more than 80 per cent. of the elements and binary compounds crystallise in the cubic system was a strong argument in favour of closest packing, yet this principle must be tested by all the physical properties as well as the geometric form of the crystals. Dr. Tutton also criticised the idea of closest packing; he suggested that the topic axial ratios should be taken as an index and measure of the relative closeness of the packing.

Prof. Abegg pointed out that, according to van der Waals, in the liquid state three-eighths of the volume are occupied by matter and five-eighths are free space, and that as substances changing from liquid to solid do not vary essentially in volume, this would seem opposed to the idea of close packing. In answer to the above, Mr. Barlow explained that the spheres were only in reality centres of influence and attraction, and thus there was no real distinction between loose and tight packing. Prof. Tilden remarked that the authors in their explanation of what happens when a change of valency occurs did not appear to recognise that there are two kinds of valency, the one corresponding to the electric charges and the other an extra valency developed under special conditions.

Prof. Larmor thought that the views of the authors seemed to carry weight in their application to the forms of crystals. The approximation that is exhibited by actual crystalline forms to those calculated for dyad molecules consisting each of two equal spheres or nearly spherical domains of influence seemed noteworthy; it gained even more weight when it was remembered that considerable difference in size of the spheres would produce but little difference in the ratios, so that the restriction to equality of the domain of influence could be largely dispensed with and yet the results remain substantially as they are. He hazarded the suggestion that the direct operations of the chemist can grasp only those molecules which have pronounced architectural features, but that there may be whole regions of incipient combinations which do not submit to architectural modification, though they may be recognisable indirectly, as by the spectroscope.

The electrochemical aspect of valency was to associate it with the number of loose and displaceable electrons in the atom. The essential physical features of a metallic atom being generally that a certain number of its negative electrons are thus relatively free, we may imagine that when it is in combination to form a molecule of a salt these electrons are attracted across into the domain of the radicle thus united with it, and when accidental separation occurs in the appropriate way they may remain there. But while something like this is a fact, the mechanism remains largely a mystery, as it has been ever since valency was first connected in this way with electric displacement by Faraday eighty years ago.

Prof. Werner (Zurich) and Prof. Abegg (Breslau) gave descriptions of their views on the broader questions of valency. Prof. Kauffmann (Stuttgart) spoke on the divisibility of valency, and dealt briefly with his own investigations on the colour and fluorescence of organic compounds in connection with structure.

The second morning was entirely given up to a joint discussion with Section G on explosion temperatures, in which Profs. Boudouard, Haber, Smithells, and H. B. Dixon spoke on the chemical side. In the afternoon Prof. Dixon described his observations on the ignition point of various gases and mixtures. In the discussion which followed Mr. Dugald Clerk dwelt on the trouble arising from pre-ignition in large gas engines, and showed that it was important to be able to predict the ignition temperature from the nature of a mixture of gases, and so to allow proper compression space in designing the engine.

Dr. H. O. Jones gave a concise account of work carried out with Sir James Dewar on iron carbonyls. The pentacarbonyl is a yellow liquid, which resembles nickel tetracarbonyl in its properties, but is more stable towards

chemical reagents. When decomposed it always gives rise to ferrous salts. On exposure to light it yields carbon monoxide and an orange crystalline solid—diferrononacarbonyl, $Fe_2(CO)_9$. This, when heated alone, gives a dark green liquid consisting chiefly of iron pentacarbonyl, but when hydrocarbons or ether are present in excess and the temperature is maintained below 100° C., an intensely green-coloured solution is obtained, which deposits dark green lustrous crystals of iron tetracarbonyl, $Fe(CO)_4$. This is stable towards reagents, and its dark green solution in organic solvents exhibits a characteristic absorption band in the yellow.

Dr. K. S. Caldwell described his investigations on the conductivity of electrolytes in pyridine carried out in Leipzig in Prof. Hantzsch's laboratory. With the exception of the pyridonium halides, the true acids, compared among themselves, follow approximately the same order in pyridine as in water, and the same applies to the pseudo-acids, which, however, yield much better conducting solutions than do true acids having the same or even greater affinity constants. He further dealt with the influence of temperature on the conductivity of electrolytes in pyridine solution. The temperature of maximum conductivity is well marked, but it is not higher the greater the conductivity as in the case of solutions in liquid sulphur dioxide. Pyridonium salts in pyridine show an abnormally high conductivity.

On Monday Dr. Alex. McKenzie presented a valuable report on the applications of Grignard's interaction. Since the discovery in 1900 that a vigorous action ensues when magnesium powder is added to a mixture of methyl iodide and anhydrous ether, and that this product is extremely active, the Grignard method has been applied with important results in almost every branch of organic chemistry, and the progress made with its help in so short a time as six years is little short of amazing.

By means of it, secondary alcohols are obtained from aldehydes, tertiary alcohols from ketones, acid chlorides or acid anhydrides. Unsaturated hydrocarbons are also obtained from aldehydes, ketones, &c., under suitable conditions. It is also applicable to the preparation of carboxylic, sulphinic and other sulphur acids, of ketones, aldehydes, ethers and esters, and also of alkyl and aryl metallic compounds. Dr. McKenzie dealt at length with the preparation of the agent, and this part of the report should prove of the utmost value to future workers in this field.

Prof. Tschitschibabin, of Moscow, read a valuable paper on triphenylmethyl, in which he discussed the formula of this remarkable substance. Dr. Chattaway described his copper mirrors discovered in the course of an investigation on the oxidation of aromatic hydrazines. When solutions of cupric salts are reduced by these compounds the metal is deposited on the glass in the form of a brilliant coherent film. A number of such mirrors were exhibited; they showed the lustrous red colour of burnished copper, and were perfect in reflecting surface and uniformity. Dr. Boudouard contributed an account in French of the suboxides of carbon.

Dr. Jaeger, of Amsterdam, described the colour changes which occur on melting cholesterol esters, and dealt with the theory of these from the point of view of the phase rule. The colours are due to the formation of doubly refracting layers of liquid crystals and occur at, or a few degrees below, the transition temperatures whilst the two liquid layers are separating from each other. The author gave a striking demonstration of these liquid crystals.

Prof. Phillips Bedson described and exhibited an apparatus for studying the inflammability of mixtures of coal dust and air, consisting of an arrangement whereby the dust was projected by a blast of air through a gap between two platinum wires, and there subjected to a series of electric sparks. A number of interesting experiments were shown with this apparatus; in one instance the flame produced by the ignition of dust at one point was made to ignite a cloud of dust at a point 2 feet or 3 feet distant from the point of inflammation.

Another experimental paper was contributed by Mr. Pratt, who described some properties of metallic calcium, which seems to have industrial possibilities as a reducing agent. In discussing the paper, Dr. F. M. Perkin mentioned his own experiments with turnings of metallic calcium, which has a more powerful reducing action on oxides than aluminium.

The reports of the research committees were as usual of considerable interest. Dr. Lowry, in the report on dynamic isomerism, brought forward very definite evidence in favour of his view that the isomeric change, which usually takes place when nitrocamphor is dissolved in chloroform or benzene, does not occur spontaneously, but is conditioned by the presence of minute traces of alkaline impurities. So sensitive is this change to piperidine that it is complete in ten hours under the influence of so small a quantity as N/1,000,000.

Dr. Orton's report on the transformation of aromatic nitroamines also laid stress on the important part played by the transforming agent in intramolecular changes which, accepting Armstrong's view, is regarded as forming an additive compound with the nitroamine. Dr. Crossley's report on hydroaromatic substances, besides giving an account of the researches made by the committee, included the usual valuable summary of recent work done in this field.

The discussion on the chemistry of flour was opened by Mr. A. E. Humphries with a short paper entitled "The Causes of the Quality Strength in Wheaten Flour." To make bread of the quality required in this country today what are known as strong flours are required, that is, flours which have the capacity of making big, shapely loaves. Most English-grown wheats are deficient in this quality of strength, and give what are known as weak flours. When attempts are made to grow a foreign strong wheat in this country, the yield of grain and straw is, as a rule, too low to make the culture pay. It has been the object of the Home-grown Wheat Committee of the National Association of British and Irish Millers to produce such wheats in England as shall combine strength with maximum crops of grain and straw. In addition to botanical and field work, this problem has demanded the solution of the question, What is the ultimate cause of strength and the nature and source of those constituents which confer on some varieties of wheat the inherent quality of strength and the power of transmitting it?

It has been proved that though climate and soil influence quality, they are not the determining factors in the production of strength, for though the strongest wheats are ordinarily produced in districts where the winters are cold, the summers hot, and the summer rainfall high, certain varieties possess and retain the inherent quality of strength when grown in England. Manuring or early cutting at harvest time has no beneficial effect on quality. Quick growth or rapid maturation is not correlated with strength, nor does the percentage of natural moisture in well-harvested wheat indicate it; indeed, in certain cases the addition of water to wheat materially increases its effective baking strength.

The term "strength" has been loosely applied to cover several characteristics. In the view of the committee it should not be measured by the quantity of water required to make doughs of a standard consistency, nor by the quantity of bread produced per sack of flour used, nor by the way a flour behaves in the dough, but by its capacity for making big, shapely, and therefore well-aërated loaves. This definition covers two characteristics; one, a flour's capacity for making gas in yeast fermentation; the other, its capacity when made into dough for retaining the gas so generated.

The gas-making power will depend largely on the percentage of natural sugar any given wheat contains and its diastatic capacity. These characteristics vary substantially in different wheats. The baker can, and does, influence the quantity of gas generated in baking. The retention of gas when made involves complex problems.

Mr. A. D. Hall pointed out that the old idea that the wheat plant takes definite materials out of the soil to give it strength is incorrect, and emphasised the view that each type of wheat elaborates a mixture of starch, proteins, &c., of definite proportions right from the very beginning, so that the plant as an individual affords a characteristic product. Strength on this assumption is a congenital factor, and probably a "character" in the Mendelian sense.

Prof. T. B. Wood described in detail experimental investigations from which he concludes that two factors are involved in the term *strength*, that of *size*, which is a function of the gas evolved by the flour due to its diastatic capacity, and that of *shape*, which is a function of the proportion of acid and salts present in the flour. Mr. Julian Baker mentioned some determinations of the diastatic power of flours from which he infers that diastase is always present in excess, so that the determination of diastatic power will not be of much value in judging a flour. Dr. E. F. Armstrong alluded to the importance of the gas formed during the early stages of fermentation in distending and affecting the gluten, and pointed out, as also did Mr. Baker, that the enzymes of flour other than diastase should receive the closest attention.

GEOLOGY AT THE BRITISH ASSOCIATION.

THE papers on local geology which followed the president's address were of more than ordinary interest. Mr. Fox Strangways dealt with the district round Leicester as a whole, dwelling specially on those points which are obscure and require further elucidation. Prof. Watts gave an account of his researches in the rocks of the Charnwood Forest. Dr. F. Bennett and Dr. B. Stacey, in describing the felsitic agglomerates occurring at Bardon Hill and in other parts of Charnwood, gave a new reading of some of the features described by Prof. Watts. These questions raised an interesting discussion, which was carried on, not only in the sectional meetings, but also in the field, when the localities were visited in the course of the admirable series of afternoon excursions which had been arranged by the local secretary of the section.

A full day was given to papers dealing with the Triassic rocks. Mr. H. T. Ferrar led off with a description of the features and activities of the desert regions of eastern and western Egypt, and he dealt more particularly with those which have a bearing on the origin of the British Trias. The Libyan Desert presents broad, featureless plains, with no very definite drainage system, and the veneer of waste is protected from removal by wind by layers of pebbles. The Etbai, on the other hand, displays bare hillsides free from débris, aggrading wadis, no sand dunes, and an integrated drainage system.

The origin of the Trias about Leicester was very ably discussed by Mr. T. O. Bosworth. He showed that the Charnian rocks beneath the Keuper were fresh right up to the surface, and when the marl had been denuded, the igneous rocks of Mount Sorrel, Croft, Scapcote, Groby, &c., were smoothed, fretted, and carved by wind action. The beds themselves dip in the direction of the slope of the underlying rocks, and catenary bedding is seen at Croft and Groby. At the base of the marls, too, there are breccias with chemically unaltered stones, and these he considered to be desert screes. Such evidence of subaqueous deposition as there is points to the existence of occasional streams and salt pools rather than the deep waters of one great Keuper lake.

Messrs. Keay and Gimson discussed the relation of the Keuper marls to the pre-Cambrian rocks at Bardon Hill. They showed that the Keuper fills in joints of the pre-Cambrian rocks to a height of 880 feet, which is the greatest altitude yet reached in Britain for any rocks of the Triassic system.

Dr. Cullis, in dealing with the mineralogical constitution of the Keuper marls in the west of England, announced the discovery of minute crystals of dolomite, which he contended were precipitated from the waters of an inland sea. In the discussion which followed, Mr. Lomas showed that dolomite was absent from the Keuper marls of the north of England, and their occurrence in the sands now being laid down by the River Mersey showed that other modes of origin are possible. The exact manner in which limestones become dolomitised and crystals of dolomite are produced in sands is still a matter of great uncertainty, and no satisfactory explanation has yet been offered.

Messrs. Bolton and Waterfall communicated a paper on the occurrence of boulders of strontia in the Upper Triassic marls of Abbots Leigh, near Bristol. This remarkable deposit contains boulders of all sizes from a pea to 100 tons in weight; the yield is about 2000 tons per acre, and it has become the principal world's supply of this mineral.

The fifth report of the committee appointed to investigate the fauna and flora of the Trias was presented by the secretary. To this report Dr. A. Smith Woodward contributed an important paper on a mandible of *Labyrinthodon leptognathus*, Owen, recently obtained from the Keuper sandstone of Cubbington Heath, near Leamington. Its structure confirms the recent conclusions as to the complex nature of the mandibular ramus of Labyrinthodonts, and helps to connect these early amphibians with the Palæozoic Crossopterygian fishes.

Mr. H. C. Beasley has taken advantage of the great find of footprints at Storeton, in Cheshire, last year to re-describe some of the forms hitherto imperfectly known, and Mr. Lomas gave a detailed account of a large slab recently presented to the Liverpool University. This slab gives a track containing fifteen impressions made by the same individual, and the markings are so perfect that the minutest detail of the skin, claws, and movements of the animal which made them, can be observed. It is suggested that Cheirotherium walked erect, and only used the manus to steady itself when bending down to drink or feed. The rocks containing the footprints have been found to contain, besides quartz, felspars, zircon, tourmaline, anatase, rutile, kyanite, staurolite, chert, and numerous black grains not identified.

Mr. A. R. Horwood also contributed to the report an account of the plants and animal remains found in the Leicestershire Trias, and a bibliography of works referring to the flora and fauna of the Keuper of the district.

Mr. L. J. Wills gave an account of a very rich assemblage of fossils he recently obtained from the Lower Keuper of Bromsgrove, in Worcestershire.

Prof. Seeley, in describing the structure of the mandible of a South African Labyrinthodont, pointed out the great resemblance between the British Triassic fauna and that of the Karroo in South Africa.

A discussion on iron-ore supplies was opened by Mr. Bennett Brough and Prof. Sjögren. Mr. Brough contended that as the production and consumption of iron per head of population is increasing year by year, and the world's production in 1905 attained the enormous total of 56,000,000 tons, the outlook for the future is disquieting, though not necessarily depressing. The future of the home demand is likely to be affected by the development of the basic open-hearth process of steel making, which enables phosphoric ores to be utilised. The development of magnetic concentration and of the briquetting of pulverulent ores for furnace use will render possible greater utilisation of poorer ores, and the electric furnace will doubtless render it possible to use black sands and other titaniferous iron ores, which cannot be treated profitably in the blast furnace.

Prof. Sjögren took a more hopeful outlook in dealing with the Scandinavian iron ores. These are distributed in "ore-provinces" characterised by special geological structures. While the view that the iron-ore supply is unlimited is not well founded, the professor estimated that the total supply for the different provinces in Scandinavia is 1105 millions of tons of ore, equivalent to 582 millions of tons of pig iron. Of these, 60 millions contain a low percentage of phosphorus and are suitable for reduction by the Bessemer process, 545 millions are richer in phosphorus and can be worked by the basic-hearth process, and 500 millions are lean ores only profitable to smelt after magnetic concentration.

Continuing the dicussion, Prof. Lapworth congratulated the association upon the importance of the communications. He referred to the great changes in the position of the centre of gravity of the iron industry. Years ago the native forests served for the working of the ores when the Weald was the great centre of output. When coal came to be used, the coalfields became the great centres, and in later days the ores of the Lias and Oolites had come to the front, and probably for some time they would be the chief British sources of supply.

Mr. G. W. Lamplugh said that an important aspect of

the question was one of cost, and as the first-class ores became exhausted and prices rose, the second-class ores would prove remunerative.

Colonel Parrett took an optimistic view, and referred to the vast quantities of rich ore in Australia and the Transvaal.

The president, in closing the discussion, looked forward to Australia, with its vast coalfields and easy transport, becoming the great centre of iron production.

Mr. W. G. Fearnsides, in describing the pisolitic iron ores of North Wales, showed that they were not, as formerly supposed, characteristic of certain geological horizons.

A paper by Prof. J. Joly, on the distribution of radium in the rocks of the Simplon Tunnel, raised many questions of great interest. From the examination of thirty-six typical samples taken from various points in the tunnel, he showed them to contain varying amounts of radium, and, taken together, they were sufficient to disturb any forecast of the temperature which under normal conditions would be encountered at the level of the tunnel. The presence of radium in the sediments, in hitherto unsuspected quantities, raises the question whether its presence may not be a factor in the events attending mountain building. The shifting of radium and its parent elements by denudation must be regarded as a convection of thermal energy, and result in the shifting of areas of high temperature and crust-weakness from age to age as the site of sedimentary accumulation changes.

The chief papers dealing with palæontology were by Mr. F. Raw, on the trilobite fauna of the Shineton shales and on the development of *Olenus salteri*; the palæontology of the North Derbyshire coalfield, by Mr. A. R. Horwood; and reports from various research committees.

The Carboniferous Zones Committee, after several years of useful work, presented its final report, but the work, which has been carried on with so much vigour and success by Dr. Wheelton Hind and others, will be continued by another committee of which Dr. A. Vaughan is secretary.

The committee appointed to investigate the fossiliferous drift deposits at Kirmington and at various localities in the East Riding of Yorkshire has devoted its energies to a careful examination of the mammaliferous gravels at Bielsbeck, in the Vale of York. The deposits occupy a depression in the Keuper marls, and have accumulated in a boggy hollow on an old land surface. None of the material excavated can be assigned to the direct agency of ice, and there is no evidence available which will definitely fix its age relatively to the Glacial period.

A new section of glacial gravels in Holderness was described by Messrs. Sheppard and Stather. They are considered by the authors to represent part of the terminal moraine of the North Sea ice sheet.

The pre-Devonian beds of the Mendip Hills were reported on by a committee appointed to examine their fossil contents and their relations to a peculiar coarse, ashy conglomerate found in the neighbourhood.

Mr. Lomas described the occurrence of a remarkable bed of peat found during excavations in the Union Dock, Liverpool. The chief interest of the deposit lies in the fact that the peat is composed of marine plants encrusted with polyzoa, hydrozoa, serpulæ, and other marine organisms.

Mr. A. R. Horwood read a paper on a hitherto unnoticed section of the *Amaltheus spinatus* zone in the Middle Lias at Billesdon Coplow, Leicestershire, and some notes on the ancient volcanoes of Basutoland were sent by the Rev. S. S. Dornan.

A catalogue of destructive earthquakes was submitted by Prof. J. Milne. Taking only those which have done structural damage, he finds that between the years 1150 and 1250 A.D. large earthquakes were very frequent, and another great increase commenced about the year 1650, and is still in progress.

Prof. Frech in a subsequent paper showed the part which earthquakes have played in mountain building.

Reports on the Anglesey rocks, by Mr. E. Greenly, and on erratic blocks, by Prof. P. F. Kendall, completed the papers read before the section. J. L.

ENGINEERING AT THE BRITISH ASSOCIATION.

IN accordance with its usual custom, the section did not meet on the opening day until 11.15 a.m., in order that members might have an opportunity of attending the presidential address in Section A.

The proceedings of Section G began with the delivery of his presidential address by Prof. Silvanus Thompson, which dealt mainly with the subjects of the history and development of electric motive power, and the education and training of engineers. After the vote of thanks to the president, Mr. Dugald Clerk read a paper on the present position of gas and petrol engines. The author pointed out that experience in the construction and design of large gas engines is gradually accumulating, but that the conditions of work in this country differ in one important respect from those on the Continent. Practically all the large Continental gas engines are operated with blast-furnace gas, while in this country producer gas has been almost exclusively used, and he was of opinion that until the problem of the bituminous fuel producer was solved, it would be difficult to continue to increase the dimensions of gas engines. Mr. Clerk himself has been working for some years now at the problem of reducing maximum pressures as well as temperatures, without reducing mean pressures, in order that the thickness of the cylinder castings, &c., might be reduced, and that the weight of the engine itself might be made more reasonable for moderate powers; he has been experimenting with a 50 horse-power engine in order to obtain definite data as to the rates of cooling of the working fluid in the actual engine at different temperatures and pressures, and he showed a very interesting diagram illustrating his results, and a table of apparent specific heats of the working fluid at varying degrees of temperature which he had worked out from these experiments. This table showed conclusively a rapid increase of apparent specific heat with increase of temperature. From the values of the specific heat thus obtained, Mr. Clerk was able to obtain a curve of heat loss to the sides of the cylinder both for complete double strokes and for partial double strokes at the inner end of the stroke. The paper concluded with a brief discussion of some interesting points in connection with the petrol engine, and especially with the problem of the exhaust gases. The author showed by results of experiments on his own motor-car that by adjusting the carburetter he was able to reduce the percentage of CO in the exhaust gases very considerably.

In the afternoon the members of the section had an opportunity of visiting the works of Messrs. N. Corah and Sons, hosiery manufacturers, where they saw many examples of the most efficient and up-to-date machinery now used in the manufacture of hosiery. The works are extremely well planned, and reflect the greatest credit upon the proprietors, not only for the skill with which the machinery has been arranged and working costs kept down, but for the great attention paid to ventilation in the workrooms and to the comfort and general well-being of the employees.

Friday morning, with the exception of a short paper by Prof. B. Hopkinson and Mr. L. G. E. Morse on the gases exhausted from a petrol motor, was entirely devoted to a joint discussion with Section B on gaseous explosions with special reference to temperature. Prof. Hopkinson and Mr. Morse in their paper gave an account of experiments which had recently been carried out in the engineering laboratory of Cambridge University on a four-cylinder Daimler engine in order to determine the conditions under which carbon monoxide is formed in an internal-combustion motor, and the relation between the composition of the exhaust gases, the strength of the mixture, the power developed by the engine, and the thermal efficiency. These experiments showed that the curve obtained by plotting the thermal efficiency reckoned on the indicated horse-power to a base of petrol consumption had a sharply defined maximum near the point where the consumption was about 2/10th lb. of petrol per 1000 revolutions, or at the point at which the petrol is just sufficient to be burnt by the available oxygen. The rapid increase in the per-

centage of carbon monoxide in the exhaust gases as the petrol consumption was increased was shown very strikingly by another curve, and it was apparent that if the carburetter was set in the usual manner in order that the engine might give its maximum power, no attention being paid to petrol consumption, the exhaust was almost certain to contain large quantities of carbon monoxide.

The discussion on gaseous explosions was opened by Mr. Dugald Clerk, who showed a part of the original apparatus used by Bunsen in his classic experiments. Mr. Dugald Clerk then briefly described his own important work in this field of research, beginning with his earlier experiments, in which the pressures reached were recorded by means of a Richard's indicator, down to his latest researches, some of which have been recently described in papers read before the Royal Society in March, 1906, and before the Institution of Civil Engineers at the beginning of the present year, in which optical methods have been used for obtaining records of the variation of pressure with changes of volume and temperature in the cylinder. Dr. Boudouard, of Paris, followed Mr. Dugald Clerk, and described, with the help of blackboard sketches, the apparatus which is being employed by the committee which has been appointed by the French Government to carry out a fresh series of experiments on gaseous explosions, with the object of determining whether the numerical results obtained in the earlier experiments are trustworthy. Prof. Haber, of Carlsruhe, another well-known worker in this subject, dealt very fully in his remarks with the subject of the variation of the specific heat of gases as the temperature of the gas is raised, and Prof. Dixon and Prof. Hopkinson, who also spoke, took up the same point. Prof. Dixon showed by a table of results obtained in his own experiments that, at any rate up to the limit of temperature to which he had at present worked, the specific heat of CO_2 rose very markedly as the temperature of the gas was increased, while, on the other hand, there was very little apparent variation in the specific heat of nitrogen.

During the afternoon the section paid a visit to the British United Shoe Machinery Co.'s works; a very excellent descriptive pamphlet had been prepared in connection with this visit, which was a most enjoyable one, and enabled members to see to what an extent self-acting machinery is now used in connection with the manufacture of boots.

The section did not meet on Saturday, but many of the members spent the day in a visit to the Leicester and Swannington Railway, one of the oldest railways in the kingdom, constructed by George and Robert Stephenson; Mr. Clement Stretton acted as conductor of the party.

Monday, as usual, was devoted to electrical papers, and the first paper taken was by Sir William Preece, on the Pupin mode of working trunk telephone lines. The author stated that he himself had pointed out in 1896 that the effect of electromagnetic induction in telephone wires was in one sense beneficial, and that Prof. Pupin had made it more beneficial in another sense, and had thus been able to reduce the weight of copper used on trunk lines and also to extend the distance to which ordinary speech is practicable. Sir William Preece inspected in April last the very successful work which has been done by the New York Telephone Co. in connection with the adoption of Prof. Pupin's methods. The Pupin coil stores up a portion of the energy, which, like a spring under pressure, is ready to react on the release of the forced condition. The size of the coils and their distance apart on the circuit is a question of experiment; Sir John Gavey has found the best results with coils at every two miles; Mr. Carty, on the other hand, employs them at every $1\frac{1}{4}$ mile on a long line, and at every $\frac{3}{4}$ mile on a short line. The author termed the addition of these inductance coils "loading" the line, and he stated that the use of loaded lines is increasing rapidly. In underground cables the range of a loaded line is found in this country to be 2·4 times that of an unloaded one. The application of this principle to submarine cables is now under investigation, though it has not yet reached a practical stage. In concluding his paper, the author pointed out that telephone troubles in this country often arise from the fact that the subscriber is entirely ignorant of the system of working, and will not take the trouble to make himself familiar with it.

Sir Oliver Lodge read a short paper on tuning in wireless telegraphy, and described the system adopted in the Lodge and Muirhead wireless telegraphy stations.

Mr. J. T. Morris then read a note on an oscillographic study of low-frequency oscillating arcs. The paper collected together a number of observations which had been made both with direct and alternating current arcs, mainly with the object of studying the effect of a change in the medium in which the arc is burning, and also to examine the effect, if any, produced on the arc by the application of a transverse magnetic field. No frequencies of more than 1000 were investigated. The paper was fully illustrated by curves representing the results of the experimental investigations.

The next paper was by Mr. Leon Gaster, on developments in electric incandescent lamps. The author stated that at the York meeting last year he had been able to show a few sample 110-volt metallic filament lamps consuming 1 watt per candle-power; to-day such lamps were ordinary commercial articles. A number of types of metallic lamps were shown by the author, including tantalum lamps, "Osram" lamps, in which tungsten is employed, and a lamp known as the Helion lamp. In the discussion Sir William Preece stated that he had lately equipped his own house with Osram lamps of 105 voltage, and, in order to reduce the pressure from 220 volts to the necessary 105, he had put in an alternating-current transformer, but the cost of this had been more than met by the saving in the payment for current within a year, and that though he had put the lamps in in January, 1906, none of them had so far needed replacement.

The business of the day concluded with a short paper by Prof. E. G. Coker descriptive of the new engineering laboratory at the City and Guilds of London Institute, Finsbury. A new wing has been added to the college, in which accommodation has been provided for an engineering laboratory, drawing offices, lecture rooms, &c. The hydraulic section of the engineering laboratory contains a long cast-iron channel, and all the necessary measuring tanks and other appliances; a number of hydraulic machines have been installed. The engines in the heat laboratory are all of moderate size, and in many cases have been designed with special reference to research work. This new laboratory will bring the teaching equipment at Finsbury well up to date.

Tuesday opened with two papers on ferro-concrete, one by Mr. J. S. E. De Vesian and the other by Mr. W. Noble Twelvetrees. Both authors made extensive use of the lantern, and showed a large number of slides illustrating the kind of work for which ferro-concrete has been so far generally employed. It was interesting to find that this method of construction is now rapidly making its way in this country; Mr. De Vesian showed in his lantern-slides a number of big mills, granaries, &c., which have recently been built in Great Britain on the Hennebique system of ferro-concrete. In the first portion of his paper this author went fully into the specifications which he uses in connection with the materials required in ferro-concrete construction, and explained the tests he carries out in connection with the Portland cement.

Mr. Noble Twelvetrees showed a series of slides to illustrate the use of reinforced concrete for such types of construction as railway sleepers, standards for overhead electric cables, &c., and he advocated the use of concrete for preserving existing steel bridges, especially where they are liable to the corrosive effect of locomotive fumes.

Mr. Worby Beaumont followed with a paper on the origin and production of corrugation of tramway rails; he suggested various causes in explanation of this peculiar phenomenon, but, though the paper led to an interesting discussion, no speaker was able to throw any light upon the real origin of this troublesome problem, which so often worries the tramway engineer.

Two other papers were dealt with by the section on this day, one, by Mr. H. I. Brackenbury, on modern machinery and its future developments, and the other, by Mr. C. V. Drysdale, on resistance coils and their comparison. The latter author exhibited his ingenious

apparatus, not only at the sectional meeting, but later on in the evening at the conversazione which was held in the Leicester Museum.

Owing to the very full programme of papers, the section was forced to meet again on Wednesday, August 7, when four papers were discussed. The first, a short paper by Mr. J. F. Brooks, described a machine for weighing the forces on a cutting tool; the author exhibited and explained one of his machines, and the values of the forces on tools with cutting angles of 65° and 70° when cutting cast-iron and mild steel with small cuts at moderate speed were shown by means of diagrams.

Mr. R. S. Ball, in his paper on the governing of hydraulic turbines, dealt with the problems involved in the speed control of hydraulic turbines for a wide range of head. He showed that such regulators may be divided into two classes:—(1) disengagement governors (mechanical), which come into action when an assigned departure from the normal speed is attained, being otherwise out of gear; (2) continuous governors (mechanical and hydraulic), which are always connected to the gate-controlling mechanism, and which begin to operate at the moment the speed rises or falls from the normal. The action of various types of governors was described by figures and diagrams plotted from the results of tests.

Prof. H. T. Barnes, of McGill University, Montreal, then read a paper on the ice problem in engineering work in Canada. He showed that in Canada there is always great steadiness of the temperature of the water throughout the ice season, and that there are three varieties of ice to be distinguished—surface or sheet ice, spicular or frazil ice, and anchor or ground ice. Prof. Barnes explained that by an intelligent use of artificial heat, especially at night time, when super-cooling is most common, the interference of ice with the normal operation of a power-house may be largely prevented. The most favourable condition for a power-house is when it is situated on a river normally frozen over on its surface and with no stretches of open water above.

The section concluded its business with the reading of some notes by Mr. J. Smyth on the application of water-power and how to secure the greatest efficiency in working same.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE sum of 250,000 dollars has been appropriated by the Kansas Legislature for the erection of engineering buildings in connection with the State university.

THE Sunderland Technical College is to be extended by the addition of a day training college and engineering laboratories at a proposed cost of 10,000*l*.

DR. JAMES E. TALMAGE has resigned the professorship of geology in the University of Utah in order to devote himself to investigation work in mining geology. Dr. F. J. Pack has been appointed to succeed him.

THIS year's scholarship of the Institution of Naval Architects has been awarded to Mr. A. M. Robb, Glasgow. The scholarship is of the annual value of 50*l*., and, subject to the regulations, is tenable for three years.

MR. SIMON FLEXNER has been made a member of the Rockefeller Institute for Medical Research, New York, and director of the pathological laboratories; and the following have been appointed members of the institute:—Mr. S. J. Meltzer (physiology and pharmacology), Mr. E. L. Opie (pathology), and Mr. P. A. Levene (biological chemistry).

THE calendar of the Manchester School of Technology and Municipal School of Art for the session 1907–8 has just been issued by the firm of John Heywood, Ltd. In it are to be found full particulars of the courses of instruction, and the scholarships, prizes, &c., at the institution. Many of the laboratories and workshops are pictorially represented in the volume.

THE following appointments abroad have recently been made:—at the Rush Medical College, Chicago, Dr. Robert R. Bensley to be professor of anatomy, and Dr. Edwin O. Jordan professor of pathological anatomy and bacteriology; Dr. Francis Huber has been elected to the chair of medicine at the New York College of Physicians and Surgeons, and Dr. Frederick Peterson to that of psychiatry in the same institution; at Yale University, Dr. J. M. Flint has been appointed professor of surgery; at Würzburg, Dr. Faust has been made professor of pharmacology.

THE remarkable progress accomplished by the Japanese during the last thirty-two years in the field of public education is brought out very clearly in the thirty-second annual report of the Japanese Minister of Public Instruction, which has been published recently. This report deals with the year 1904–5, the date of the war with Russia. It is instructive to note that this time of stress was allowed to interfere in no way with educational activity. The Emperor, indeed, proclaimed it to be a national duty that the zeal and efforts of educational administrators and teachers should be redoubled. Despite the financial difficulties to which a great war gave rise, the expenditure on education was not diminished. While in 1873 only twenty-eight out of every 100 children were under instruction in public schools, the ratio had risen in the year under review to the remarkable one of 97 boys and 91·5 girls out of every hundred, and the number of children in the schools had reached 7,551,445. Higher education, too, was in an equally flourishing condition. For example, the number of students in the University of Tokyo had reached 3500, and in Kioto 1300. Numerous special schools, technical schools for engineers and for agricultural specialists, medical schools, and schools for the study of modern languages, were all in a high state of efficiency. Moreover, a point of special interest in our country to-day, the hygiene of schools, is scrupulously watched, and medical officers are charged specially with the duty of keeping the pupils under examination. Altogether the report provides abundant evidence of the success with which Japan is educating her people.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 6.—"The Osmotic Pressure of Compressible Solutions of any Degree of Concentration." By Alfred W. **Porter.**

An exact equation is obtained connecting osmotic pressure with the vapour pressures of solvent and solution, viz.:—

$$\int_{\pi_\pi}^{p} s\,dp + \int_{p-P_p}^{\pi_{00}} u\,dp = \int_{\pi_\pi}^{\pi_{00}} v\,dp,$$

where

P_p is the osmotic pressure when the hydrostatic pressure of solution is p;

π_{00} is the vapour pressure of the solvent when under the hydrostatic pressure of its vapour alone;

π_π is the vapour pressure of the solution when under the hydrostatic pressure of its vapour alone.

v and u are the specific volumes of vapour and solvent;

s is the diminution of a very large volume of the solution when 1 gram of solvent is removed.

The equations given by van 't Hoff and the Earl of Berkeley can at once be derived from this general one by taking the liquids as incompressible and considering respectively the cases in which (1) the solvent, (2) the solution, is under the pressure of its own vapour alone.

It is shown that if two solutions in the same solvent have the same osmotic pressure, they have also the same vapour pressure provided the values of these pressures be measured for the same hydrostatic pressure of the solution. They have also the same freezing point.

It is shown that when a solution is in equilibrium with the pure solvent across a semi-permeable membrane the vapour pressure of the solution is necessarily equal to the vapour pressure of the solvent, *each being measured for the actual hydrostatic pressure of the fluid to which it refers.*

The above involves a recognition of the variation of vapour pressure with the hydrostatic pressure of the fluid to which it relates; an equation giving the mode of variation is derived.

A graphical solution of the osmotic-pressure equation is given.

June 13.—"Some Points in the Development of *Ophiothrix fragilis*." By Prof. E. W. **MacBride**, F.R.S.

The paper contained a preliminary report on the result of researches on the development of the British Ophiurid *Ophiothrix fragilis*. The eggs of this species are small (0·1 mm. in diameter) and opaque, and the development until the completion of the metamorphosis occupied twenty-six days. The full account of the research, which will shortly appear in the *Quarterly Journal of Microscopical Science*, will contain the first complete description of the formation of all the organs of an adult Ophiurid from their rudiments in the Ophiopluteus larva. In the preliminary account two points of special interest are emphasised:—(1) the varying character of the early development according to the conditions under which the egg was fertilised; and (2) the indications of metamerism in the cœlomic sacs of the larva. With reference to (1), if the eggs were artificially fertilised, *i.e.* if the ovary were removed from the body and the eggs shaken out and then mixed with sperm, a larva resulted in which there was a precocious formation of mesenchyme, so that the blastula stage was practically solid; this was succeeded by an invagination in which the endodermic plate was many layered. As a result, the gastrula had a wedge of cells projecting into the gut which was slowly absorbed. A similar wedge seems to be a normal feature of the development of *Ophiura brevis*, according to Dr. Caswell Grave. If the animals were allowed to spawn naturally, a hollow blastula was formed, and invagination was normal; in addition, at the anterior end of the larva a vacuolated crest of cells was formed, which later disappeared. With regard to (2), the cœlom on both sides of the larva became divided into three somites. Of these, the middle one on the left side gave rise to the hydrocœle, or rudiment of the water-vascular system; its fellow on the right is the homologue of the "dorsal sac" or "madreporic vesicle" of Asteroidea and Echinoidea, but in *Ophiothrix fragilis* it sometimes assumes a form similar to that of its left antimere, showing that the water-vascular system was originally paired.

PARIS.

Academy of Sciences, August 26.—M. A. Chauveau in the chair.—Study of the spectrum of the comet 1907*d*. Peculiarities of the tail: H. **Deslandres** and A. **Bernard**. The spectrum of this comet has been studied by two methods, with and without a slit. The present note gives an account of the results obtained working without a slit. The spectrum shows bands in the yellow, green and blue corresponding to hydrocarbons, and, in addition, the characteristic ultra-violet band of cyanogen. Differences were observed between the spectrum of the tail and that of the head, but further observations are required to elucidate the exact meaning of these differences.—Parthenogenetic developments in solutions isotonic with sea water: Yves **Delage**. All the principal salts of sea water, employed separately, including the chlorides of sodium, potassium, magnesium, calcium, the sulphates of sodium and magnesium, and magnesium bromide, can determine parthenogenesis of the eggs of sea urchins; these vary greatly in their effects, and the best solutions for each are given in detail. One unexpected result is noted: a pure solution of saccharose sometimes allows of strong development of the egg. As regards the stage to which it is possible to raise the eggs, the author has at last been able to obtain true sea urchins furnished with all the characteristic organs by a purely chemical action.—Propylene oxide: Louis **Henry**. It is known that primary alcohols arise from the action of alkyl magnesium compounds upon ethylene oxide, and in a previous paper the author has shown that the symmetrical dimethylethylene oxide behaves differently. In the present communication it is shown that methylethylene oxide, or propylene oxide, resembles ethylene oxide in its reaction with ethyl-magnesium-bromide, normal methylpropylcarbinol being formed.—The ephemeris for the search for the comet 1907*d* on photographic negatives: P. **Stroobant**.—The root of the least modulus of an algebraic equation: Léopold **Fejér**.—The theory of the radiation of incandescent mantles: M. **Foix**. The conclusion is drawn from the mathematical investigation given that the yield of light may be increased either by diluting the cerium oxide in thorium oxide or by reducing the thickness of the cerium oxide. The latter result has been confirmed by experiment.—The probable formation of thorianite and uraninite: B. **Szilàrd**. The amounts of uranium and thorium in these two minerals are in practically inverse ratios; the proportion of uranium in thorianite is the same as the proportion of thorium in uraninite, and inversely. From this fact hypotheses are deduced as to the mode of formation of these two minerals.—The action of cold in the treatment of coffee trees against the Indian borer (*Xylotrechus quadrupes*): Louis **Boutan**. The momentary cooling of the stem of the tree by such a substance as ethyl chloride presents no inconveniences from the point of view of the life of the plant, and is sufficient to kill all the larvæ in the interior of the wood. The price of ethyl chloride, however, is too high for any practical use to be made of these results.—A newly born hippopotamus at the menagerie of the Natural History Museum, fed by goats: E. L. **Trouessart**. The mother of the infant hippotamus had always on previous occasions refused to feed her young. In the present case the young animal was removed, and has been successfully reared for eleven days by goats, eight of whom serve as foster-mothers.—The mechanism of the closing of the appendicular canal: R. **Robinson**.

CONTENTS.