THURSDAY, OCTOBER 4, 1900.

A MANUAL OF THE ECHINODERMS.

A Treatise on Zoology. Edited by E. Ray Lankester, F.R.S. Part iii. The Echinoderma. By F. A. Bather, J. W. Gregory and E. S. Goodrich. Pp. ix + 344. (London : A. and C. Black, 1900.)

THE first instalment of the long-expected "Oxford Zoology"—first, that is to say, in order of publication—will be heartily welcomed as filling a distinct gap in zoological literature, and not of this country alone. During the latter half of the nineteenth century scientific literature has accumulated with such rapidity as to render it practically impossible for a zoologist at the present day to master thoroughly more than a limited part of his subject. To acquire a knowledge of the results gained in fields other than that which he has made his speciality, he must be dependent to a large extent upon the manuals and guide-books compiled by those who are sufficiently familiar with the latest discoveries in particular branches of zoology to be able to give a clear and critical account of the present state of knowledge in these departments. Nowhere is this necessity more strongly felt than in dealing with the Echinoderms, a group in which the student is confronted, on the one hand, with intricate morphological problems and with phylogenetic questions of a most puzzling kind ; and, on the other hand, with such a vast array of extinct types that the non-expert feels at once out of his depth when attempting to obtain an adequate knowledge of them. In the Pelmatozoa, practically half the phylum, we find a group of the greatest historical and phylogenetic importance, but one in which the existing forms teach us no more about the race in the past, and regarded as a whole, than do the modern Egyptians about the former dynasties whose remains are entombed in their land. The abundance of forms unearthed by the palæontologist has called forth a literature which exemplifies fully the danger of something like a deadlock in zoological science, as the result simply of its fertility. The student soon loses his way and finds himself struggling with a mass of hard facts and contradictory hypotheses, due on the one hand to the great diversity of form and structure in the objects themselves, and on the other hand to difficulties inseparable from the study of animals known almost entirely as fossils. Any one who has endeavoured, for instance, to gain an acquaintance with the structure and evolution of fossil Crinoids from the voluminous works of Messrs. Wachsmuth and Springer and other writers must have felt the urgent need for a guide and interpreter, failing whom it was necessary either to study deeply or to pass lightly by, to become an expert or to be content with ignorance. Yet no one with even a superficial acquaintance with the problems of Echinoderm morphology and phylogeny would willingly pass over the extinct forms, and least of all the more ancient Pelmatozoa, such as the Cystids and their allies, since it is obvious that here, if anywhere, is to be found in a concrete form the solution of many puzzles in the evolution of the phylum. Nowhere is palæontology, as a source of material evidence for theories of phylogeny, given so fair a trial as in the case of Echinoderms with their complete skeleton and consequent abundance of well-preserved fossil types, and it must be conceded that palæontology, if it condescends to speak clearly, can give the only final judgment in questions of evolution and ancestral history.

For many reasons, therefore, a plain and intelligible account of the Echinoderms, and especially of the Pelmatozoa, by those who have an expert knowledge of them, both as fossils and as recent forms, was greatly to be desired, and in the present volume we have the first complete treatise that has been published under these conditions in any language. The intention of the authors is to give a systematic account of the Echinoderms, including every known genus, living or extinct, and at the same time to trace as far as possible the evolution and relationships of the forms comprised under each class or order, as inferred both from their structural affinities and from their succession in time. The aim in view is therefore to effect a happy combination of the older styles of systematic treatise with the modern methods of comparative morphology, developmental history and phylogenetic speculation.

An introductory chapter, giving a general description of the organisation and development of Echinoderms, from the pen of Mr. Bather, attempts to trace the origin of the characteristic radiate symmetry from the bilateral ancestor represented by the Dipleurula larva. Like most other recent authorities on the group, Mr. Bather supports the opinion that the radiate symmetry was acquired in all Echinoderms during an ancestral fixed stage, in which the animal fed by means of currents produced by cilia and directed along special food-grooves towards the mouth. In all animals with this mode of nutrition, which was probably the primitive method in each of the principal phyla, except perhaps the Cnidaria and the Arthropods, the general tendency of evolution is towards a reduction or loss of active locomotion, and frequently towards fixation, which certainly occurred in the Echinoderms. The common ancestor of the phylum was, in fact, to all intents and purposes, a Pelmatozoon, fixed by the aboral pole, the original right side of the bilateral ancestor, and with ciliated grooves converging to the mouth on the upper side. Amongst the Cystids ancestral stages are to be found showing the gradual acquisition of a radiate pentamerous symmetry, first by the food-grooves and then by the skeleton and other organs of the body, last of all by the gonads. The Pelmatozoa retained permanently this mode of life, continually adapting and perfecting their organisation to the necessities entailed by it. The other Echinoderm classes, on the other hand, grouped together as Eleutherozoa, and including the modern starfishes, sea-urchins and holothurians must have become free again at a very early period after the acquisition of radiate symmetry, giving up their method of nutrition by means of ciliary currents, and losing in consequence their food-grooves, which atrophy as such, the condensation of the nerve-plexus at the base of the grooves persisting, and being further specialised as the "superficial" nervous system. The holothurians were the first stock to become Eleutherozoic, radiate symmetry in their case not having extended to the gonads, as it has in the case of the starfish and urchins.

The direct and positive evidence which is available may seem at first sight an insufficient foundation for the hypothesis of a Pelmatozoic ancestor of all Echinoderms, that is to say, a pre-Cambrian form in which the food-grooves initiated a radiate symmetry with which all other systems of organs gradually fell into line. But the necessity of some such assumption becomes irresistible when we realise by careful reflection the inadequacy of any other theory to account for the evolution of the characteristic radiate symmetry and the complete hold it has taken upon all organs of the echinoderm body. In the ontogeny of existing types it always seems as if it were the hydrocœle or water vascular system which actually set the tune to which all the other systems of organs dance, but it is difficult, if not impossible, to imagine clearly a course of ancestral evolution, limited and guided, as it must have been, by the necessities of the struggle for existence, in which the hydrocœle took the initiative in this respect, and did not itself follow the lead of some other system. The hydrocœle of the Pelmatozoic ancestor was probably at its first origin simply a compartment of the cœlom which had the function of furnishing tactile tentacles, formed as hollow outgrowths of the body-wall, in connection with the food-grooves. On this hypothesis it is easy to understand why the hydrocœle was the first system of organs to be affected by the radiate symmetry initiated by the primitive nutritive system, and consequently why, in the Eleutherozoa, after atrophy of the food-grooves, the symmetry should apparently start from the hydrocœle itself.

In the present volume the Pelmatozoa are also undertaken by Mr. Bather, who recognises four classes—Cystids, Blastoids, Crinoids and Edrioasterids. Another and perhaps more natural (*i.e.* phylogenetic) classification is hinted at (p. 39), but the arrangement quoted above is adopted as involving the least disturbance of established names and ideas. The Pelmatozoa occupy about two-thirds of the volume, and the treatment of this most difficult group cannot be too highly praised. An expert in this branch of zoology might perhaps find details to criticise or ideas with which to disagree; the worker in other fields can only express his appreciation of the erudition displayed and the labour expended in setting forth the structure and evolution of this vast series of forms. In a group which is to a large extent represented by fossils, and in which so little material is available at the present day for the scalpel and the microtome, it is natural that less space and attention should be given to the anatomy and morphology of the soft tissues than to that of the skeleton and its never-ending complications of plates and ossicles. A simple Crinoid is taken as a type of Pelmatozoic organisation, and its anatomy is briefly described. One small point, at least, in this description is open to criticism. The author identifies Ludwig's blood-vessel and ring in the Crinoid as the "pseudhæmal," *i.e.* perihæmal, system (pp. 100 and 102). This seems to be an oversight, as elsewhere (p. 26) he states that this system "is so much reduced in Crinoidea that its existence is denied by some authors." Since the perihæmal system of canals, where well developed, as in the starfish, has been shown very clearly to be of cœlomic origin, it is impossible to identify with it the Crinoid "blood-vessel," which has all the characters of the canals termed in this work the "lacunar" or "hæmal" system. If anything in the Crinoid arm is to be identified as perihæmal (a term we much prefer to pseudhæmal), then probably the subtentacular canals have the most right to this title, as being cœlomic canals which occupy approximately the same position as the perihæmal canals in the starfish, and which have also the same relation to the lateral nerve cords that the perihæmal canals have to "Lange's nerves." On this view we should have to regard the perihæmal system as a portion of the cœlom, which in the Pelmatozoa has reached only an incipient degree of specialisation, being in the region of the disc completely merged in the general body-cavity.

The account of the Holothurians has been written by Mr. E. S. Goodrich, who gives a useful summary of our present knowledge of the group. The remaining Eleutherozoa—Stelleroidea and Echinoidea—have been undertaken by Prof. J. W. Gregory, whose researches on these groups are well known to zoologists, and who gives us a most valuable and complete account of them. It is necessary, however, to point out a few errors or oversights which have crept in, some of which are important, though they do not detract from the value of the work as a whole. On p. 261 it is pointed out that we are indebted to Sladen for a memoir on the aberrant form *Astrophiura*, and the work is quoted in due course amongst the literature of Stelleroidea, but nowhere else is any reference made to *Astrophiura* and its peculiarities; it is omitted from the classification, does not appear in the index, and is, in fact, ignored altogether. The genus *Ophioteresis* is used as an argument for uniting the Asteroids and Ophiuroids on the ground that "the radial ambulacral vessels and nerve trunks lie in shallow grooves on the ventral surface of the anus" (p. 262; also pp. 270 and 274). The author gives no definite authority for this statement, but leaves us to infer that he obtains the fact from Bell's description of the genus. Bell, however, did not describe any such condition as that which Gregory dwells upon so often and makes the basis for such important deductions, and it is highly improbable that it occurs at all. It is much more probable the ambulacral vessels and nerve trunks pass in *Ophioteresis* through the aperture in the centre of the vertebral ossicle which Gregory figures plainly enough (Fig. xiv.), while maintaining a discreet silence about it. Finally, it must be mentioned that the peristomial plates in the Ophiuroid mouth skeleton are *not* "between the mouth frames and the buccal shields" (p. 264), but are above, *i.e.* to the aboral side of, the former, according, at least, to the careful descriptions and figures of Ludwig; the "mouth frames" are between the buccal shields and the peristomial plates.

A conscientious reviewer does his best to find mistakes in the works submitted to his scrutiny and judgment. In the present instance it cannot be said that we have been very successful in our search, having regard to the size and scope of the work. In conclusion, we can but congratulate heartily the editor, authors and publishers on the very valuable treatise they have produced, a work which reflects credit on all concerned, and is a triumph for English zoology. E. A. M.

THE BOTANY OF CAPTAIN COOK'S FIRST VOYAGE.

Illustrations of the Botany of Captain Cook's Voyage Round the World in H.M.S. "Endeavour" in 1768–71. By the Right Hon. Sir Joseph Banks and Dr. Daniel Solander, with Determinations by James Britten. Part I.: Australian Plants. 101 Plates, with descriptive letterpress. (London: Printed by order of the Trustees of the British Museum. All Booksellers. 1900.)

"BETTER late than never" may be said of the book the title of which is given above. It is a curious fact that the scientific results of several of the most important and most costly voyages of discovery, both English and foreign, have either not been published at all, or only in part, and in a fragmentary manner. Cook's first voyage is, perhaps, the most notable example of unfinished works of this kind in the history of British exploration. This is the more to be deplored, because collecting and methodical investigation were carried out on a scale previously unknown, and an immense sum was subsequently expended by Sir Joseph Banks in preparing the botanical results for publication. This is not the place to enter into the causes of the cessation of this part of the work; but it was not the only part that was long belated. It was not till 1893 that Captain Cook's own "Journal" was published, edited by Sir William Wharton; and three years later appeared Banks's "Journal" of that memorable voyage, edited by Sir Joseph Hooker. Although I have said "better late than never," it is obvious that the illustrations now in course of being issued have been, to some extent, forestalled, and the letterpress is historically interesting, rather than a contribution to science. According to the prospectus the complete work will comprise 800 plates; these will include a series illustrating the botanical collections of Cook's second voyage, when the Forsters, father and son, were the naturalists. Sydney Parkinson was the botanical artist on the first voyage, but he and the two other artists all died on the voyage, and their work was left in an unfinished condition. So much has been written about the plates now being issued and the desirability of their publication, that something superior to what they really are was probably expected by most people. Indeed it is difficult to suppress a feeling of disappointment. Compared with the botanical illustrations of other expeditions of discovery of a little later date, they are hard and unattractive, and floral dissections are almost entirely wanting. They lose, too, in effect, as they are transfers and not direct impressions of the original engravings on copper. The majority of the plates were engraved from drawings by F. P. Nodder, prepared from Parkinson's sketches and the dried specimens, and only the former name appears on the plates. Our remarks on this point, however, should be regarded in the light of explanation rather than criticism, because after all we must not forget that their publication has been delayed more than a century. Of course, it is highly regrettable that they were not published at the time, so that they might have been more fully utilised in the many publications that have appeared during the last century and a quarter on Australasian and Pacific Islands botany. A fact of great importance is that a comparatively small number of the plants here depicted had previously been figured. Mr. Britten has most conscientiously reproduced Solander's descriptions and remarks, even to the extent of palpable errors. Thus the locality Endeavour River is given throughout as Endeavour's River, and "petioli ½-uncialia," instead of unciales. But perhaps this course is more satisfactory than any attempt at improving the original; and errors of the latter kind may be due to slips of the transcriber. The keenest reader may overlook false terminations in Latin descriptions, and the most ready writer is apt to make them.

On the other hand, our thanks are due to Mr. Britten for much valuable information, and the correction of many current errors. Doubtless when the time comes for the "Introduction," some account will be given of the countries or districts explored, and the botanical results summarised.

With regard to nomenclature, it is fortunate that, although the rule of priority has been strictly followed, there are few suppressions of familiar names; but that is because there were few opportunities. Of course, the familiar names appear, but only as synonyms. Mr. Britten is an uncompromising disciple of the school of reformers, and he has been permitted to exercise his will in this national publication. Thus *Ionidium* becomes *Calceolaria;* and the calceolarias that everybody is familiar with have *Fagelia* for their generic name. *Cosmia* takes the place of *Calandrinia; Damapana* that of *Smithia;* and *Caulinia* that of *Kennedya.* The complications that such changes cause are almost interminable, as the revival of one name may affect half-a-dozen other well-established generic appellations. But this is not the place to discuss the question. Botanists will be thankful to the Trustees of the British Museum for this valuable addition to their pictorial books, which is at the same time a monument to some of the scientific pioneers in British exploration.

W. BOTTING HEMSLEY.

OUR BOOK SHELF.

Fancy Water-Fowl. By F. Finn. Pp. 45. Illustrated. (London: *Feathered World* Office, 1900.)

MR. FINN, especially to Indian readers, is such a well-known writer on popular ornithology in more than one journal that the reproduction of a series of his articles in book-form can scarcely fail to be welcomed by a wide circle. And in selecting ornamental, or "fancy," water-fowl as a subject, he has hit upon one which appeals to a large number of bird lovers, if for no other reason than the facility with which these handsome birds can be reared and kept in confinement, even when the available space is limited.

The author has confined himself, on the advice of a lady friend, to well-known species, and in the selection he has made he is, on the whole, to be congratulated. We should, however, have liked to see mention made of the so-called Coscoroba Swan of South America, on account of its very peculiar organisation, although we are well aware that, chiefly owing to its delicate constitution, it is seldom seen in European collections.

Both the illustrations and the text have been reproduced in their original guise from the *Feathered World.* With regard to the page plates there is considerable individual variation in their degrees of excellence, the figure of the Spotted-bill Duck, forming the frontispiece, being decidedly superior to that of Rosy-billed Pochards which comes later, the last-mentioned being somewhat coarse

and blurred in outline. Indeed, we venture to think that if a second edition be called for it would be a decided improvement if the plates were photographed down to octavo size, while at the same time the text might be printed in larger type.

As it is, however, the book is decidedly attractive, and ought to prove indispensable to all breeders of ornamental water-fowl. R. L.

Catalogue of Eastern and Australian Lepidoptera Heterocera in the Collection of the Oxford University Museum. Part ii. Noctuina, Geometrina and Pyralidina. By Col. C. Swinhoe. Pterophoridæ and Tineina. By the Right Hon. Lord Walsingham and John Hartley Durrant. Pp. vi + 630; with 8 plates. (Oxford: Clarendon Press, 1900.)

THE first volume of this important work was published as long ago as 1892; it included the Sphinges and Bombyces; and the second and concluding volume, which is nearly twice as thick as the first, has at length been issued.

A great number of *Lepidoptera Heterocera* (moths) were described by the late Francis Walker, not only from the British Museum, but from various private collections, chiefly from that of W. Wilson Saunders. After the death of the latter, large portions of his collection found their way into the Oxford Museum, and the types have now been carefully identified, and a considerable number figured. This is extremely important, as it will enable lepidopterists at a distance to identify species with more certainty than by descriptions alone; and a figure also helps to fix the identity of a species in case the type should be lost or destroyed.

About 2340 species of moths are enumerated in the present volume, and we note that in addition to Walker's types many described by Mr. F. Moore and other entomologists are likewise contained in the Oxford Museum; nor must we omit to mention that several new genera and species are described and figured by the authors of the Catalogue for the first time. However, the work is one which, notwithstanding its importance, appeals so exclusively to specialists that a more lengthy notice is hardly required in the columns of NATURE.

W. F. K.

Sir Stamford Raffles: England in the Far East. By H. E. Egerton, M.A. Pp. xx + 290. (London: Unwin, 1900.)

THIS volume, which is one of a series, entitled "Builders of Greater Britain," and edited by Mr. H. F. Wilson, does not call for much comment in a journal devoted to science. The author of the biography naturally deals mainly with Sir Stamford Raffles as an administrator in the Straits Settlements and the Malay Archipelago, and only incidentally, and that very briefly, refers to him as a zoologist. Raffles was, as everybody knows, one of the founders, and the first president, of the Zoological Society of London; and his bust adorns the lion house of that society. Mr. Egerton, in narrating this fact, is chiefly impressed by "how much innocent pleasure this distinguished child-lover has given to countless thousands of children" by his successful efforts in this direction. He mentions, however, the collections which he took care to make, and which were largely reported upon by Dr. Horsfield. In those days much that was brought back from the East in the way of zoological specimens was quite new to science, and the animals had to have names given to them; it is not such a great compliment as Mr. Egerton seems to think to name a species *Gymnura rafflesii*, after Sir Stamford. This compliment is usually paid to the capturer of a new form, and it is ridiculous to say that "Raffles' reputation in the scientific world is attested by the fact that the great French naturalist, M. Geoffroy St. Hilaire, described a new variety of animal under the specific name 'Rafflesii.'"

LETTERS TO THE EDITOR.

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

The Teaching of Mathematics.

PROF. JOHN PERRY has asked me to write something in criticism of the views he has lately expressed about the teaching of mathematics. I am inclined to ask, What is the use? He knows my views pretty well, and others too; and those who don't can learn them if they want to by buying my books. That is the best way, as it brings in one-and-threepences, and so does some good. I think there is a great deal to be said on both sides, and that if you are a born logic-chopper you will think differently from Faraday. The subject is too large, and I will only offer a few remarks about the teaching of geometry, based upon my own experience and observations. Euclid is the worst. It is shocking that young people should be addling their brains over mere logical subtleties, trying to understand the proof of one obvious fact in terms of something equally, or, it may be, not quite so obvious, and conceiving a profound dislike for mathematics, when they might be learning geometry, a most important fundamental subject, which can be made very interesting and instructive. I hold the view that it is essentially an experimental science, like any other, and should be taught observationally, descriptively and experimentally in the first place. The teaching should be a natural continuation of that education in geometry which every child undergoes by contact with his surroundings, only, of course, made definite and purposeful. It should be a teaching of the broad facts of geometry as they really exist, so as to impart an all-round knowledge of the subject. It should be Solid as well as Plane; the sphere and cube, &c., as well as the usual circle and square; models, sections, diagrams, compasses, rulers, &c., every aid that is useful and practical should be given. And it should be quantitative as well. The value of π should be *measured*; it may be done to a high degree of accuracy. So with the area of the circle, ellipse and all sorts of other things. The famous 47th. The boy who really measures and finds it true will have grasped the fact far better than by a logical demonstration without adequate experimental knowledge; for it happens that boys, who are generally very stupid in abstract ideas, learn a demonstration without knowing what it is all about in an intelligent manner. It may be said by logicians that you do not *prove* anything in this way. I differ. It might equally well be said that you prove nothing by *any* physical measurements. You have really proved the most important part. What a so-called rigorous proof amounts to is only this, that by limitation and substitution, arguing about abstract perfect circles, &c., replacing the practical ones, you can be as precise as you please. Now when a boy has learnt geometry, and has become competent to reason about its connections, he may pass on to the theory of the subject. Even then it should not be in Euclidean style; let the invaluable assistance of arithmetic and algebra be invoked, and the most useful idea of the vector be made prominent. I feel quite certain that I am right in this question of the teaching of geometry, having gone through it at school, where I made the closest observations on the effect of Euclid upon the rest of them. It was a sad farce, though conducted by a conscientious, hard-working teacher. Two or three followed, and were made temporarily into conceited logic-choppers, contradicting their parents; the effect upon most of the rest was disheartening and demoralising. I also feel quite certain about the experiential and experimental basis of space geometry, though that opinion has been of slow growth. If I understand them rightly, it is generally believed by mathematicians that geometry is pre-existent in the human mind, and that all we do is to look at nature and observe an approximate resemblance to the properties of the ideal space. You might assert the same pre-existence of dynamics or chemistry. I think it is a complete reversal of the natural order of ideas. It seems to me that geometry is only pre-existent in this limited sense; that since we are the children of many fathers and mothers, all of whom grew up and developed their minds (so far as they went) in contact with nature, of which they were a part, so our brains have grown to suit. So the child takes in the facts of space geometry

naturally and easily. The experience of past generations makes the acquisition of present experience easier, and so it comes about that we cannot help seeing it. But it is all experience, after all; although learned philosophers, by long, long thinking over the theory of groups and other abstruse high developments, may perhaps come to what I think is a sort of self-deception, and think that their geometry is pre-existent in themselves, whilst nature's is only a bad copy. Like the old Indian pundit, whose name was something like Bhatravistra, who, after fifty years inward contemplation, discovered God;—where—it would not be polite to mention. OLIVER HEAVISIDE.

September 22.

The New Senate of the University of London.

IN your paragraph (NATURE, September 27, p. 543) on the new Senate about to be elected in the University of London, you have put the issue as it has occurred to me. I have not been able to give my support to either of the two bodies which have set their electoral machinery in motion, for the simple reason that neither of them has produced a list of names of candidates in which higher educational work is adequately represented. I thoroughly endorse your remark that "It would be nothing less than a calamity were Convocation to elect sixteen irreconcilables with no idea outside that of introducing the peculiar needs of the external student into all deliberations of the Senate."

The University may boast of the value of the degree; but this is only to say that as an organism its *cell*-life is strong. As an organism, however, its *somatic* life is weak; and the *summation and co-ordination of function* is the main idea for the new Senate of the University to keep before it, if the University is to be a factor of real power in our national and imperial life in the centuries to come. An experience as a teacher of over a quarter of a century (Wellington College and Nottingham) entitles me, I think, to speak on this matter.

Bishop's Stortford, September 28. A. IRVING.

The Peopling of Australia.

IN the issue of NATURE dated December 28, 1899, there appeared a notice of my book, "Eaglehawk and Crow," from the pen of Prof. A. C. Haddon. A copy did not reach me till the end of February, and for that and other reasons which need not be mentioned I delayed replying to the criticisms passed. With your kind permission I shall now endeavour to meet the principal objections raised to my work, with a desire of advancing, if even in a very small measure, our knowledge of Australian ethnology. All ethnologists are agreed upon the difficulty of the Australian problem, and no one who attempts to solve it will be surprised at their agreement.

I regret that, owing to my omitting to define my use of the term Melanesian, Prof. Haddon misapprehended one of my fundamental positions. In a note on page 5 I say, "Papuan is applied, not in its narrowest application (dark New Guinean), but as the equivalent of Melanesian, and is meant to include the Tasmanian aborigines, &c." From this Prof. Haddon inferred that I excluded the Papuans proper from my Papuan race. Nothing was further from my intention. I included them as a sub-race under the wider term Melanesian, as many writers have done, as even the latest writer on the subject, Deniker, has done in his "Races of Man," page 285, and elsewhere. The basis of my ethnological position may be thus represented:—

Papuan or Melanesian Race.
- Papuan Proper.
- Malanesian Proper.
- Tasmanian Papuan.
  - Primitive Australian.
  - Tasmanian.

This classification underlies my whole book. I confess that I would now prefer to restrict the name Melanesian to the Melanesians proper as less liable to ambiguity, but in making Melanesian the general name I followed the lead of others much more competent than I am. That I recognised the narrower application of Papuan is evident from the above quotation from page 5, and such a passage as the following shows that I recognise Melanesians proper. "There are indications of groups of Melanesians having reached Australia on the eastern Queensland coast," page 73. Further, I invariably refer to the Tasmanians as Papuans, with occasionally some such qualifying word as *primitive*.

My solution of the Australian racial problem having received the approval of Prof. Keane ("Ethnology," pp. 291–2), I may state it briefly here. The now extinct Tasmanians represent the primeval Australian aborigines. They were probably not a pure race, but embraced Negrito and Papuan elements. At the time of their arrival in Australia they probably occupied the islands to the north, and their congeners were the first to occupy Melanesia. Upon the primitive Papuans there was a strong graft of what, for want of a better name, and following the example of others, I have called "Dravidians," using this as a term of convenience to indicate likeness to the people of southern and central India. Then followed a further migration, in a desultory manner, of people of Malay stock; the precise locality whence these came is indeterminable, but I give evidence of distinctly Sumatran influence in the north-west. Concurrently, or subsequently, companies of Melanesians proper and Papuans proper have mingled with the Australians on the north and east of Queensland.

The two earliest immigrations entered Australia from New Guinea or neighbourhood. The population became distributed by streams diverging from the base of Cape York Peninsula.

When allowance has been made for Prof. Haddon's misconception of my use of the term Papuan, there is little more in his notice that needs to be referred to, as he concedes my main positions.

Mr. S. H. Ray, having been invited by Prof. Haddon to offer observations upon the linguistic part of the work, criticised it in a manner which seems to be unnecessarily caustic, fastening attention upon petty points which he objected to, and ignoring the main issues. He begins by asserting that I belong to a school of Australian pseudo-philologists who believe that a likeness of words in sound and meaning is a proof of common origin, and this in spite of my explicit disavowal of such a position, and my exposure of the unsoundness of it on page 44, where I show that on such a principle the Australian languages might be derived from the English. Having made so fair a start with a *petitio principii*, by gross misrepresentation of my statements, he proceeds to buttress his assertion. "We are asked to believe," he continues, "that Malay immigrants, presumably from various parts of the Archipelago, entered Australia from the north, and wandering about the interior, scattered 'astonishing relics' of the speech of one of their sections all over the island continent." He is not asked to believe any such ridiculous nonsense, and it is singularly disingenuous to say so in the face of my sober statements on page 57, "Either the Malay inroad, if made at the north, took place in long past ages, or now and again parties of Malays, either from choice or necessity, landed and became naturalised at various spots on the east, north and west, and modified the speech of the people, first immediately round them, and then landwards": and on page 61, "This last influx (the Malay) may have come by several little rills, entering at places widely apart and gradually losing themselves in the life-lake." The "wandering about the interior" is a pure invention of Mr. Ray's. When the universal practice of exogamy is taken into account, along with the general pressure and movement of people, language, customs, &c., from north to south, my theory of Malay influence on the Australian people and language will be accepted as reasonable by unprejudiced minds. In the *Journal* of the Anthropological Institute for 1894–5, in a paper on "The Languages of British New Guinea," this very Mr. Ray uses language, and language alone, as a basis of classification for proving racial distinctions and affinities and movements. I do not say that this was an improper use of the linguistic argument, but it differs from mine in this, that I rarely rely upon language alone. I back up the linguistic evidence by that of other ethnological characters.

To come to particulars: my identifying a certain type of Australian words for "Head" with the Malay "Kapala" is objected to because "Kapala" is a word of Indian origin. But the word has been current in Malay for five or six centuries, and is in use in that very part of Sumatra from which, according to my hypothesis, came the authors of the best Australian rock-paintings. It is quite possible that I may be mistaken in relating certain Australian words to "Kapala," but Mr. Ray's ground of objection has little or no cogency.

"Mama" and "bapa" are terms for mother and father of

wide currency in Australia. The former I connect with early Papuan influence, the latter more especially with Malay. He objects on the ground that connectives of "mama" are more common in the Malay districts of the Eastern Archipelago than "bapa." But in Australia the word "mama" occurs only in the extreme S.W. and S.E., among the purest modern representatives of the earliest occupants of Australia, thus affording ground for the conclusion that the term "mama" preceded the term "bapa." The wide prevalence of "bapa" forms in other countries I myself refer to on page 44; but the question is, What race was specially influential in giving such forms currency in Australia? As against my position it is not sufficient for Mr. Ray to say that "mama" variants are of more frequent occurrence in Malay centres than "bapa" variants, he will have to prove that the words of "mama" type are not adopted words in Malay, were not earlier in use in the East Indian Archipelago than the other type of words, and are not more markedly Papuan than these.

Mr. Ray complains that individual words in the languages quoted "are not always accurately given or properly understood." This may be; but like himself I am dependent upon my authorities. When further on he suggests that I might have attempted uniformity of spelling in the foreign words, he is like the "children sitting in the market-place." A desire to be free from suspicion of tampering with my borrowed materials kept me from applying to them a uniform system of spelling, and evidently my caution was not unnecessary.

Mr. Ray's harshness is all the more indefensible since he himself falls demonstrably into error on the very point upon which he proposes to correct me. As proof of my mistaking the form and meaning of words, he cites the New Guinea numerals (pp. 165, 169). He says they are explainable compounds. He does not, however, attempt to explain them. But even if they are, this fact alone does not prove that they could not be transmitted to Australia. One feature about Australian numerals is clearly shown in my tables, viz. that they occur geographically in lines that converge on Cape York Peninsula. Some of them are most certainly identical with forms in use on Saibai Island on the New Guinea coast, *e.g.* "woorba," with variants traceable along the Queensland coast from a point about 1000 miles S.E. of Cape York, and represented in the form "warapune" Prince of Wales Island, "woorapoo" at Warrior Island, and in "urapon" at Saibai. One numeral, "luadi" (two), used by the Kalkadoon tribe, whose territory is about 150 miles south of the Gulf of Carpentaria and some 600 miles S.W. of Cape York, is a Melanesian numeral. It did not fly that distance through the air. And there is just as little doubt about the identity of at least several of the other Australian numerals with the New Guinea forms to which I have related them. My table of numerals was not formed rashly. It will be worth Mr. Ray's while to examine and test it carefully. The convergence of numerals upon Cape York Peninsula is only one striking illustration of what occurs in the case of other words, and words thus traced to the very coast must have come from New Guinea and adjacent islands.

As another example of my misunderstanding words, Mr. Ray refers to my "ori kaiza," pp. 66–7. He says: "Ori kaiza" is mongrel, "ori" (bird) is Toaripi, Papuan Gulf, and "kaiza" (big thing) is Saibai, West Torres Straits. This is, for himself, a most unfortunate example. Although he speaks so authoritatively, he is utterly at fault. Sir W. MacGregor's reports give "uroi" (bird) as a Saibai word; and even Mr. Ray himself, in his paper already quoted from, gives "urui" as Saibai for 'bird,' a fact he appears to have forgotten. Besides, in the "Voyage of the *Rattlesnake*," containing vocabularies obtained in 1849 from a white woman who had been among the natives for four and a half years, McGillivray gives "wuroi" as a Cape York word, and "ure" as a Kowrarega word, both meaning bird. Mr. Ray's assertion, therefore, that "ori kaiza" is mongrel, is contrary to fact, and my tracing of this compound word across Australia from S.W. to N.E., and to the New Guinea coast, is not in the least invalidated by Mr. Ray's groundless and inconsistent statement that the word is mongrel.

Mr. Ray characterises my comparison of Australian words with Malay and New Hebridean as "absurd and misleading." This may be so to one with his pre-conceptions, but certainly not from the point of view which I have taken of the relation subsisting between the races whose words are compared. If the Tasmanians were the original occupants, both of Australia and the greater part of Melanesia, which is my hypothesis, it is not unreasonable to suppose that certain radicals would be common to Tasmanians, Australians and Melanesians proper. And further, one of the most competent authorities on the Oceanic languages, the Rev. Dr. MacDonald, of Efate, is of opinion that Malay, Melanesian and Polynesian are sister languages derived originally from one mother tongue. If he be right, there would be no absurdity in affirming analogies between Malay and New Hebridean words. But I have included the Malay with a note almost like an apology. I only cite eight Malay words, and the only conclusions I draw concerning the Malay in this connection is "The terms for father, skin, are the same in Malay, Australian and New Hebridean" (page 156).

I would have liked to have shown that the Melanesians proper have had much more influence upon the Australians than Mr. Ray seems to have any conception of, but I have already taken up so much space that I must content myself with saying that this proposition can be successfully maintained, and with your indulgence I hope in a future letter to make good my words. In conclusion, I would just say that I welcome fair and sound criticism based on accurate knowledge for its influence in promoting truth, but mere fault-finding and ridicule can benefit neither authors nor readers. One sentence from my reviewer in the *Saturday Review* may not be out of place here:—"If Mr. Mathew has not proved his theories to the satisfaction of all his readers, it is not from lack of knowledge or scientific methods, but from the imperfection of his materials."

Coburg, Victoria, August 16. JOHN MATHEW.

THE PRESERVATION OF BIG GAME IN AFRICA.

PAST experience in America and South Africa shows how rapidly the teeming millions born of the soil may be shot out. Writers of half a century ago describe on the veldt in South Africa a paradise of varied life, which is now irretrievably lost, through the carelessness and wastefulness of white men. Some species have absolutely disappeared, never to be seen again on the face of the earth. Others are so scarce that it is doubtful whether their power of reproduction can save the race. The fact that an International Conference, attended by delegates from Germany, France, Italy, Portugal and the Congo Free State, on the subject of the preservation of the game from destruction in Africa, met recently in London, under the auspices of our Foreign Office, shows that a widespread interest is now taken in this subject. Let us see how the matter stood previous to the meeting of the Conference—at least as regards British territory.

Excluding the settled parts of South Africa which were outside the purview of the Conference, we may observe, in the first place, that our Foreign Office appears to be thoroughly alive to the urgency of the question in those territories under their jurisdiction. They had enacted game regulations which ought to have been effective for their purpose. A 25*l.* license was imposed upon strangers, and one of 3*l.* upon residents and officials, as a necessary condition of shooting, while the licensees were limited to two specimens in the case of elephants, rhinoceros, hippopotamus, buffalo and giraffe. Fines up to 500 rupees, and imprisonment for two months, were the maximum penalties. Above all, Reserves for the game were defined. Similar regulations to the above were in force in German territory; but let us confine our attention to British East Africa as an example with which I am familiar. Here, on the best feeding grounds, there are vast herds of wildebeest, hartebeest, impala, zebras, gazelles of several species, and in lesser numbers waterbuck, giraffes and rhinoceros. All these, and others, may be seen from the windows of the train as it traverses the new Uganda railway, which has now been constructed to a point about two-thirds of the way to Lake Victoria. The Kenia province, which is about 100 miles by 40, has been constituted a game Reserve. Other Reserves have been established in Uganda and British Central Africa. Each of the Foreign Powers engaged

in the Conference have bound themselves to provide similar Reserves where they have not already done so, and to maintain them as such with strictness, and much depends upon the interpretation of that word. Now this is just what we had not until recently done in the case of the Kenia Reserve.

One of the regulations provides "That public officers may be specially authorised to kill, &c." in that Reserve. Unfortunately the words "may be authorised" in this regulation were interpreted by many of the Protectorate and railway officers stationed at Nyrobe, Kikuyu and elsewhere as "are authorised," and thus as making them free of the Reserve. This laxity of interpretation had a tendency to spread, and large quantities of game were at first killed there after the arrival of the railway. A Reserve is no true Reserve which is subject to personal exceptions, and in the circumstances which I have detailed was a delusion and of little value. We may rest assured that, now that this defect has been pointed out, the Foreign Office will not be backward to remedy it; and even if it were not so, they are under an international obligation to make the Reserve a reality. We may, therefore, confidently expect that the words I have quoted, which admit of a serious leakage, will disappear. It must not be thought that the officers to whom I have referred are indifferent to the preservation of game. It is in their interest, above all others, that these regulations should be maintained, and I am confident that the good sportsmen, of whom there are many among them, are anxious to be protected against those who cannot be so described. Nothing can be stronger than their reprobation of the worst transgressors, as, for instance, of a gentleman wearing her Majesty's uniform, who, I was told, killed approximately a score of wildebeest in a day, and left them rotting on the ground. The author of this disgusting butchery was brought to book, but he passed into Uganda, and thus, sheltered by a technicality, escaped the payment of the fine. It is to be hoped that the long arm of the autocratic committee which governs both territories will ultimately reach this glaring offender.

It remains to be considered in what respects the recommendations of the Convention will strengthen the game laws in their present form. The principal recommendations of the Conference may be summarised as follows. A special and select list of animals are to be absolutely protected at all times. Another schedule comprises the species which are to receive protection for immature animals and breeding females. The sale of tusks of elephants weighing less than eleven pounds is forbidden, and finally each Power undertakes to establish adequate Reserves and to protect them from encroachment. It will be seen that these recommendations impose upon them certain obligations, and we may thus expect that the new regulations for the British territories will include a schedule of animals as sacred from molestation as the bulls of Apis. The giraffe, eland and buffalo are, at any rate, among those which are sure to enjoy this royal distinction. It is a little difficult to see why vultures, owls and rhinoceros birds, which are exceedingly useful, but are not sought for food, should have been added by the Conference to such a distinguished list. The second list, of which the breeders and young are to be protected, will doubtless include such animals as rhinoceros, hippopotamus, waterbuck, sable, greater and lesser koodoo. The importance of this will be seen when it is remembered how slowly these larger animals breed. Apart from these restrictions a limit will doubtless be placed on the numbers of all the game animals allowed to be killed under each license, a high limit being given for the common species, and a much lower one, probably not exceeding two specimens, for those in most danger of disappearance.

Infractions of this rule may be somewhat difficult to detect, but every licensee, at the expiry of his license, should be required to furnish a return of what he has killed. This would impose a certain restraint on thoughtless sportsmen, and when the returns are collated would form a basis for a valuable tabulation of the numbers of each species killed from year to year, and serve as an indication of the increase or diminution of any species in a given area. A small export duty on skins and horns would be a useful assistance to such a return.

The maintenance of Reserves is of the highest importance for the preservation of the various species. In my opinion, the position and boundaries of the Kenia Reserve, which is perhaps the most important of all, should be reconsidered. These boundaries were selected because they happened to be the defined limits of a Province, and not because they represented the real needs of the game. A large portion of the area is densely populated and cultivated. Another considerable area is at a high elevation and covered with forest which harbours some elephants; but is of no use to the great families of grass feeders, such as the zebras, the numerous kinds of antelope and gazelle, the rhinoceros and ostrich. The great bulk of these are confined to the grass plains along the Athi River, and unfortunately its left bank only is within the Reserve. This feeding area is thus but a small fraction of the whole Reserve, and is quite inadequate to feed the vast herds; nor does it, as a matter of fact, cover their frequent migrations in search of fresh grazing, which extends to both sides of the Athi, and southwards to the plains of Kilimanjaro. The limited belt of grazing ground within the Reserve has been still further curtailed by the location of the important railway centre of Nyrobe in the midst of it, since the Reserve was constituted. This will necessarily drive the game from that part of the protected plains. It is therefore desirable that the boundaries of the Reserve should be reconsidered by competent officers on the spot, not forgetting the important assistance which would be rendered by the railway in safeguarding and watching it, provided it traverses it or skirts its boundary on one side.

Then as to the difficult question of elephants, difficult because of the high money value of their tusks. I am personally opposed to the destruction of elephants at all, on the ground that, valuable as they are for their ivory, that will soon come to an end at the present rate of destruction, and that they might be still more valuable as weight-carriers. That is, perhaps, a counsel of perfection, but that they require some far more effective protection is obvious to every one who has studied the subject. Recently an Englishman sold in Mombasa the produce of his trip in ivory for 8000*l*. The hundreds of elephants necessary to produce this amount were, of course, not in the main killed by his own rifle. Some of the ivory may have been bought, but numbers of native hunters were said to have been hired for this purpose and attached to his staff, and were sent far and wide over the country. Thus this caravan must have left a broad trail of destruction for hundreds of miles. When the wealthy and powerful set such an example, how can the law be enforced against those who have the excuse of poverty. It is to be hoped that the Foreign Office will be able to devise means for the arrest of wholesale destruction like this. Although the Convention has not recommended it, is it too much to hope for the imposition of an adequate export duty, uniform at all the ports of exit, to whatever Power they may belong, and the total prohibition of the export of cow ivory?

The question of bringing resident natives under the prohibition which extend to Europeans requires to be carefully weighed. In my opinion, it is neither possible or just to stop their hunting so long as they are confined to their primitive weapon, the poisoned arrow. From time immemorial the destruction caused by the indigenous

inhabitants has not appreciably diminished the stock. The land and the animals upon it are their birthright, and to interfere with it would surely cause trouble. We are not bound, however, to furnish them with civilised weapons, and every precaution should be taken to prevent their obtaining them.

Finally, the best of rules are useless without two things —a sound public opinion among the resident whites whom they chiefly affect, and a firm and knowledgable man to carry them out. The first exists, and I am convinced is on the increase. How should it be otherwise, unless one presupposes the most shortsighted selfishness? As to enforcing the rules, that which is the business of several officials, all of whom are engaged in office work, is practically no one's business. Let there be one man on the spot—that is to say one in each great game district, and especially in each Reserve—whose duty it is to know and to act.

E. N. BUXTON.

NOTES.

AS was announced in our last issue, many of the medical schools in London and elsewhere were re-opened this week, and addresses were delivered by well-known medical men and men of science. At the Charing Cross Hospital Medical School the third Huxley Lecture was delivered by Lord Lister on Tuesday.

A COURSE of twelve "Swiney" lectures on "Extinct and Persistent Types" will be delivered in the lecture theatre of the Victoria and Albert Museum, South Kensington, by Dr. R. H. Traquair, F.R.S., on Tuesdays, Wednesdays, and Fridays from October 9 to November 2. No charge is made for admission to the lectures.

AT the meeting of the Royal Photographic Society to be held on Tuesday next, October 9, the President will deliver his annual address, and present the medals awarded at the Society's Exhibition.

THE Lettsomian lectures will be delivered before the Medical Society of London in March and April next, and the oration will be given in May by Mr. F. Richardson Cross.

THE seventeenth annual meeting of the Association of Official Agricultural Chemists is to be held at the Columbian University of Washington, commencing on Friday, November 16 next.

THE fourteenth International Medical Congress will be held at Madrid early in 1903, under the presidency of Prof. Julien Calleja.

THE annual "Fungus Foray" of the Essex Field Club will take place on Saturday next from High Beach, Epping Forest. The prospective arrangements of the club include the opening of the Essex Museum of Natural History by the Countess of Warwick, on the 18th inst. The scientific winter evening meetings will be resumed in the Physical Lecture Theatre of the West Ham Technical Institute on October 27.

Science announces that Prof. H. T. Todd, having reached the age limit, has retired from the Directorship of the U.S. Nautical Almanac. Prof. S. J. Brown, astronomical director of the U S. Naval Observatory, has undertaken the duties of the office.

ACCORDING to the *Lancet*, a scheme has been sanctioned by the Charity Commissioners by which 644*l.* left to the Royal College of Surgeons of England in 1884 will be devoted to providing every four years a "Cartwright Medal" for an essay on dental surgery. The medal will be accompanied by an honorarium.

THE gold medal of the American Philosophical Society, known as the Magellanic, will be awarded in December next for the best discovery or most useful invention in the physical sciences brought before the Society before November 1.

PROF. F. KLEIN has been awarded 800 marks by the Göttingen Society of Sciences for his Mathematical Encyclopædia, and the same society has awarded 500 marks to Prof. Wiecherts for that worker's seismological recording instruments.

IN addition to the medals and prizes given for communications discussed at the meetings of the Institution of Civil Engineers in the past session, the Institution has made a number of other awards in respect of other papers dealt with during the same period, *e.g.* a George Stephenson medal and a Telford premium to Mr. L. F. Vernon Harcourt, and Telford premiums to seven other gentlemen. For students' papers, the James Forrest medal and a Miller prize have been awarded to Mr. C. B. Fox, the James Prescott Joule medal and a Miller prize to Mr. J. W. Smith, and Miller prizes to four other students. The council have nominated Mr. R. F. Whitehead to the Palmer scholarship at the University of Cambridge in succession to Mr. A. H. Kirby.

A NEW technical school is to be erected in Belfast on a portion of the grounds purchased from the Royal Academical Institution, and a principal is to be appointed shortly at a salary of 600*l.* per annum, whose experienced practical advice will, it is hoped, be of much value in making the interior arrangements of the building, and in organising the work of the institution while the building operations are in progress.

PROPERTY valued at upwards of 200,000 dollars has been left by Mr. Charles H. Smith for the maintenance of the botanical specimens in the city park of Providence, Rhode Island.

WE have had pleasure on more than one occasion to refer to the good work that is being done to the cause of scientific education by the Essex Technical Instruction Committee, and are glad now to call attention to two new courses of lectures that are about to be inaugurated by the committee. A first-year's course of instruction in botany for teachers will commence at Chelmsford on Saturday, October 6, and will be continued on successive Saturdays until about the middle of May, 1901, and an elementary course of practical instruction in dairy bacteriology will commence on Thursday, October 11, and will be continued on ten consecutive Thursdays.

THE *Windward*, according to *Science*, was expected to reach St. John's by about the middle of September, but a short delay would not be surprising as the vessel started late, owing to some difficulty with the machinery, and was subsequently delayed by ice along the coast of Labrador. The arrival of the steamship is awaited with interest and some anxiety, as news will be brought, not only of the return of Peary, but also of Captain Sverdrup and Dr. Stein. The former has the *Fram* provisioned for five years, with a crew of twelve men. He planned to round the northern boundary of Greenland and to make his way down its unknown east coast to Cape Bismarck. It is said that the expedition under Dr. Robert Stein of the U.S. Geological Survey, who is accompanied by Mr. Leopold Kann, of Cornell University and Mr. Samuel Warmbath of Harvard University, was poorly equipped and left in a dangerous position. Lieut. Peary himself expected to establish his last depôt at Cape Hecla, the most northerly point of Grinnell Land just beyond the 82nd parallel, whence he intended to advance with Eskimo and sleds as far north as possible.

AT a meeting held on June 12 last at the University o. Melbourne, it was unanimously resolved to form a society to be called the Society of Chemical Industry of Victoria, the objects for the establishment of the society being: (*a*) to afford its members opportunities of meeting and discussing matters connected with applied and industrial chemistry; (*b*) generally to advance the cause of chemical industry in Victoria. It was

further resolved that meetings shall be held at monthly intervals during the greater part of the year, at which papers on special branches of industrial chemistry are to be read and discussed. At a subsequent meeting, Prof. Orme Masson was elected president. The first paper to be read before the Society was one by Mr. D. Avery on September 4, on the cyanide process for gold extraction. The Society has made an encouraging start, as up to the end of August 118 members had been enrolled. We trust a lengthy and prosperous career lies before the new arrival.

THE sixteenth session of the Queensland branch of the Royal Geographical Society of Australasia was inaugurated at Brisbane on August 17, when a paper was read by the secretary—Mr. J. R. Thomson—on the geographical evolution of the Australian Continent. In connection with the society it has been decided to award a medal annually for the best and most scientific paper on some subject dealing with Queensland, and a fund for this purpose has been opened.

THE seventy-second annual meeting of the Association of German Naturalists and Physicians opened on September 17 at Aix-la-Chapelle with an attendance of about two thousand members. Of the thirty-eight sections, seventeen are devoted to such subjects as natural history, geology, geography, education, &c., the remaining twenty-one dealing with all the special subjects of medicine, including balneology, accidents, history of medicine and medical geography, and finally veterinary matters. A special correspondent of the *British Medical Journal* states that at the opening meeting the usual speeches of welcome were delivered by the Mayor and others, and the introductory addresses this year were by arrangement devoted, not only to giving a retrospect of the subject, but also to a sketch of its development during the nineteenth century. Dr. J. H. van 't Hoff spoke on the development of the exact natural sciences (natural history, chemistry and allied subjects). Dr. G. Hertwig delivered an address on the evolution of biology, in which, after relating anatomical discoveries, he came to the large question of the natural origin of the organic world. He considered that theories as to inheritance and natural selection still rested on the uncertain basis of hypothesis. He pointed out, however, that the difficulty arose from the absence of sufficient prehistoric records, and expressed his agreement with the opinion of Huxley that Darwin's teaching as to evolution will survive, apart from his principles of selection. Prof. Naunyn gave an address on the evolution of medicine, connecting the progress of the science with the names of Schwann, Pasteur, and Lister. The fourth and last address was given by Prof. Chiari, whose subject was the evolution of pathological anatomy.

THE British Mycological Society and the Cryptogamic Society of Scotland held a most successful meeting at the Boat of Garten from September 17 to 22. Various portions of the old forests of Rothiemurchus and Abernethy were worked from day to day, and a rich collection of scarce Hydnei and Cortinarii was secured. Prof. Marshall Ward (President of the British Society) gave an address, entitled "Nutrition of Fungi," and also contributed a paper on "Naematelia." Exeter was selected as the centre for next year's foray in the last week in September, and Prof. Marshall Ward was re-elected President.

AT the annual meeting of the Hull Scientific and Field Naturalists' Club, on September 26, an active and successful year of work was reported. A committee has been formed to work in connection with the National Trust for Places of Historic Interest or Natural Beauty; several important "finds" have been made during the weekly excursions; an exhibition of local natural history, geological and archæological specimens has been held in the Technical Schools; and the Club has become a Corresponding Society of the British Association.

EVERY one interested in astronomy will welcome the new publication *Astronomischer Jahresbericht*, the first volume of which, for the year 1899, has recently made its appearance. This important yearly volume is published by Herr Walter F. Wislicenus with the aid of the *Astronomischen Gesellschaft*, and printed in Berlin (Druck und Verlag von Georg Reimer, 1900, pp. 536). The object of this volume is to present to astronomical readers a brief summary of the contents of every publication, whether it be in book, article or pamphlet form, which treats of any matter connected with theoretical or practical astronomy, or with researches in astrophysics. The project is a great one, and with careful attention could be carried out successfully. This, the initial volume, reflects great credit on Herr Wislicenus, who, although associated with five other workers, seems to have laboured nobly and undertaken the greater part of the volume. The subject-matter is divided into four main sections, namely:—General and historical; astronomy, which includes spherical, orbit determinations, celestial mechanics, instruments and methods of observation, and, lastly, observations; astrophysics; and geodesy and nautical astronomy. The work is made complete by an excellent table of contents, and an index of names and the full titles of works referred to are given in each case. The author hopes that for future volumes he will have the help of all well-wishers of this work, and that such help will take the form of either references to published works or the works themselves, especially when they appear in transactions of societies which are published too late for insertion in the yearly volume, or other publications which are not specially devoted to astronomical matters. A glance at the present volume is sufficient to show the utility and value of this work, and it should be found in every astronomical observatory and laboratory.

QUOTING from the *Botanical Gazette*, *Science* says that the private herbarium of Mr. Harry N. Patterson, of Oquawka, Illinois, containing about 30,000 sheets, has been secured by the Field Columbian Museum, and will be installed as promptly as careful cataloguing will admit. The botanical department of the museum is, says our contemporary, to be congratulated upon this accession of one of the notable private herbaria of the country; one that will add a complete collection of Pringle's Mexican plants to its already excellent representation of the flora of that region and the Antillean islands. Mr. Patterson's herbarium is more or less contemporaneous with that of the late Mr. Bebb, which the museum secured some three years ago, and as Mr. Patterson made it his aim to secure a complete series of the species of North America, its addition to the collections of the museum will be of great value to botanical students and specialists in the west.

THE Royal Italian Institute of Military Geography has thoroughly revised the old map of the region round about Vesuvius, issued by the institute in 1876, on the scale of 1/10,000. It has also completed a new plan in relief of the cone of Vesuvius which has been subject in recent times to considerable changes in its configuration owing to the repeated eruptions. Both map and plan have been prepared under the direction of Prof. Matteucci, who for years has made a study of Vesuvius. The correction of the map has been rendered necessary, not only by the eruptions, but also by the number of new roads and buildings.

THE discovery of a new gutta-percha is reported from Zanzibar. This substance is derived from a tree which grows principally at Dunga. When tapped with a knife, a white fluid exudes, which, when placed in boiling water, coagulates into

a substance which in character bears a very striking resemblance to gutta-percha. As the material cools it becomes exceedingly hard, but while soft it can be moulded into any required shape. The fruit of the tree resembles a peach in shape, but grows to the size of a small melon. Experts have experimented with this new product to see if it in any way possesses the qualities of gutta-percha, and although it is not expected to prove equal to the genuine article, it is considered that it will be quite suitable for some purposes for which gutta-percha is at present utilised, and it will thus become a marketable article. It is said to abound in Zanzibar, and will be a very cheap product.

WRITING to the *British Medical Journal* on the subject of "Mosquitoes and Malaria," Mr. H. J. Elwes, F.R.S., says:—"The connection between mosquitoes and malaria seems to be now so clearly proved that some experiments should be undertaken by the Indian Medical Department to find out under what conditions mosquitoes do not produce malaria. Some years ago when on a hunting expedition in a very malarious district in the Bhotan Terai, I succeeded in escaping malaria by keeping within mosquito curtains till after sunrise, and getting into them again as soon as possible after dark, smoking freely at the same time within the curtains of my camp bed. Two out of the four Europeans of my party, and nearly all the natives who did not take these precautions, suffered so severely from malaria that our camp was unable to march after three weeks in the district. I may mention that it was then observed by experienced officers that from fourteen to eighteen days was the time which elapsed between exposure to infection and the appearance of severe fever. But there are places in Eastern Bengal and no doubt elsewhere where mosquitoes are very numerous and annoying, which do not seem to be subject to severe malaria, and I remember that Dacca, the only place where I was kept from sleeping a whole night by mosquitoes, was looked on as a station free from severe malaria, and I certainly, though I had previously been suffering from fever in Assam, never had a touch of it there. The great importance of finding out as soon as possible what precautions should be enforced by those responsible for the health of soldiers and others who are obliged to live in malarious districts cannot be overrated."

IN his report on the work of the Government Laboratory, Dr. T. E. Thorpe refers to the examination of some ordinary writing ink which was submitted to him by the Stationery Office, on a complaint that it thickened excessively and clogged the pen, and, in illustration, a sample of the contents of the ink-wells in use in the particular public office was forwarded, together with a sample of the ink as supplied. It was found that after the deposition of the separated solid matter of the ink, collected from the ink-wells in use, the fluid portion had a specific gravity twice that of the ink supplied. In other words, the ink had been allowed to become concentrated by evaporation to practically double its original strength through the use of excessively large ink-wells and inattention to the supply. It is, of course, necessary that the ink supplied shall be capable of furnishing a record which may be relied upon as permanent. Ink made with tannin and iron salts has had the advantage of very extended and prolonged use, with the result that complete confidence is felt as to the permanence of writing, for which it is used. But ink of this character possesses the undoubted disadvantage that it rapidly thickens on exposure, and Dr. Thorpe points out that it is specially advisable that such ink should be used in ink-wells of small size which receive regular attention at short intervals.

IT may safely be said that as petrol stands to-day as the paramount means of propulsion for automobiles accommodating passengers and of a light character, so steam has forced its way (at least in this country) as the means adopted for heavy motor vehicles for road service, carrying a load varying from three to ten tons. In support of this argument, an interesting article is given in the *Engineering Magazine* for September, describing these heavier types of vehicles, and although all typical designs are mentioned in every case, not petrol, but steam, represents the power used. As can be well imagined, these heavier class of waggon have had many difficulties to overcome, and with the exception of one type, a ten ton steam motor waggon by Messrs. C. and A. Musker, of Liverpool, the general designs are practically the same. The Thorneycroft waggon is fully described and illustrated in its different applications, ranging from the tipping dust van to a steam delivery waggon, and provided with a "trailer," by which is meant a vehicle towed behind. The ratios of gearing between the engine and the driving axle are 10·1 and 17·7 to 1. On all ordinary gradients five or six tons can be taken, two of which are conveyed on the trailer. Several other waggons by different makers are illustrated, with their dimensions graphically stated. The chief differences lie in the position and type of the engine, the power transmitted to the driving wheels in different ways, various kinds of boilers and different working pressures employed, and slight external appearance. The "Musker," already referred to, is only in its experimental stage, its chief features being an efficient liquid fuel burner combined with a flash-type boiler built up of three cylindrical coils of strong steel tubes, and the flame circulating in the annular space between them. All machinery is placed beneath the "body," thus affording a larger loading area than any other vehicle. It remains to be seen, however, whether the advantage claimed will be realised; if so, and considering its great load capacity (ten tons), it is indeed an important step in this branch of engineering.

A REPORT on the geology of the West Moreton or Ipswich coal-field in Queensland, by Mr. W. E. Cameron, has been published at the Geological Survey Office, Brisbane. It is accompanied by an appendix on the economic value of Queensland coal by Mr. Robert Wilson. The Ipswich coal-field is estimated to cover an area of about 12,000 square miles, and the coal has been most extensively worked in the neighbourhood of the town of Ipswich, which is about twenty-five miles south-west of Brisbane. The strata are of Jura-Trias age, and they are a good deal folded and faulted. They yield workable coals from two to four feet and more in thickness. Experiments made on the Government steamer *Otter* by Mr. Wilson show that some varieties are very good and useful steaming coals; and that generally the coals of Queensland "are well able to hold their own with any others at present found in Australia." The report is illustrated by a detailed geological map on a scale of an inch to twenty chains, and also by a geological map of a large area on the scale of an inch to a mile.

THE third volume of the *Annales* of the French Meteorological Office, containing rainfall values and completing the observations for the year 1897 (see p. 490), has been published in a greatly reduced form. The daily rainfall values are given for three hundred stations only, instead of nine hundred, and the scale of the rainfall charts has also been reduced. The valuable series of monthly and annual summaries are given for all stations, as before.

IN the *Botanical Gazette* for August, Prof. D. G. Fairchild is enthusiastic as to the advantages presented by the Botanic Garden at Rio de Janeiro for the study of tropical botany, although at present no facilities are afforded for teaching or study. He regards Rio, with its fashionable suburb Petropolis, as the most picturesque city in South America. To any botanist who wishes to study tropical vegetation, Petropolis and the other suburbs of Rio will prove the most attractive place in the

world. As compared with the mountains of Java or Sumatra, they are civilised, and have a much more salubrious climate and all the conveniences of modern civilised life. The south island of Hawaii or the South Pacific Islands have no such stretches of virgin forest, or such a flora or fauna; to explore Ceylon is hot and uncomfortable in comparison; and the mountains of Jamaica and Trinidad are uninhabited except by scattered planters. Prof. Fairchild reckons the hotel expenses at Petropolis as about two dollars *per diem*.

FREQUENT as earthquakes are in the Philippine Islands, those of the year 1897, being unusual both in number and in violence, form the subject of an important memoir by P. José Coronas, which we have just received from the Observatory of Manila. He estimates the total number of shocks at 307, occurring in 108 groups. No part of the archipelago was entirely free from earthquakes, though less than five were felt in Mindoro, Paragua and the central part of Luzon. In the north-east of Samar, where more than a hundred were felt, they were most frequent and most destructive. Full descriptions are given of the three most important earthquakes—those of Luzon, on August 15; Zamboanga, on September 21, with the accompanying sea-waves and long series of after-shocks; and Samar, on October 19–20. Four of these earthquakes were recorded at distant stations, both Shide and Edinburgh being more than 11,000 kms. from the origins. The mean velocities of the waves of the two principal Zamboanga earthquakes are estimated at 8·7 and 8·1 kms. per second along the surface, or 7·6 and 7·1 kms. per second along the chords.

DETERMINATIONS of the rate of increase of underground temperature, apart from their scientific interest, have an important practical application in fixing the limit of depth at which mining operations can be carried on successfully. In this connection a report has been lately issued by the Department of Mines of the Government of Victoria, dealing with observations of underground temperature at Bendigo, the author being Mr. James Stirling, Government Geologist. The rise of temperature of the rocks with the depth varies in different parts of the earth's surface, thus making it difficult in any mining district to determine what the rate of increase is without actual experiment. Thus, if we accepted the hitherto recognised formula for the Bendigo field of 1° Fahr. for every 60 feet in depth, we should have a temperature of 125° at the 3,500 feet level. The observations already made prove that this temperature is not reached. It has been asserted in some quarters that mining might extend to as great a depth as 10,000 feet, if the difficulties of haulage could be overcome; but when we consider the effect of compressing the air at such a depth (*i.e.* the compression caused by its own weight), it will be seen that ventilation under ordinary conditions would be practically unattainable. At a depth of 10,000 feet the ventilating current entering the shaft at, say, a temperature of 60° Fahr., would attain a temperature of 90° by its own weight, altogether apart from the additional heat acquired by contact of the air with the heated rock surfaces. It is possible, however, to imagine a limit of 5000 feet as a workable depth, although the present observations as to the normal rate of increase of temperature of the rocks at Bendigo—1° Fahr. for every 135 feet—suggest 4000 feet as a convenient practical limit to healthy working. Mr. Stirling's report is accompanied by charts illustrating the temperature and pressure gradients in No. 180 mine. In connection with the composition of the air, Mr. Stirling calls attention to the very defective ventilation of many mines, and to the necessity of owners and directors of mines taking steps to remedy the existing evils.

IN NATURE, vol. lix. p. 133, we briefly referred to the very interesting investigations of MM. Hildebrandsson and Teisserenc de Bort into the history and present conditions of dynamical meteorology. Part ii. of this important work has now been issued, dealing generally with revolving storms, and the organisation of the international meteorological services, and particularly with the parts taken by Le Verrier, FitzRoy, and Buys Ballot, and reproducing specimens of the earliest reports and charts issued by each. Le Verrier seems to have been the first in Europe to conceive the idea of telegraphic weather forecasts, although, owing to inadequate support, he was the last of the three to introduce a regular working service. It is interesting to read, thirty-five years after the death of Admiral FitzRoy, the judgment of the eminent authors upon his work in this country, viz. that the criticism of his weather service was both severe and unjust, and Le Verrier's opinion is quoted that if he did not arrive at sufficiently practical results, probably on account of the limited area dealt with, no one else in his place could have done better. In another chapter, dealing with the fundamental works in the different countries between 1865 and 1872, the laborious investigations of Dr. Buchan occupy a prominent place. The publication of his remarkable memoirs and charts at this early epoch were of the highest importance in the development of dynamical meteorology, and the early researches made subsequently in other countries have been, to a great extent, simply verifications of his ideas. The Storm Atlas of Prof. Mohn, the present chief of the Norwegian Meteorological Service, the publications of the Meteorological Office, and the Synoptic Charts of the late Captain Hoffmeyer and of the Copenhagen and Hamburg institutes, are also specially referred to as having contributed greatly to the development of meteorological science.

THE remarkable colour-changes exhibited by a familiar prawn (*Hippolyte varians*) form the subject of an extremely interesting and most beautifully illustrated paper by Dr. Gamble and Mr. Keeble, which appears in the *Quarterly Journal of Microscopical Science* for September. The species in question may be met with commonly in the lower tidal pools along the shore, or may be obtained by trawling in deeper water. It has long been known that different individuals exhibit variations in colour ranging from one end of the spectrum to the other, and also that many specimens display a protective resemblance to the particular seaweeds on which they may be resting. It is now demonstrated that all the different colour-variations are capable of passing into one another, and the protective resemblances of individuals to their environment are most admirably displayed in the coloured plates with which the paper is illustrated. But this is not all. Twice during the twenty-four hours every specimen is living in deeper water than ordinary, and this includes a certain change in coloration to harmonise with the stronger or weaker light. But a much more important colour-change is induced by the daily alternation of light and darkness, and as the shades of evening approach every single individual of the species gradually loses its distinctive diurnal hue and becomes of a full transparent azure blue. The change is heralded by a reddish glow followed by a green tinge, which finally melts into the azure. And it is not a little remarkable that the day-and-night change has been so long established that it has become periodic and occurs whether the specimens are kept in perpetual darkness or *vice versâ*.

TO the same journal Monsieur E. L. Bouvier communicates a supplemental paper on the results of his examination of the series of examples of Peripatus in the British Museum. He deals especially with the specimens described as *P. jamaicensis*, which are shown to include two perfectly distinct species.

OUR German contemporary, *Naturwissenschaftliche Wochenschrift*, of September 23, contains a long digest of Prof. G. Siebert's translation of Lydekker's "Geographical History of Mammals," which was published so long ago as 1897.

THE additions to the Zoological Society's Gardens during the past week include two Macaque Monkeys (*Macacus cynomolgus*) from India, presented respectively by Mrs. Woods and Mrs. Sassoon; a Plantain Squirrel (*Sciurus plantani*) from Java, a Vulpine Phalanger (*Trichosurus vulpecula*) from Australia, presented by Mrs. A. Jeffrey; a Ground Hornbill (*Bucorvus abyssinicus*), a Bell's Cinixys (*Cinixys belliana*) from West Africa, presented by Mr. Henry Strachan; a Peregrine Falcon (*Falco peregrinus*), European, presented by Mr. W. R. Bryden; a Brazilian Tapir (*Tapirus americanus*), two Snowy Egrets (*Ardea candidissima*), six Ring-necked Lizards (*Tropidurus torquatus*), three Surinam Lizards (*Ameiva surinamensis*), a —— Lizard (*Crocodilurus lacertinus*), two Tuberculated Iguanas (*Iguana tuberculata*), six Giant Toads (*Bufo marinus*) from Para, presented by Captain A. Pam; a Vivacious Snake (*Tarbophis fallax*), European, presented by Mr. W. H. St. Quintin; a Spix's Macaw (*Cyanopsittacus spixi*) from Brazil, a Large Grieved Tortoise (*Podocnemis expansa*) from the Amazons, six Florida Tortoises (*Testudo polyphemus*) from North America, four Elegant Snakes (*Tropidonotus ordinatus infernalis*), four Couch's Snakes (*Tropidonotus ordinatus couchi*) from California, deposited; a Bristly Ground Squirrel (*Xerus setosus*) from South Africa, a Pink-headed Duck (*Rhodonessa caryophyllacea*) from India, purchased.

OUR ASTRONOMICAL COLUMN

EPHEMERIS FOR OBSERVATIONS OF EROS:—

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THE ROYAL PHOTOGRAPHIC SOCIETY'S EXHIBITION.

THE Royal Photographic Society hold their annual exhibition this year in the New Gallery, Regent Street, instead of, as heretofore, at the Water Colour Society's Gallery in Pall Mall. The result of the change to the larger galleries is certainly a matter for congratulation, because the very restricted accommodation of previous years crowded out professional and trade work, and gave very little space indeed for the exhibition of scientific and technical photography. This year, if any branch of photography is not represented, it is because of other difficulties than want of space. The only notable omission that occurs to us is that of cinematography, and this is accounted for by the very stringent regulations now enforced making a practical demonstration impossible.

The pictorial section occupies about as much of the walls as usual, and the greater part of the remaining space is taken up by professional and trade work, and apparatus exhibits, many of which, however, are not entirely devoid of scientific interest. But upstairs, in the gallery that runs round the central hall, there will be found a very excellent collection of "scientific, technical and photomechanical exhibits."

The Royal Observatory, Greenwich, contribute some of their most recent work with the 30-inch reflector, the 26-inch Thompson photographic refractor and other instruments. The photograph of the great nebula in Orion, taken last December, appears to be especially noteworthy. Two plates of the planet Eros are shown. A photograph of ξ Ursæ Majoris, taken with the 28-inch equatorial, the object-glass being corrected for photography by the separation of the lenses and reversal of the crown lens, as proposed by Sir G. G. Stokes, testifies to the value of this method of correction. Examples of work with the occulting shutter and several recent eclipse photographs will be examined with interest. Among several other astronomical photographs may be mentioned a paper enlargement of very considerable dimensions of the transit of Venus in 1882, by Prof. David P. Todd, and a series of photographs by the Rev. John M. Bacon illustrating his balloon ascent to search for the Leonids last November.

There are several contributions of photomicrographs. As examples of skill in this direction, the series by Mr. E. M. Nelson, of diatoms, exhibited by the Royal Microscopical Society, will probably attract the most attention. The natural history and biological photographs of all kinds are too numerous to refer to in detail. As notable illustrations of the value of a series of photographs illustrating biological changes, the sixteen lantern slides, by Mr. Martin F. Woodward, from his photomicrographs, showing the fertilisation and segmentation of the egg of *Ascaris megalocephala*, and a frame of photographs, by Mr. Edgar Scamell, showing the different stages in the growth of a nasturtium, will well repay careful study. The photographs in the latter series are so numerous that they would almost serve to illustrate the growth of the plant as a "living picture" by means of a cinematograph. It is very usual to slow down a rapid movement that its details may be recognised, and there is doubtless much to be learnt from the representation in a few seconds of changes that naturally require days or even weeks for their completion.

The applications of photography in many other directions are well illustrated. The automatic recording of the variations of scientific instruments, spectroscopic work, surveying, mining, engineering, the production of metal reliefs, are a few of the subjects that occur to us. Dr. W. J. Russell shows prints to illustrate the photographic activity of the radiations from "the metals radium and polonium," and also from uranium salts, which he finds do not lose any of their activity by keeping them for three years in the dark.

Photography itself, as distinguished from its applications, has received considerable attention, and we would point out that if exhibits of this character could be kept together in future exhibitions, it would much facilitate their study. A print from the enlargement (four thousand diameters), by Dr. Neuhauss, of a section of a film of a Lippmann interference photograph, copies of which have already been seen here, is exhibited by the doctor himself, and shows very clearly that the silver is deposited in layers, as the theory of the process indicates. Several examples of the Lippmann process may be seen in another part of the exhibition. An interesting demonstration of the possible range of exposure is given by the Kodak Company. They show seven negatives exposed under the same conditions, but for periods of from one to fifty, all of which were developed for the same length of time in the same developer. The longer the exposure the denser the negative, but the prints from them are scarcely distinguishable from one another. They prove clearly that a small variation in exposure, or even none at all, will serve for very different subjects if negatives of various densities are not objected to.

Mr. Thomas Manly, the inventor of the "Ozotype" process of pigment printing, shows some examples of his method, one of which was exposed and washed thirteen months before the pigment was applied to it, proving that the power of the exposed bichromated paper to render gelatine insoluble and so fix the pigment does not sensibly change by keeping it. The process which in this country has hitherto been associated with Prof. Joly's name is illustrated by the Colour-photo Company of Chicago, and called the "McDonough-Joly process," referring to Mr. McDonough, who worked out the method in America simultaneously with Dr. Joly. They show that there is still room for improvement in the ruling of the triple coloured lines, and also in the nearer approximation of the photographic plate and the coloured screen. By looking at various angles across the ruling, the colour of the different parts of many of the pictures alternate between green, red and blue. This, we take it, is due to the distance between the colour screen and the photographic plate. Mr. Sanger Shepherd shows some striking examples of his triple film three-colour photographs.

The most notable novelty in apparatus is the "panoram kodak," for which the Kodak Company have been awarded a medal. All forms of projection have their advantages and their disadvantages. By adopting the cylindric or panoramic perspective, many subjects are possible for photography that could not be rendered by the plane perspective given by the ordinary fixed lens and plate. The arrangements necessary for a rotating

lens have invariably been costly and heavy, and the Kodak Company have made quite a new departure in such cameras in designing one that is light and cheap, and rapid enough in action to serve as a hand camera. The sample shown is called the "No 1 Panoram Kodak," from which we suppose that larger cameras of the same pattern will be issued in due course. It gives a picture seven inches long with a lens of about three and a half inches focal length. Film is used, and the drawing of it over the curved guides, to bring a new piece into position, is no more difficult than changing the film in any of the other kodaks. It has no shutter as usually understood, but the lens with its cone behind it swings beyond the sensitive surface and past a little flap, so that in its position of rest light cannot pass through the lens to the film. The apparatus is very ingeniously constructed, simple and effective.

There are many other exhibits of technical interest that might be noticed in detail, particularly, perhaps, photographs of living creatures of all kinds; but to enumerate them would be to reproduce a considerable portion of the catalogue. Many are evidence of the great skill and perseverance of the exhibitors. Some fine examples of photogravure show this process at its best. A few photogravures in colour, by Messrs. Ignatz Herbst and Theodore Reichs, show what can be done by a single printing after the various colours have been applied to the plate by the hand of one or more artists.

The exhibition is open daily until November 3.

THE INTERNATIONAL GEOLOGICAL CONGRESS.

THE eighth International Geological Congress was held this year in France. The work of the Congress consisted of papers read at the meetings at Paris, which were followed by discussions, and by excursions into different parts of the country, conducted by French geologists.

The meetings of the Congress took place from August 10–27 at the Palais des Congrès, within the enclosure of the International Exhibition.

The inauguration was held on Friday, August 16, under the presidency of M. Leygues, Minister of Public Instruction and the Fine Arts. M. Karpinsky, president of the last session of the Congress at St. Petersburg, gave an address; he then read the following list of the members of the Committee, proposed by the Council:—Ex-presidents, MM. Capellini and Karpinsky. President, M. Albert Gaudry. General secretary, M. Charles Barrois. Vice-presidents—Germany: MM. H. Credner, Lepsius, Schmeisser, Zirkel, von Zittel. Austria and Hungary: MM. Böckh, Mojsisovics of Mojsvar, Tietze. Belgium: MM. Mourlon, Renard. Bulgaria: M. Zlatarski. Canada: Dr. Frank Adams. United States: Messrs. Hague, Osborn, Stevenson. France: MM. Michel-Lévy, Marcel Bertrand. Great Britain: Sir Archibald Geikie, Sir John Evans. India: Dr. Blanford. Italy: MM. Cocchi, Mattirolo. Japan: M. Kochibe. Mexico: M. Aguiléra. Norway: Dr. Brögger. The Netherlands: M. Martin. Portugal: MM. Choffat, Mendés-Guerreiro. Roumania: M. G. Stéfanescu. Russia: MM. Loewinson-Lessing, A. P. Pavlow, Sederholm, Tschernyschew. Sweden: M. Högbom. Switzerland: MM. Baltzer, C. Schmidt. Secretaries: MM. Zimmermann, W. Pavlow, von Arthaber, Gäbert, Crema, Cayeux, Thévenin, Thomas. Treasurer: M. Léon Carez. This list was voted with applause.

M. Albert Gaudry, the new president, then read the inaugural address. In the warmest terms the eminent geologist welcomed the assembly of scientific men who had come from all parts of the world, and then proposed that they should rise to show honour to the memory of the learned geologists who had passed away since the last Congress. The president referred to the principal propositions submitted during the preceding sessions, and enumerated the four sections of the present Congress:—

I. Section of general and tectonic geology.
II. Section of stratigraphy and palæontology.
III. Section of mineralogy and petrography.
IV. Section of applied geology and hydrology.

M. Charles Barrois, general secretary, read his report on the work of the Committee of Organisation. M. Leygues, Minister of Public Instruction and the Fine Arts, welcomed the foreign members of the Congress in the name of the Government.

Section I. (General and Tectonic Geology). President: Sir Archibald Geikie.

Papers:—Presidential Address on international co-operation in geological investigation; *Chamberlin*, the assistance of the Congress in the fundamental investigations of geology; *J. Joly*, the geological age of the earth fixed by the amount of sodium in the sea; on the experiments relative to erosion in fresh water and salt water; order of the formation of silicates in igneous rocks; mechanical structure of marine sedimentation; *A. de Lapparent*, definition for each of the periods of the history of the globe, of the regions where by preference arguments should be sought on which the precise delimitation of the geological strata and substrata could be founded; *Munier-Chalmas*, Parisian Tertiary strata, delimitation of the Secondary and Tertiary formations; *Stanislas-Meunier*, phenomena of subterranean sedimentation; *Bleicher*, denudation of the Lorraine plateau and its results; *Richter*, reading of the report of the Commission on Glaciers; *H. F. Reid*, on the movements of glaciers; *Arctowski*, remarks relating to the former extent of glaciers in the land regions discovered by the Belgian Antarctic expedition; *Popovici-Hatzeg*, presentation of the new geological map of Roumania on the scale of 1/300,000; *Vorweg*, proposition tending to simplify the observation of the inclination and strike of the strata; *l'Abbé Parat*, geological observations in the caves of La Cure (Morvan).

Section II. (Stratigraphy and Palæontology). President: Dr. von Zittel. Discussion on the report of the International Commission on Stratigraphic Classification.

Papers:—*Scott*, fauna of Patagonia; *Raulin*, Tertiary districts of Aquitania; *C. Eg. Bertrand*, charbons gélosiques et charbons humiques; *Grand'Eury*, formation of coal-seams in the coal basins of Central France; *Lemière*, transformation of vegetables into fossil fuel; *Osborn*, progress of the methods of palæontology; relations between the mammal fauna and the Tertiary horizons of Europe and America; *E. Ficheur*, presentation of the third edition of the geological map of Algeria on the scale of 1/800,000; *Flamand*, on the geology of the south of Algeria and the regions of the Sahara; *Douvillé*, on the Jurassic formation of Madagascar; on the results of the exploration of M. de Morgan in Persia; *Zeiller*, fossil plants of Tonquin; *Malaise*, the Cambrian and Silurian of Belgium; *Dr. P. Œhlert*, on the reproduction of fossil types; *W. F. Hume*, the rift valleys of Sinaï; *T. Barrow* and *W. F. Hume*, on the geology of the eastern desert of Egypt.

Section III. (Mineralogy and Petrography). President: Dr. Zirkel. Honorary Presidents: MM. Rosenbusch and Fouqué.

M. Lacroix announced the views adopted by the International Commission of Petrography in its meetings of October 25 and 26, 1899.

The following proposals were adopted by the Assembly:—

(1) The names of the authors should always be given after the names of the rocks, as is the custom in zoology and botany.

(2) It is proposed to the Congress of 1900 to appoint an International Commission charged to publish the names of all new rocks with their descriptions as concisely as possible, with also their chemical analysis and, if necessary, a drawing representing their structure. This publication is to appear in the volume of the reports of the International Congresses.

(3) It is, above all, desirable to regulate the nomenclature of the eruptive rocks, where the want of unity is particularly felt. Different authors attribute a different sense and signification to one and the same name, while different terms are employed to designate the same rock, the same group of rocks, or the same structure. All the inconveniences of the present nomenclature can, and should be, avoided, at least for the large groups.

(4) The characteristics of the large groups, for example, of the families should be founded on the mineralogical composition, supported by the chemical composition and the structure.

(5) The large groups ought to be fixed from the present without disturbing the subsequent development of the classification, and the separation of these groups into subdivisions.

(6) It is desirable to designate the principal types of structure by special names.

(7) It is necessary to avoid the employment of the same term in different senses.

(8) One should avoid as much as possible the employment and introduction of different terms to designate the same notion, the same rock, or the same group of rocks.

(9) It is necessary to avoid as much as possible for new types of rocks the employment of pre-existing names, and assigning to them a new sense, or restricting or enlarging their meaning.

Dr. Zirkel was elected president of the Committee of Petrography.

Papers:—*Sacco*, attempt at a general classification of rocks; *Salomon*, attempts at a nomenclature of the metamorphic rocks; *Weinschenk*, on dynamo-metamorphism and piézo-crystallisation; on the formation of graphite; *Hague*, on the Tertiary volcanoes of the Absaroka Range; *Sabatini*, the present state of our knowledge of the volcanoes of Central Italy.

Section IV. (Applied Geology and Hydrology). President: M. Schmeisser.

Papers:—*Mourlon*, the new methods of Belgian geology; *Gosselet*, mineralisation of deep-seated waters; *Van der Veur*, on the enlargement of the kingdom of the Netherlands by the draining of the Zuyder Zee; *L. Fabre*, the plateaux of the Hautes-Pyrenees and the dunes of Gascony; *Van den Broeck*, the applications of geology; *Kunz*, progress of the production of precious stones in the United States; *Léon Janet*, utilisation and protection of sources of drinking water; *De Launay*, the teaching of practical geology; *A. de Richard*, origin of petroleum.

General meetings. Presentation of works:—*E. de Margerie* and *L. Raveneau*, cartography at the Universal Exhibition of 1900; *Louis Raveneau*, ninth annual geographical bibliography of the annals of geography, 1899. Presentation of the reports and proposals of general interest adopted by the Council; the Assembly adopted successively:—

(1) Report of the Committee of Geological Nomenclature, presented by M. Tschernyschew, with the benefit of the remarks made at the meeting of the Section.

(2) Report of the Committee of the Geological Map of Europe, by M. Capellini.

(3) Report of the Committee of Petrography, by Dr. Zirkel.

(4) Report of the Glacier Committee, by M. Richter.

(5) Proposal by Sir A. Geikie on international co-operation in geological investigations.

(6) Proposition by M. Œhlert on the reproduction of types.

M. Tietze proposed to the meeting, on the part of the Austro-Hungarian Government, to organise in three years a new Session of the International Geological Congress at Vienna. He informed them of the advanced state of the preparatory work for such a congress, and enumerated the many excursions which would be arranged for the members of the Congress.

The invitation of the Austro-Hungarian Government was unanimously accepted, and M. Tietze thanked the Congress for the warm reception given to his proposal.

Papers:—*Matthew*, on the most ancient Palæozoic fauna; *Walcott*, the pre-Cambrian fossiliferous formations; *Cayeux*, on the radiolaria and sponges of the pre-Cambrian rocks of Brittany; *Pavlow*, the Portlandian rocks of Russia compared with those of the Boulonnais; on some means which would contribute to the determination of the genetic classification of fossils; *Van den Broeck*, on the age of the deposits of the Iguanodons of Bernissart; *Guébhard*, disturbances and fractures of the folds in the Alps of France; *Stanislas-Meunier*, structure of the diluvium of the Seine; *Hull*, sub-oceanic terraces and valleys of the rivers of the western coast of Europe; *Hudleston*, the eastern shores of the Atlantic; *E. Martel*, on the recent discovery of large caverns and fissures.

During the Congress receptions were offered to its members, first by the Geological Society of France, at their new rooms in the Hôtel des Sociétés Savantes. The president of this society, M. A. de Lapparent, of the Institute, inaugurated this reception by an address, which was warmly applauded. M. and Mdme. Albert Gaudry invited the members of the Congress to their house to a most brilliant soirée. Prince Roland Bonaparte received at his hotel the united members of the Geological and Anthropological Congresses, who were also received together by the Municipal Council at the Hôtel de Ville of Paris.

The Committee of Organisation offered a most brilliant banquet at the Hôtel du Palais d'Orsay; the addresses of M. Albert Gaudry, Sir Archibald Geikie, and MM. Tietze, Credner and de Lapparent were warmly applauded. Finally, cards for a reception at the Elysée, and tickets for the National Theatre, were placed at the disposal of the president by the Minister of Public Instruction and the Fine Arts, for distribution among the foreign members. Visits were arranged by the aid of the Committee, to the International Exhibition, the National collections of geology and mineralogy, to the Museum of Natural History, to the Sorbonne, and to the School of Mines.

The excursions of the Congress were well attended. The programme submitted to the geologists of the whole world was of the most tempting description. A pocket-guide, prepared by the united efforts of the French geologists, gave in several numbers a complete account of the geology of France.

In order to allow every one to take part in the greatest number of excursions, they were divided into three periods: before, during, and after the Congress.

(1) Excursions before the Congress: Ardennes, conducted by M. Gosselet; Gironde, by M. Fallot; Touraine, by M. G. Dollfus; Pyrenees (crystalline rocks), by M. Lacroix; Aquitania (Charente et Dordogne), by M. Glangeaud; Turonian of Touraine and Cenomanian of Le Mans, by M. de Grossouvre; Mayenne, by M. D. P. Œhlert; Brittany, by M. Barrois.

(2) Excursions during the Congress: Tertiary basin of Paris, MM. Munier-Chalmas, Léon Janet, Stanislas-Meunier and G. Dollfus.

(3) Excursions after the Congress: Boulonnais and Normandy, MM. Gosselet, Munier-Chalmas, Pellat, Rigaux, Bigot, Cayeux; Central Rocks, MM. Michel-Lévy, Marcellin Boule, Fabre; Coal-basin of Central France, MM. Fayol, Grand'Eury; Tertiary basins of the Rhone; Secondary and Tertiary rocks of the Lower Alps, MM. Deperet, Haug; Alps of Dauphiny, MM. Marcel Bertrand, Kilian, Lory, Paquier, Sayn, Léenhardt, Termier; Picardy, MM. Gosselet, Cayeux, Ladrière; Range of the Black Mountains, M. Bergeron; Pyrenees (sedimentary deposits), M. L. Carez; Lower Provence, MM. Marcel Bertrand, Vasseur, Zürcher.

These excursions, beginning on August 3, ended on October 2, and have had therefore a duration of three months.

The next meeting of the International Geological Congress will be held at Vienna in 1903. L. GENTIL.

FORTHCOMING BOOKS OF SCIENCE.

MR. F. ALCAN (Paris) announces:—"De l'Infection en chirurgie d'armée. Evolution des Blessures de Guerre," by Dr. Nimier; and a new edition of volume i. of "Manuel d'Histologie Pathologique," by Profs. Cornil and Ranvier.

The Australian Book Company (of West Smithfield) announce:—"The Geology of Sydney and the Blue Mountains; A Popular Introduction to the Study of Australian Geology," by Rev. J. Milne Curran.

The announcements of Messrs. Baillière, Tindall and Cox include:—"The Hair in Health and Disease," by Dr. David Walsh; "Infantile Syphilis," by Dr. G. Carpenter; "Microscopy of the Starches," by Prof. Hugh Galt; "Standards of Foods and Drugs," by C. G. Moor; and new editions of Rose and Carless's "Manual of Surgery," Stewart's "Manual of Physiology," Walsh's "Röntgen Rays in Medical Work," Himes's "Guide to Public Health Acts," Hutchinson's "Aids to Ophthalmic Surgery and Medicine," Sparke's "Artiolic Anatomy of Man," Dennis's "Second-Grade Perspective."

Mr. Batsford promises:—"Waterworks Distribution," by J. A. McPherson, and "Sanitary Engineering," by Colonel Moore.

Messrs. Bemrose and Sons, Ltd., call attention to:—"Decimal Calculator and Multiplier," by C. Barker; and a new edition of "The Scientific Angler," by D. Foster.

Messrs. A. and C. Black will publish:—"The Human Ear: its Identification and Physiognomy," by Miriam A. Ellis; "Introduction to the Study of Physics," by A. F. Walden and J. J. Manley; vol. i. "General Physical Measurements—a Textbook of Zoology," by Dr. Otto Schmeil, translated R. Rosenstock; part iii. "Invertebrates."

Messrs. W. Blackwood and Son's list includes:—"Khurasan and Sistan," by Lieut.-Colonel C. E. Yate, illustrated; "The Sovereignty of the Sea," by Dr. T. Wemyss Fulton, illustrated; "A Manual of Classical Geography," by John L. Myres; "Physical Maps for the Use of History Students, (Greece, British Isles)" by Bernhard V. Darbishire; "Exercises in Geometry," by J. A. Third.

In the Cambridge University Press's list we notice:—"Scientific Papers," by Lord Rayleigh, F.R.S., vol. ii.; "Scientific Papers," by the late Dr. John Hopkinson, F.R.S., 2 vols.; "Scientific Papers," by Prof. Osborne Reynolds, F.R.S., vol. ii.; "The Scientific Papers of John Couch Adams," vol. ii., edited by Prof. W. G. Adams and R. A.

Sampson; "Lectures on the Lunar Theory," by John Couch Adams, from his collected Papers, edited by R. A. Sampson; "A Treatise on Spherical Astronomy," by Prof. Sir Robert S. Ball, F.R.S.; "A Treatise on Geometrical Optics," by R. A. Herman; "Advanced Exercises in Practical Physics," by Prof. Arthur Schuster, F.R.S., and Dr. Charles Lees; "The Prevention of Valvular Disease of the Heart," by Dr. Richard Caton; "Zoological Results based on material from New Britain, New Guinea, Loyalty Islands, and Elsewhere," collected during the years 1895, 1896 and 1897, by Dr. Arthur Willey. Part v., an account of the Entozoa, by A. E. Shipley; of the Nemertina, by R. C. Punnett; the development of the Robber Crab (*Birgus*), by L. A. Borradaile; new genera and species of Entromostraca, by the Rev. T. R. R. Stebbing, F.R.S.; anatomy of *Neohelia porcellana* (Moseley), by Edith M. Pratt, illustrated. "Fauna Hawaiiensis," or the Zoology of the Sandwich Islands: being results of the explorations instituted by the Joint Committee appointed by the Royal Society of London for promoting Natural Knowledge and the British Association for the Advancement of Science, and carried on with the assistance of those bodies and of the trustees of the Bernice Pauahi Bishop Museum, edited by Dr. David Sharp, F.R.S., vol. ii., part v. Arachnida, by Mons. Eugène Simon; Crustacea, Isopoda, by M. Adrien Dollfus; Amphipoda, by Rev. T. R. R. Stebbing, F.R.S.; (Cambridge Natural Science Manuals—Biological Series).—"Zoology," by Prof. E. W. MacBride and A. E. Shipley; "Fossil Plants; a Manual for Students of Botany and Geology," by A. C. Seward, F.R.S. In 2 vols. Vol. ii. (Physical Series)—"Electricity and Magnetism," by R. T. Glazebrook, F.R.S. (The Cambridge Series for Schools and Training Colleges)—"The Teacher's Manual of School Hygiene," by E. W. Hope and Edgar Browne; "An Introduction to Logic," by W. E. Johnson; "Euclid: Books I.-III., with Simple Exercises," by R. T. Wright; "An Introduction to Physiography," by W. N. Shaw, F.R.S.; "A New Primer of Astronomy," by Prof. Sir Robert S. Ball, F.R.S.; "A New Primer of Mechanics," by Prof. L. R. Wilberforce; "A New Primer of Physics," by the same author; "A New Primer of Physiology," by Dr. Alex. Hill; "A Brief History of Geographical Discovery since 1400," by Dr. F. H. H. Guillemard. (Pitt Press Mathematical Series)—"The Elements of Hydrostatics," by Prof. S. L. Loney.

Mesrs. Carré and Naud (Paris) announce:—"Les Terres rares," by A. Job; "Les Nouveaux gaz," by Raveau; "Les sucres et leurs principaux dérivés," by Prof. L. Maquenne; "Essais du Commerce et de l'Industrie," by Cuniasse et Zwilling; "Chimie des matières colorantes," by Rudolf Nietzki, translated by C. Favre and Vaucher; "La Chimie photographique," by Namias Rodolf, translated by Jaquez; "La Vinification dans les pays chauds," by Dugast; "La Pratique industrielle des courants alternatifs," by Chevrier; "Microbiologie de la distillerie (Ferments, Microbes)," by Levy.

Messrs. Cassell and Co., Ltd., give notice of:—"Our Bird Friends," by R. Kearton, illustrated; "Cyclopædia of Mechanics," edited by P. N. Hasluck; "Practical Gas-Fitting and Practical Draughtsmen's Work," edited by P. N. Hasluck; "A Practical Method of Teaching Geography," by J. H. Overton, part ii.

Messrs. Chapman and Hall, Ltd., announce a new edition of "What is Heat? a Peep into Nature's most Hidden Secrets," by Frederick Hovenden, illustrated.

The list of Messrs. J. and A. Churchill includes:—"A Treatise on Physics," by Prof. A. Gray, F.R.S., in three parts, illustrated; and new editions of Notter, Firth and Horrocks's "Hygiene," and "Carpenter's Microscope and its Revelations," edited by Rev. Dr. W. H. Dallinger, F.R.S., illustrated.

Messrs. T. and T. Clark (Edinburgh) will publish:—"The Herschells," by James Sime.

In the list of Messrs. Archibald Constable and Co., Ltd., we notice "Through Siberia," by J. Stadling, edited by Dr. F. H. H. Guillemard, illustrated; "Across and About the Black Republic of Hayti," by Hesketh Prichard; "Travels in the East of Nicholas II., 1890-1," written by Prince E. Ookhtomsky, and translated by Robert Goodlet, edited by Sir George Birdwood, vol. ii.; "Motor Vehicles and Motors," by W. W. Beaumont, illustrated; "Modern Astronomy," by Prof. H. H. Turner, F.R.S., illustrated: "Practical Electro-Chemistry," by B. Blount, illustrated.

Messrs. Dent and Co. announce:—"Birds that come to our Houses and Gardens," by the Rev. H. D. Astley, illustrated; White's "Natural History of Selborne"; "Modern Chemistry," 2 vols., by Prof. Ramsay, F.R.S.; "Plants, their Structure and Life," by Dr. Dennert; "Primitive Man," by Dr. Homes; "First Aid to the Injured," by Dr. Drinkwater.

Messrs. Duckworth and Co. call attention to:—"Problems of Evolution," by F. W. Headley.

Mr. Wilhelm Engelmann (Leipzig) announces:—"Pompeji in Leben und Kunst," von A. Mau; "Die Rohstoffe des Pflanzenreichs. Versuch einer technischen Rohstofflehre. 2. Gänzlich umgearbeitete und erweiterte Auflage," I. Band, von J. Wiesner (Wien); "Monographien afrikanischer Pflanzenfamilien und -Gattungen," herausgegeben von A. Engler. V. R. Schumann, *Sterculiaceae africanae*; A. de Bary's "Vorlesungen über Bakterien." Dritte Auflage, durchgesehen und teilweise neu bearbeitet von W. Migula; "Hoffmann v. Fallersleben, Unsere volkstündichen Lieder." Vierte Auflage, herausgegeben und neu bearbeitet von Karl Hermann Prahl; "Die Assanierung von Paris" (Assanierung der Städte in Einzeldarstellungen, I. Band, Heft 1), von Dr. Th. Weyl; "Physikalisch-chemische Propaedeutik, unter besonderer Berücksichtigung der medizinischen Wissenschaften und mit historischen und biographischen Angaben," I. Band, von Prof. H. Griesbach.

Messrs. R. A. Everett and Co. give notice of:—"The Veterinary Manual for Horse Owners," by Frank T. Barton, illustrated; "The Stable Key, or Stud and Stable Studies," by Captain W. A. Kerr, V.C., illustrated.

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Mr. W. Heinemann's list includes:—"The Regions of the World, 1900," a series of twelve volumes descriptive of the physical environment of the nations, with maps by J. G. Bartholomew, edited by H. J. Mackinder, illustrated; vol. i. "Britain and the British Seas," by the editor; vol. ii. "Western Europe and the Mediterranean," by Élisée Reclus; vol. iii. "Central Europe," by Dr. Joseph Partsch; vol. iv. "Scandinavia and the Arctic Region," by Sir Clements R. Markham; vol. v. "the Russian Empire," by Prince Kropotkin; vol. vi. "The Near East," by D. G. Hogarth; vol. vii. "Africa," by Dr. J. Scott Keltie; vol. viii. "India," by Col. Sir T. Holdich; vol. ix. "The Far East," by Archibald Little; vol. x. "North America," by Prof. Israel C. Russell; vol. xi. "South America," by Dr. John C. Branner; vol. xii. "Australasia and Antarctica," by Dr. H. O. Forbes; "The Life of William Cotton Oswell," by his son, W. E. Oswell, illustrated; "The First Ascent of Mount Kenya," by H. J. Mackinder, illustrated; "Mount Orin and Beyond," by Archibald Little: "Nature's Garden: An Aid to Knowledge of Wild Flowers and their Insect Visitors," by Neltje Blanchan, illustrated; "Pompei; The City, its Life and Art," by Pierre Gusman. Translated by Florence Simmonds and M. Jourdain, illustrated.

Messrs. Hodder and Stoughton will issue in their "Self Educator" series:—"Botany," by R. S. Wishart; "Chemistry," by J. Knight.

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In the list of Messrs. Sampson Low and Co., Ltd., we observe:—"Golden Tips, a Description of Ceylon and its Great Tea Industry," by H. W. Cave; "The Inhabitants of the Philippines," by Frederic H. Sawyer, illustrated; "Lepcha Land, or Six Weeks in the Sikhim Himalayas," by Florence Donaldson, illustrated; "Textile Machinery, Recent Improvements," by E. A. Posselt, part ii.; and a new edition of "On the Manufacture of Vinegar, Cider and Fruit Wines, &c.," by W. T. Brannt.

The science list of Messrs. Macmillan and Co., Ltd., is:—"Life and Letters of Thomas Henry Huxley, F.R.S.," by Leonard Huxley, with portraits and illustrations, in 2 vols.; "Studies Scientific and Social," by Dr. Alfred R. Wallace, F.R.S., in 2 vols., vol. i. Scientific, vol. ii. Social, illustrated; "The Cambridge Natural History," vol. viii. Amphibia and Reptiles, by Dr. H. Gadow, F.R.S., illustrated; "The Scientific Memoirs of Thomas Henry Huxley," edited by Sir M. Foster, K.C.B., F.R.S., and Prof. E. Ray Lankester, F.R.S., in 4 vols., vol. iii.; "Dictionary of Philosophy and Psychology," edited by Prof. J. Mark Baldwin, in 3 vols.; "Cyclopedia of Horticulture," vols. iii. and iv., edited by Prof. L. H. Bailey, illustrated; "Botany, a Text-Book for Schools," by Prof. L. H. Bailey, illustrated; "The Principles of Vegetable-Gardening," by Prof. L. H. Bailey, illustrated; "Principles of Stock-breeding, the Application of Biological Laws to the Breeding of Domestic Animals (including Poultry), whether for 'Fancy' or Profit," by Prof. W. H. Brewer; "First Experiments in Psychology, a Manual of Elementary Laboratory Practice," by Prof. Edward B. Titchener, in 2 vols., vol. i. Qualitative Experiments, vol. ii. Quantitative Experiments; "Foundations of Knowledge," by Prof. Alexander T. O. McCosh; "School Geography," by Prof. R. S. Tarr, vol. iii. Europe, &c.; "The Principles of Mechanics," by Prof. Frederick Slate; "Design and Construction of Electric Power Plants," by Bion J. Arnold; "Elementary Electricity and Magnetism," by Prof. D. C. Jackson and Prof. J. P. Jackson, illustrated; "An Introduction to Celestial Mechanics," by Prof. Forest Ray Moulton; Surgical Technique, being a Handbook of and Operating Guide to all Operations on the Head, Neck, and Trunk," by Prof. Fr. von Esmarch and Dr. E. Kowalzig, translated by Prof. Ludwig H. Grau, edited by Prof. Nicholas Senn, illustrated; and new editions of "West African Studies," by Mary H. Kingsley; "The Golden Bough, a Study in Magic and Religion," by Dr. J. G. Frazer, 3 vols.; and "Modern Perspective, a Treatise upon the Principles and Practice of Plane and Cylindrical Perspective," by Prof. William R. Ware, with a portfolio of plates.

Messrs. Methuen and Co. give notice of:—"The Science of Hygiene," by W. C. C. Pakes, illustrated; "The Principles of Magnetism and Electricity: an Elementary Text-book," by P. L. Gray, illustrated.

Mr. Murray's announcements include:—"A Treatise on Medical Jurisprudence," by Dr. G. Vivian Poore; "The Life of Gilbert White," based on letters, journals, and other documents in the possession of the family and not hitherto published, by his great grand-nephew, Rashleigh Holt-White. 2 vols., illustrated; "The Birds of Siberia," by the late Henry Seebohm, with the author's latest corrections, edited by Dr. F. H. H. Guillemard, illustrated; "The Life of Sir John Fowler, Bart., K.C.M.G.," a record of engineering work, 1834-1898, by Thomas Mackay, illustrated; "The Natural History of Religion," based on the Gifford lectures delivered in Aberdeen in 1889-90 and 1890-91, by Prof. E. B. Tylor, F.R.S., illustrated; "A Handy Book of Horticulture," by F. C. Hayes, illustrated; "Heredity," by Prof. J. Arthur Thomson, illustrated; a popular edition of "The Origin of Species by means of Natural Selection," by Charles Darwin, F.R.S., with a photogravure portrait of the author; and a new edition of "Scrambles Amongst the Alps in the Years 1860-69," including the history of the first ascent of the Matterhorn, by Edward Whymper, Illustrated.

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Mr. D. Nutt's list contains:—"Mythology and Folktales, their Relation and Interpretation," by E. Sidney Hartland.

The announcements of the Oxford University Press include:—"The Structure and Life-History of the Harlequin Fly," by Prof. L. C. Miall, F.R.S., and A. R. Hammond; "A Text-book of Arithmetic," by Richard Hargreaves; "The 'Junior' Euclid," by S. W. Finn, Books III. and IV.

Mr. Y. J. Pentland announces:—"Text-book of Physiology," edited by Prof. Schäfer, F.R.S.; vol. ii. "Text-book of Medicine," edited by Dr. G. A. Gibson; "Text-book of Pharmacology and Therapeutics," edited by Dr. W. Hale White; and "Diseases of the Throat, Nose and Ear," by Dr. P. McBride.

Messrs. G. P. Putnam's Sons promise:—"Care of the Consumptive," by Dr. Charles Fox Gardiner; "Thomas Henry Huxley, a Sketch of his Life and Work," by P. Chalmers Mitchell, with portraits; "Medical and Surgical Nursing," edited by Dr. H. J. O'Brien; and a new edition of "Materia Medica for Nurses," by L. L. Dock.

The list of the Religious Tract Society includes:—"The Royal Observatory, Greenwich, a Glance at its History and Work," by E. Walter Maunder.

Mr. Grant Richards promises:—"Flame, Electricity, and the Camera," by George Iles, illustrated.

Messrs. Sands and Co. will add to their Library for Young Naturalists, edited by F. G. Aflalo, "The Animals of Africa," by H. A. Bryden, illustrated; "Types of British Plants," by C. S. Colman, illustrated.

Messrs. Walter Scott, Ltd., will add to their "Contemporary Science" Series:—"The Mediterranean Race," by Prof. Sergi, illustrated.

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The list of the Society for Promoting Christian Knowledge contains:—"Among the Birds," by Florence Anna Fulcher; "Sounding the Ocean of Air," being six lectures delivered before the Lowell Institute of Boston in December, 1898, by A. Lawrence Rotch, illustrated.

Messrs. Swan Sonnenschein and Co., Ltd., call attention to:—Aristotle's "Psychology, including the Parva Naturalia," translated and edited with commentary and introduction by Prof. William A. Hammond; "A History of Contemporary Philosophy," by Dr. Max Heinze, translated by Prof. William Hammond; "Ethics," by Prof. W. Wundt, vol. iii.: The Principles of Morality and the Sphere of their Validity, translated by Prof. E. B. Titchener; "Physiological Psychology," by Prof. W. Wundt, translated by Prof. E. B. Titchener, 2 vols., illustrated; "Text-book of Palæontology for Zoological Students," by Theodore T. Groom, illustrated; "Text-book of Embryology: Invertebrates," by Dr. E. Korschelt and Dr. K. Heider, translated by Mrs. H. M. Bernard, and edited (with additions) by Martin J. Woodward, vol. iv., illustrated; "The Romance of the Earth," by Prof. A. W. Bickerton, illustrated; "Biological Types in the Vegetable Kingdom," by Wilfred Mark Webb; "Mammalia," by the Rev. H. A. Macpherson; "Birds' Eggs and Nests," by W. C. J. Ruskin Butterfield; "Inductive Geometry," by H. A. Nesbitt; and a new edition of "Handbook of Practical Botany, for the Botanical Laboratory and Private Student," by Prof. E. Strasburger, edited by Prof. W. Hillhouse, illustrated.

The following is the science list of the University Corre-

spondence College Press :—"Algebra, The Tutorial, Part I., Elementary Course," by Rupert Deakin; "Arithmetic, The Tutorial," by W. P. Workman; "Building Construction (Science and Art)," by Brysson Cunningham; "Machine Construction, First Stage (Science and Art)," by J. Handsley Dales; "Mathematics, First Stage (Science and Art)"; "Physiography, Section One (Science and Art)," by Fabian Rosenberg; "Practical Plane and Solid Geometry, First Stage (Science and Art)," by G. F. Burn.

Mr. T. Fisher Unwin will add to his "Masters of Medicine" Series, "Thomas Sydenham," by J. F. Payne, and "Andreas Vesalius," by C. L. Taylor.

Messrs. Frederick Warne and Co. will issue new editions of:—"The Cattle Doctor," by Geo. Armatage; "Wayside and Woodland Blossoms, First and Second Series," by Edward Step.

Messrs. Wells Gardner, Darton and Co.'s list includes a new edition of "Playing at Botany," by Phœbe Allen.

Messrs. Whittaker and Co.'s announcements are :—"Periodic Classification and the Problem of Chemical Evolution," by George Rudorf; "Inspection of Railway Material," by G. R. Bodmer; "Electric Wiring Tables," by W. Perren Maycock; "Telephone System of the British Post Office," by T. E. Herbert; and "Horseless Road Locomotion," by A. R. Sennett.

MATHEMATICS AT THE BRITISH ASSOCIATION.

THE mathematical communications to this year's meeting of the British Association were made on Monday, September 10, in one of the halls assigned to the Mathematical-Physical-Astronomical Section. Major P. A. MacMahon, F.R.S., took the chair.

The committee appointed in 1888 to calculate tables of certain mathematical functions opened the proceedings by presenting a report on their year's progress. The work on which they have for some time been engaged, namely, the preparation of a new "Canon Arithmeticus," is now almost completed. The calculations have been made by Lieut.-Colonel Allan Cunningham, who, in presenting the report, announced that the liberality of the British Association and of the Royal Society had enabled the committee to undertake the publication of the tables as a separate volume. Before the Association meets next year this will probably have been given to the world, and the committee, after an existence of thirteen years, will (unless some other work is found for it) cease to exist.

Another report was taken next—this time not of a committee, but of a single worker, Miss F. Hardcastle, of Cambridge, who was commissioned two years ago to prepare an account of "The present state of the theory of point-groups" for the Association. In the absence of Miss Hardcastle, one of the secretaries stated that a first instalment of the work is to be published in this year's annual report; this, however, will give only the general classification of the subject, and an account of those memoirs on the theory of elimination which are of importance in it. The greater part of Miss Hardcastle's report will not be ready until next year.

The chair was then taken by Prof. Forsyth, while Major MacMahon read a paper on "A property of the characteristic symbolic determinant of any n quantics in n variables." Let

$$\begin{matrix} \xi_1 & \xi_2 & & \xi_n \\ a_{1x}, & a_{2x}, & \ldots & a_{nx} \end{matrix}$$

be (in symbolic notation) any n quantics in m variables, and let

$$a_{1x}\, a_{2x} \ldots a_{nx} = \ldots + C_{\xi_1 \xi_2 \ldots \xi_n}\, x_1^{\xi_1} x_2^{\xi_2} \ldots x_n^{\xi_n} + \ldots$$

Major MacMahon arrives at the remarkable result that

$$\Sigma\Sigma \ldots \Sigma C_{\xi_1 \xi_2 \ldots \xi_n}$$

(where the summation is extended over all positive integral values of $\xi_1, \xi_2, \ldots \xi_n$) has the value $\frac{(-1)^n}{f(1)}$, where $f(\theta)$ is the characteristic determinant of the umbræ $a_{11}, a_{12}, \ldots$

The next communication was made in French by Prof. Cyparissos Stephanos, of the University of Athens, "Sur les relations entre la géometrie projective et la mécanique." The fundamental thought of this paper may be explained as follows. Consider a system of forces in equilibrium. What geometrical transformations of space will transform this system into another system of forces also in equilibrium? Prof. Stephanos solves this problem, and finds that the only transformations which thus conserve equilibrium are those which, considered as performed on the Pluckerian co-ordinates of the forces, are linear and homogeneous. When the system of forces is coplanar, these transformations are homographies in the plane. This train of thought is of some importance in Graphical Statics.

Mr. H. S. Carslaw (Fellow of Emmanuel College, Cambridge) followed with a paper on "The use of multiple space in applied mathematics." The method of images, so powerful in electrostatical problems, can in its original form be applied only when the fundamental angles of the problem are submultiples of π. Prof. Sommerfeld pointed out a year or two ago that by introducing the idea of a branched space, analogous to the branched planes used in Riemann's Theory of Functions, the method of images can be freed from this limitation. Mr. Carslaw's work is an extension and development of this suggestion, which is applied by him to the solution of several of the standard problems of the potential theory.

Lieut.-Colonel Cunningham then gave some results obtained by himself and Mr. H. J. Woodall in the "Determination of successive high primes." As an example of a new process due to the authors, the factors of all numbers between 16 776 196, and 16 778 236 have been determined. 117 of the numbers in this series are found to be primes, a fact which led to some discussion on Riemann's work in the theory of prime numbers.

This was followed by a paper on "The construction of magic squares," by Dr. J. Willis, of Bradford, in which some new modes of formation were described and exemplified in diagrams. Major MacMahon then communicated two papers in succession. The first was entitled "The asyzygetic and perpetuant covariants of systems of binary quantics"; it was concerned with the extension, to a system containing any number of binary quantics, of the work which has already been done in connection with the semivariant forms of a single binary quantic.

In the second paper, "On the symbolism appropriate to the study of orthogonal and Boolian invariant systems which appertain to binary and other quantics," Major MacMahon explained a new and most remarkable method which he has discovered in the invariant theory, which promises to revolutionise the treatment of that subject. Previous writers have considered the invariant theory as consisting in the investigation of those forms associated with a quantic, which are invariant when the variables of the quantic are subjected to the general linear transformation. When the variables are subjected only to linear transformations of special types, such as the orthogonal and Boolian transformations, the family of invariant forms associated with a given quantic is, of course, much larger; but these special classes of transformations have hitherto been, comparatively speaking, ignored, as forming a tedious and outlying branch of the subject. Major MacMahon's discovery is a new symbolic method for obtaining the forms which are invariant for orthogonal and Boolian transformations, in the same way as Aronhold's symbolic method enables the investigator to obtain the forms which are invariant for the general linear transformation. Major MacMahon obtains six symbolic factors analogous to Aronhold's symbolic factors a_x and (ab), and the ordinary invariant-theory can be derived as a particular case of the new theory, by simply rejecting those forms which contain any one of a certain four of these factors.

A paper by Mr. A. B. Basset, F.R.S., in which the result that "a quintic curve cannot have more than 15 real points of inflexion"—an extension of a theorem of Zeuthen's on quartic curves—is obtained, was briefly communicated by the chairman; and a remarkably interesting session closed with two communications by Prof. J. D. Everett, F.R.S., "On Newton's contributions to central-difference interpolation," and "On a central-difference interpolation formula." In the former of these papers the author observed that certain formulæ in the calculus of finite differences, usually attributed to Stirling, were really known to Newton; in the second, a formula of interpolation was obtained which is less unsymmetrical than those generally given.

E. T. WHITTAKER.

PHYSICS AT THE BRITISH ASSOCIATION.

THE interesting way in which Dr. Larmor, in his Presidential Address to Section A, touched on some of the problems of theoretical physics appears to have had a considerable influence on the subsequent proceedings of that section during the meeting at Bradford. At few recent meetings has the number of impromptu discussions of theoretical questions been so great, and even although these discussions may not always have been ended in the settlement of some question previously in dispute, they have provided in a way that only the Association meetings can, opportunities for exchanges of opinions so necessary in these days of specialisation, and so valued by those who have the advance of their subject at heart.

The large section room was well filled for the President's address. After a vote of thanks moved by Prof. FitzGerald and seconded by Principal Oliver Lodge had been carried, a large proportion of the audience left to hear the address of Prof. Perkin, the President of Section B, and the reading of papers commenced. In what follows they are given in order of subject and not of reading.

Dr. Trouton gave a short account of his experiments on the creeping of liquids, and on the surface tensions of mixtures. He has found that the tendency of certain liquids to creep up the sides of their containing vessels is due to such liquids being mixtures. The more volatile constituent creeps in advance of the other, and the action is stopped if evaporation is prevented. Zinc surfaces seem more favourable to the process than surfaces of other metals or of glass. The surface tensions of mixtures of liquids are as a rule less than the values calculated from the surface tensions and proportions of their constituents, while those of salt solutions increase with the number of gram equivalents of the salt present at a rate nearly independent of the nature of the salt, a fact to which Quincke was the first to draw attention.

Prof. G. H. Bryan, in a note on the partition of molecular energy, explained how, in his endeavour to build up irreversible thermal phenomena from reversible dynamics, he had been led to a novel method of investigating the mean distribution of energy amongst a number of particles moving in an external field having a potential. He found that two such particles do not follow Maxwell's law of partition of energy, and concluded that the law would not be followed in a general assemblage of particles. Prof. FitzGerald considered that two particles in an external field did not sufficiently represent the molecules of a gas, and suggested that if the case of three particles had been worked out, they would have been found to follow Maxwell's law. He hoped that physicists would accept that law as valid for gases till a system had been constructed for which it could be proved conclusively not to hold. Prof. Bryan, on the other hand, challenged physicists to construct a simple system of particles which *would* tend towards Maxwell's distribution of energy.

Dr. Larmor gave some results of his application of the principle of least action to the statistical dynamics of gas theory, as illustrated by meteor swarms and optical ray systems. He finds that if a swarm of meteors is moving under its own mutual attractions and conservative outside forces, and if from some point vectors be drawn equal and parallel to the velocities of the meteors, the product of the volume marked out by the ends of these vectors into the volume occupied by the meteors themselves will remain constant throughout the motion. If the mutual attractions are insensible, the product of the solid angle bounded by the velocity vectors into the square of the mean velocity of the swarm will remain constant. In optics this corresponds to the concentration in cross section of a beam being proportional to the solid angular divergence of the beam, into the square of the refractive index of the medium in which it is travelling. In the case of a gas where encounters between the particles may take place, the above distribution of particles and velocities is found to be a possible steady state.

The report of the Seismological Committee was presented by the secretary, Mr. Milne. During the past year he has analysed the records of the earthquakes which occurred during 1899, and has found that the earthquake wave takes about 110 minutes to travel from its origin to the opposite end of the earth's diameter, but whether it is propagated through the centre of the earth or as a surface wave cannot at present be decided. He suggests that earthquakes may be connected with the small changes of latitude known to occur, and that earthquake waves may have a disturbing effect on the timepieces of observatories. Messrs. Clement Reid and Horace Darwin are engaged in an attempt to detect movements at a geological fault owing to earthquakes.

The Committee on the sizes of pages of periodicals reported that it had succeeded in some cases in inducing societies publishing proceedings of exceptional sizes to conform to the rules the committee laid down in its 1895 report. It did not seek re-appointment.

A paper on the relation of radiation to temperature was contributed by Dr. Larmor. The late Prof. Balfour Stewart pointed out at the meeting of the Association in 1871 that if an enclosure at constant temperature contained a moving body at the same temperature, the radiation received from the body at a point in advance would, by Döppler's principle, differ from that received by a point behind the body. Dr. Larmor applies this principle to the case of a spherical enclosure shrinking in size, in which, therefore, the wave-lengths of all radiations will decrease as the radius. Further, there will be a pressure of the radiation on the inside surface of the sphere, which will require work to be performed during the shrinkage. This work is converted into radiation, and changes the temperature of the radiation inversely as the radius, and the energy of the radiation inversely as the fourth power of the radius. From this Stefan's law that radiation is proportional to the fourth power of the temperature follows; and further, the energy of radiation between λ and $\lambda + d\lambda$ is of the form $\lambda^{-5} f(\lambda T).\delta\lambda$. Prof. FitzGerald pointed out the great simplification which Dr. Larmor had introduced into the treatment of the problem by the consideration of the radiation in the ether only, a method of which the legitimacy could not be doubted.

Dr. S. P. Langley sent over from America a chart of the infra red spectrum from ·7 to 5·3 μ, obtained by the bolometric method described in his communication to the Association at Oxford in 1894. His bolometer is now arranged so that a difference of temperature of one-millionth of a degree centigrade is detected; and the whole operation of producing the charts is automatic. They show distinctly the variation of atmospheric absorption with the seasons, and may possibly, he thinks, lead to a new method of weather forecasting.

The Committee on Meteorological Photography reported that as the result of about 400 photographic observations of clouds made from two stations near Exeter, the following mean heights have been found:—Cirrus, 10,200; cirro-cumulus, 8600; cumulus top, 3000; base, 1300; strata-cumulus, 2200 metres. During the early part of the day the clouds rise, attain their maximum altitudes about 2 or 3 p.m., and fall during the afternoon and evening. The greatest altitudes are associated with thunderstorms and the lowest with cyclones.

The Committee on Solar Radiation reported that experiments had been made under the direction of Prof. Callendar, with a view to testing the modified copper-cube actinometer and reducing its records to an absolute scale. During the course of these experiments it has been found necessary to introduce further changes, and the instrument now used consists of a blackened copper disc provided with thermojunctions, suspended within a tubular water jacket around which a stream of water at constant temperature is maintained. The radiation to be measured passes down the tube and falls normally on the copper disc. This instrument has been tested by exposing it to the radiation from an electric lamp at a known distance, and has been found capable of giving consistent results for weak radiation, but the intensity of solar radiation is too great to permit the elementary theory of the instrument to be applied. It is, therefore, proposed at present to record only the *vertical* component of the radiation from sun and sky by means of the bolometric method described in the 1898 report. Two flat platinum thermometers, one bright and the other blackened, are placed horizontally side by side and exposed to the radiation from the sky. Their difference of temperature is automatically recorded, and is taken to be proportional to the radiation to which they are exposed. By means of an observation with an electric lamp at a fixed distance, the indications of the instrument can be converted into absolute measure.

Mr. A. S. Davies described a novel form of mercurial barometer, in which a fixed volume of the gas the pressure of which is to be determined, is compressed isothermally by a column of mercury of known length and the compression measured. The instrument consists of a glass bulb, from which a tube of small bore projects downwards, and ends in another

bulb open to the air and containing a little mercury. When a reading is required, the instrument is inverted so that a column of mercury runs down the tube towards the first bulb and compresses the air in it. From the position taken up by the end of this column, when the compressed gas has cooled to its original temperature, the original pressure of the gas can, if the gas is dry, be found. In the instrument this pressure is read off on a scale alongside the tube. The air enclosed is dried by passage through a plug containing calcium chloride. The instrument is very compact and portable.

Mr. A. L. Rotch contributed a note on the use of kites for meteorological observations at Blue Hill Observatory, Mass. Observations with kites have been made up to 16,000 feet above sea level, and have been reduced and published in abstract in NATURE, July 12 and August 9.

Captain Campbell Hepworth exhibited and discussed some charts illustrating the weather of the North Atlantic Ocean during the winter of 1898-9. At sea this period was one of violent storms, while the weather in America was exceptionally cold, and in Europe very mild. Some of the cyclones crossed quickly from the American coast to the British Isles, while others—in particular the worst one in February—made slow progress. Much damage was done to shipping, and even powerful vessels, like the *Lucania* and the *Fürst Bismarck*, were unable to make headway, and arrived at their destinations several days late.

Mr. J. W. Thomas, in a communication on the physical effects of wind in towns and their influence upon ventilation, pointed out that the well-known effect of currents of air in diminishing the air pressure in vessels across the openings of which they passed, was generally neglected by writers on ventilation. A gusty wind, during its period of maximum velocity, reduces the air pressure in a room by the withdrawal of air through the chimney. When the wind lulls, the air passes down the chimney into the room, and the chimney "smokes."

Mr. J. Hopkinson gave an account of the rainfall of the northern counties of England. The means for the ten years ending 1890 are:—

Cumberland, 57·9; Westmoreland, 55·9; Derbyshire, 40·2; Lancashire, 38·3; Yorkshire, 33·4; Cheshire, 31·3; Northumberland, 31·0; Durham, 28·1; Nottinghamshire, 24·4; Lincolnshire, 24·3 inches per annum. These numbers show distinctly the effect of highlands in increasing the average rainfall.

Mr. G. E. Petavel described the apparatus he is using in his experiments on the explosive pressures of gases. He measures the maximum pressure attained in his explosion vessel by means of a piston which is forced out and makes a telephone contact if the pressure exceeds a certain value. By means of the compression of a cylinder he measures also the rate of change of the pressure. He finds that in the case of hydrogen and oxygen the maximum is about ten times the initial pressure, and that inert gases delay but do not greatly diminish the maximum pressure.

Mr. J. W. Gifford gave an account of a quartz-calcite lens he had designed, having the same focal length for wave-lengths 5607 and 2761, which he considers may be taken as the centres of the visual and photographic portions of the spectrum respectively.

Messrs. A. Dufton and W. M. Gardner exhibited at the Technical College an arrangement they had devised for the production of an artificial light of the same character as daylight. Such an artificial light has been much wanted by those engaged in dealing with coloured stuffs, and the practical demonstration given by the authors showed that they have successfully supplied this want. They use an enclosed arc lamp, and surround the translucent bulb of the lamp by a tank containing a solution of copper sulphate of the proper strength, or by a box with sides of glass of the same colour and the requisite thickness.

Mr. H. Ramage described his method of investigating correspondences between spectra. He takes wave frequency as abscissæ, and atomic weights of the elements whose spectra are to be compared as ordinates, and joins by lines the "corresponding" points of the various spectra. These lines are in general curved, and in the case of the components of a doublet their distance apart increases with the atomic weight. If the squares of the atomic weights are taken as ordinates, they become straight lines intersecting on the axis of wave frequency. He proposes, therefore, to introduce a term aW^2, where a is a constant, and W the atomic weight, into Rydberg's formula, which will thus become $n = n_0 - aW^2 - \frac{N_0}{(m-\mu)^2}$.

Mr. G. J. Burch exhibited an experiment on simultaneous contrast. One half of the slide of a stereoscope consists of blue and the other of red glass. By means of diffraction gratings in the eyepiece of the stereoscope, two spectra are produced which appear to cover two patches of black paper on the two glasses. Under these circumstances, that seen by the eye which looks at the red glass appears to lack red, the eye being partially blinded for red, the other for a similar reason lacks blue. In Mr. Burch's opinion these facts confirm the views of Thomas Young on colour contrast.

The Committee for improving the method of determining Magnetic Force on Board Ship reported that an instrument had been constructed according to the designs of Captain Creak, which gave promise of overcoming many of the difficulties met with in using Fox's circle.

The work of the Committee on Radiation in a Magnetic Field had been interrupted by the death of Mr. Preston, but the committee now proposed to issue copies of Preston's photographs showing how the various types of lines are affected by the magnetic field.

The Electrical Standards Committee reported that the standards had been removed to Kew, where an outbuilding had been fitted up for the temporary use of the committee of the National Physical Laboratory. The sub-committee on platinum thermometry has decided that platinum thermometers shall be constructed of a selected sample of platinum wire, and be used as standards for high temperature measurements. The selection of wire is still under the consideration of the committee. Arrangements have been made for the construction of a mercury resistance standard and an ampere balance. The Committee approves of the adoption of the names *Gauss* and *Maxwell* for the C.G.S. units of magnetic field and flux respectively.

Mr. R. S. Whipple gave an account of his improved standard resistance coils. Alongside the platinum-silver wire of the standard coil a second wire of platinum is wound. The difference of resistance of the two coils depends on their temperature, which may therefore be regulated to have any required value. Dr. R. T. Glazebrook pointed out that the method had been used by Messrs. Crompton in constructing their standard resistances.

Mr. E. H. Griffiths described the form of Wheatstone bridge he has devised for determining the freezing-points of dilute solutions by platinum thermometry. A platinum thermometer of about 18 ohms resistance placed in the solution, and another similar one in ice, form two of the arms of a Wheatstone bridge. The rest of the bridge is of platinum. The galvanometer is connected to the bridge by means of two sliders, each of which moves along a pair of platinum wires, one of the pair forming part of the bridge, and the other connected permanently to the galvanometer. The readings of these sliders for a balance determine the difference of temperature of the two thermometers. Using a Paschen galvanometer giving a deflection of 1 mm. on a scale 1 metre distant for a current of 10^{-12} ampere, Mr. Griffiths can determine temperature to one-millionth of a degree centigrade. Mr. R. Threlfall pointed out that although the temperature of the platinum wire of the thermometer could be determined to this degree of accuracy, the temperature of the solution could not. In reply to Dr. Glazebrook, Mr. Griffiths stated that the mercury contacts in Carey Foster's method introduced changes which prevented this high degree of accuracy being attained with it.

Prof. F. G. Baily described a lecture-room form of volt and ammeter which he had devised. By means of a series of resistance coils all contained in a small box, the deflections of a galvanometer of the d'Arsonval type are made to correspond to simple multiples or submultiples of a volt or an ampere.

Prof. W. B. Morton communicated some results he had obtained by applying J. J. Thomson's and Sommerfeld's solution of the propagation of an electric wave along a single wire, to the approximate solution of cases of several parallel wires, some of which may be returns, when the square of the ratio of the radii of the wires to their distances apart may be neglected. His results agree with the more complete investigations given by Mie in the June number of the *Annalen der Physik*.

A communication from Mr. S. H. Burbury on the vector potential of electric currents in a field where disturbances are propagated with finite velocity, was, in the absence of the author, taken as read. There are difficulties in the way of the usual definition of the vector potential due to electric currents when these currents are changing. These difficulties Mr. Burbury

proposes to obviate by substituting in the definition, for the current at a given point at the given instant, the current which existed at that point r/V seconds before, where r is the distance of the point from that at which the vector potential is to be measured, and V is the velocity of propagation of an electric disturbance.

The communication which most attracted the attention of the members of the Association, and produced a great addition to the attendance at Section A, was that of Sir William H. Preece on wireless telephony. By a series of experiments carried out at Lock Ness, the Menai Straits, the Skerries and at Rathlin Island, he has shown conclusively that wireless telephony is a practical and commercial system. At the Skerries a line half a mile long terminated by earth plates placed in the sea, at a mean distance of nearly three miles from a similar wire three and a half miles long on the mainland, was quite sufficient to enable telephonic messages to be transmitted with the ordinary instruments. At Rathlin Island the wire is eight miles from the mainland and communication is readily maintained. Endeavours are to be made to extend the system to ships and there seems every probability of success.

Prof. G. F. FitzGerald, in a note on Crémieu's experiment, described the arrangement adopted by Mr. Crémieu and the negative result he had obtained, and contrasted them with the arrangement and result obtained by Rowland in his experiments on electric convection made in 1876. He considered that the discrepancy of the results of experiments, which appeared to have been carried out with great care, did not necessarily disprove our theory of electromagnetism, but rather signified that there was some action of a moving ion not hitherto included in our equations which was well worth investigating. Dr. J. Larmor pointed out that any want of symmetry of the revolving disc and fixed case in Crémieu's apparatus would tend to cause some part of the charge on the disc to remain stationary. Prof. A. Gray announced that he had already commenced work with a view to repeating both Rowland's and Crémieu's experiments with the same apparatus.

Prof. J. Chunder Bose gave an account of his work on the effect of electrical stimulus on inorganic and living substances. By measurements of conductivity he determines the magnitudes of the changes produced in the molecular structure of substances due to an electric stimulus. Taking time of exposure to stimulus, or time of recovery from effect of stimulus, as abscissæ, and change of conductivity as ordinates, he draws curves for numerous substances under varying conditions. He finds that the curves for organic and inorganic substances are similar. On this as a basis he has constructed an artificial retina, which has enabled him to explain many obscure phenomena of vision.

The Committee on Electrolysis and Electro-chemistry reported that the experiments on the freezing points of the solutions whose electrical conductivities had been found by Mr. Whetham were still in progress. Some experiments on the consumption of carbon anodes in electrolysis have been made by Mr. Skinner, who has found that the anion produced by electrolysis of any highly oxidised material consists partly of carbonic acid. The committee now lapses.

Prof. G. F. FitzGerald opened a joint discussion with the chemical section, on ions. While acknowledging that the dissociation theory of electrolysis had proved a useful hypothesis, he wished to draw attention to the fact that there were phenomena which it was incapable of explaining, and that dissociation itself had not been dynamically explained. Why should water dissociate a dissolved salt into its ions? where does the necessary energy come from? how can the dissociated ions wander about in the solvent without recombining? and why do some ions travel faster than others? seemed to him questions which the supporters of the theory had never satisfactorily answered. The recent work on conduction in gases seemed to render it necessary to restrict the term "ionisation" in future to the process of producing atoms differently electrified, and to introduce a new term "electronisation" for the production of conductivity by the motion of particles of apparent mass about 1/500 of that of a hydrogen atom. In gases conductivity was probably due to both causes, and in liquids to the former only. In the case of metals, he should like to ask, how thick was the layer of electricity on the surface? did the thickness of a thin metal plate alter its capacity? and would the electrons fly to the surface of a metal when it revolved? He thought the questions still open to discussion might be summarised as follows:—

(1) The cause and nature of ionisation.

(2) The source of the energy in dissociation in a liquid.

(3) The cause of the failure of the law of dissociation as the concentration increased.

(4) The reason for the different rates of migration of the ions.

(5) The nature of the double layers, or why different metals should attract electricity differently.

(6) Are the processes of ionisation the same in liquids and gases? and, if so, why?

(7) Do electrons gravitate, *i.e.* have they a material nucleus or not?

(8) Is magnetism due to rotation of the electrons?

Dr. Larmor, before calling on the chemists present for their remarks, pointed out that the large dielectric constant of water meant a large electric moment for the water molecule, and therefore a considerable separation of the positive and negative charges on the molecule. A molecule of dissolved salt might therefore readily come under the influence of one of these charges alone.

Prof. H. E. Armstrong stated that in the opinion of chemists the atoms were permanent and stable, and that the removal of 1/500 of the mass of a hydrogen atom along with its negative charge seemed to them impossible. He thought that the same process produced conductivity in gases which produced it in liquids; that in gases the vapour of water played the part of the water in electrolysis of a dissolved salt, and that in all cases it was necessary to form a "triplet" by the presence of a third substance, before any chemical or other action could result. This third substance was generally one having one of its constituents in an "unsatisfied" condition, like the oxygen in water or the nitrogen in ammonia, and in which there was in consequence a tendency towards "association" of molecules.

Mr. Whetham stated by letter that he did not think the difficulties of the dissociation theory were as great as they were represented. The ions might be free from each other but be connected with the molecules of the solvent.

Principal Oliver Lodge thought that although in a liquid the charges apparently travelled with the atoms, while in a gas the electrons appeared to be free, in neither case was conduction by means of molecular aggregates excluded. He considered metallic conduction the handing on of the electrons from one atom to another. He looked forward to an electrical theory of matter, in which the hydrogen atom would consist simply of 500 electrons without nuclei.

Mr. W. J. Pope pointed out that the dissociation theory only held up to concentrations of 5 per cent., and that there was a difficulty in the case of salts which on account of their asymmetry rotated the plane of polarisation of light.

Dr. H. C. Pocklington gave an account of his work on the radiation of a black body on the electro-magnetic theory. Assuming that the energy of the total radiation emitted by a black body at any temperature is the product of powers of the temperature θ, the velocity of propagation of the radiation v, and the atomic charge Q, Dr. Pocklington finds by the theory of dimensions that the power of the temperature is 4, *i.e.* Stefan's law, and that the radiation between λ and $\lambda + \delta\lambda$ is proportional to

$$\theta^4 . v . Q^{-6} \frac{d\lambda}{\lambda^5} . f\left(\frac{\theta\lambda}{Q^2}\right),$$

in agreement with Wien's law.

Mr. C. E. S. Phillips gave an account of his experiments on the apparent emission of kathode rays from an electrode at zero potential. He has found that the green flecks which make their appearance on the inner surface of a partially exhausted vacuum bulb when a discharge passes, are due to the emission from the kathode of jets of occluded gas, which continue even when the two electrodes of the bulb are both earth connected. These jets produce shadows of opaque bodies held in their path, and although their velocity is probably not greater than that of sound, they can cause the green fluorescence in the glass on which they impinge.

Mr. J. B. B. Burke communicated a paper on the phosphorescent glow in gases. He uses electrodeless tubes, and finds that the glow begins to appear at a pressure of ·7 mm., is a maximum at ·1, and disappears at ·02 mm. of mercury. It seems to be composed of two parts, one carrying the charge, the other uncharged, but capable of producing conductivity in those parts of the tube to which it penetrates. The conductivity effect is propagated quickly, but the glow appears to be propagated by diffusion along the tube. Prof. A. Smithells mentioned that his experiments on flame showed that the emission of light from

the flame was in the same way independent of the conductivity of the flame.

At the close of the meeting of the section on Wednesday morning, September 12, votes of thanks to the president and secretaries were passed, and the section adjourned to Glasgow.

C. H. LEES.

ASTRONOMY AT THE BRITISH ASSOCIATION.

ASTRONOMY this year constituted a distinct department of Section A, with its own chairman and secretaries, and a separate room was provided for the reading of papers on this subject. The new departure was sufficiently justified by the attendance at the meetings, and in future years, when the formation of the Department of Astronomy becomes more widely known, increased success may be confidently expected. The department met on Friday, September 7, and Tuesday, September 11, and altogether sixteen papers were read.

At Friday's meeting, after the chairman's address, three papers by Prof. Todd, relating to eclipse work, were read by one of the secretaries in the absence of the author. In one of these attention was called to the "application of the electric telegraph to the furtherance of eclipse research." In 1878, the idea first occurred to Prof. Todd to telegraph eastward in advance of the lunar shadow in order to enable the immediate verification of any possible discovery, as of an intramercurian planet, without waiting for another eclipse. The feasibility of the method was demonstrated in January 1889, and again more completely during the eclipse of May 28, 1900. At the station occupied by Mr. Douglas in Georgia, totality preceded the same phenomena in Tripoli, where Prof. Todd himself was observing, by 2h. 45m., and the outcome of the experiment was that, through the generous help afforded by the various telegraph companies, an account of the American observations was received by Prof. Todd more than two hours before totality occurred at Tripoli. Abundant time for special preparations to verify any important discovery was thus available.

In his second paper Prof. Todd dealt with a variety of methods of operating eclipse instruments automatically. The "mechanical system," as distinct from the pneumatic and electric arrangements which he had previously devised, was first tried during the recent eclipse. The instruments being set up on the roof of the British Consulate, gravity was utilised for the mechanical operation of slides and shutters. One hundred photographs were secured at Tripoli by seven instruments operated in this manner. Experience indicates that the gravity method is the best where the number of instruments is not great.

Another paper by Prof. Todd described the use of a wedge of yellow optical glass in giving correctly graduated exposures of the partial phases and corona on a single biograph film.

An important paper on the classification of sun-spots was read by the Rev. A. L. Cortie, S.J., and illustrated by a fine series of lantern slides selected from the thousands of drawings made at Stonyhurst during the last twenty years. Five types, with a certain number of sub-divisions, were found sufficient to denote the characters of all the spots which had so far been examined.

The chief type, of which the others are probably but phases, is the two-spot formation. The faculæ associated with the different types are also of different characters, and it may be possible to foretell the outburst of a spot by the observation of a certain kind of facula. As an illustration of the use of the type numbers, the life-history of a composite disturbance which crossed the solar disc five times between May 14 and September 4, 1887, was thus described :—

I., II.*b* | IV.*d*, IV.*a* | IV.*a*, IV.*d*, IV.*a* | IV.*a*, I., II.*a* | I.

In the course of the discussion on this paper it became evident that the need for some short system of notation had long been felt by observers of sun-spots, and that, providing the scheme suggested would cover all cases, it would be very valuable. The chairman remarked that possibly a still better system, which would tax the memory less, might be devised on the plan of Herschel's notation for nebulæ.

Prof. Turner exhibited and explained "a cheap form of micrometer for determining star positions on photographic plates." The essential features are a wooden frame to support the photograph, with an attachment carrying a simple microscope containing a scale in the eye-piece. For less than thirty shillings an efficient instrument can be constructed, capable of yielding measures of practical utility. It thus becomes possible for any one to undertake important researches at a much smaller outlay than would be involved in the purchase of a telescope, since there is no lack of material to work upon. Among the investigations mentioned by Prof. Turner as possible with such a machine, were the determination of the positions of nebulæ and comets, and measurements to ascertain the forms of the trails of meteors. Considerable interest in the proposal was displayed, and the hope was expressed that many who now spend their time in fruitless star gazing with small instruments may be induced to undertake these micrometric measurements.

Thursday's meeting was opened with an interesting paper by Dr. Lockyer, in which a comparison was made of the details of the prominences and corona as shown in photographs taken during the recent eclipse at intervals of 2½ hours, by Prof. Langley and Sir Norman Lockyer, in America and Spain respectively. While enormous changes in the prominences were revealed, no change was detected in the structure of the corona in the region of the North Pole, which had been specially investigated. An interesting feature of one of the photographs taken in Spain with an exposure of 40 seconds was the extreme hardness of the moon's limb, notwithstanding the relative motion of the moon during the exposure; the explanation of this unexpected appearance was based on the rapid diminution in intensity of the corona as the outer layers are reached, so that the momentary exposures of the lower corona on the advancing limb of the moon at the beginning of the exposure, and on the following limb at the end, were sufficient to give a strong impression.

The new form of refracting telescope recently erected at Cambridge, chiefly for photographic work, was described by Mr. A. R. Hinks, and illustrated by lantern slides. The object-glass is a Taylor triple lens of 12½ inches aperture, and the chief peculiarity of the mounting is that the portion which is usually the lower half of the tube forms the polar axis, with the eye-end at the top, while the object-glass end is hinged to the other piece, and a plane mirror is placed at the junction. In another paper Mr. Hinks referred to the preparations which are being made for determining the solar parallax by observations of Eros during the coming winter, and exhibited a series of diagrams showing the path of the Cambridge Observatory as seen from that planet at various times. With the aid of such diagrams the observer can see at a glance the most favourable times for making micrometric measurements or taking photographs for the purpose in hand. The importance of the observations of Eros was emphasised by Prof. Turner, who remarked that at the present time the probable error of the adopted value of the solar parallax was equivalent to the thickness of a wicket in the length of a cricket pitch. Unlike the transit of Venus, the observations of Eros would be easily reduced, and the results of the observations would soon be accessible.

A paper on "some points in connection with the photography of a moving object," by Mr. W. E. Plummer, had an important bearing on the photographic method of ascertaining the position of such a rapidly moving object as the planet Eros. A comparison of measurements of the positions of a comet made with a micrometer and those determined from photographs indicated that considerable errors might be introduced in the photographic results on account of the difficulty of determining the epoch of observation. Since the first few moments of exposure on the moving object leave no impression, the middle of the trail does not correspond to the middle of the exposure. In exposures of ten minutes on Eros the danger of error was very considerable. Mr. Hinks remarked that it was hoped to obtain sufficiently strong impressions of the field containing Eros with exposures of one or two minutes, under favourable circumstances, and, moreover, special precautions to eliminate this difficulty had been arranged at the Paris Conference.

Mr. John Herschel described in detail his method of observing and recording the paths of meteors. Special maps are constructed in which the brighter stars are represented by perforations made with needles of various sizes, the side of the paper away from the observer being blue, while that towards him is white. The map being laid on a sloping desk of ground glass illuminated by a night light, the paths of the meteors are ruled in by means of a transparent celluloid ruler having a black edge,

The duration of flight is estimated by repeating the letters of the alphabet, minus w, at the rate of five per second, after experience gained from previous practice.

Among other papers presented to the astronomical department was one by Mr. C. T. Whitwell, on "The Duration of Totality of the Solar Eclipse of May 28, 1900." A table which was given illustrated very forcibly the discrepancies between the calculated and observed durations at various observing stations. It was pointed out that to reconcile the observations and calculations by supposing that there were errors in the adopted value of the moon's diameter, or in the position of the observing station, involved the assumption of greater errors than were probable, though each may account in part for the discordance. Another suggestion, due to Mr. Crommelin, was put forward—namely, that, on account of the irregularities of the moon's limb, the beginning of totality is retarded by an amount corresponding to the movement of the moon required to bring the lowest depressions to the edge of the sun's disc after the assumed geometrical boundary has made contact, while for a similar reason the end of totality would be hastened. A. FOWLER.

CHEMISTRY AT THE BRITISH ASSOCIATION.

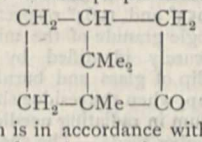
ALTHOUGH the president of section B, Prof. W. H. Perkin, junr., is mainly known as a specialist on polymethylene compounds, his address upon the teaching of inorganic chemistry proved to be of very general interest and was enthusiastically received by a large audience. His contention that the present system of examinations would be advantageously superseded by an inspection of the students' laboratory notebooks was favourably commented upon by Sir H. E. Roscoe and Dr. H. E. Armstrong, although it was admitted that the practical difficulties in the way of such a method are very considerable. The presidential address was followed by the report of the committee on the teaching of science in elementary schools, of which Dr. J. H. Gladstone is chairman; the report consisted principally of a discussion of the returns of the Education Department in so far as they concern the teaching of elementary science. The debate which ensued materially assisted the strong case which was subsequently made out in favour of establishing a separate section of the Association for dealing with educational matters. A paper was next read by Dr. Letts and Mr. R. F. Blake on some problems connected with atmospheric carbonic anhydride and on a new and accurate method for determining its amount, suitable for scientific expeditions; attention was drawn to the variations in the amount of atmospheric carbonic anhydride, and possible explanations of the variations were considered. The authors determine carbonic anhydride in air by absorbing it from about six litres with caustic potash solution, subsequently liberating it by boiling the potash solution with acid in a vacuum and measuring the volume of the carbonic anhydride in a suitable eudiometer. Mr. W. Ackroyd contributed papers on the distribution of chlorine in West Yorkshire and on a limiting standard of acidity for moorland waters. Water from the upper reaches of the West Yorkshire rivers contain from 0·7 to 1·3 parts of chlorine per 100,000, but as the sea or a more populous district is approached, the chlorine number becomes much greater. No cases of plumbism have yet been traced to the solvent action upon lead pipes of water of which the acidity is less than the equivalent of 0·5 part of sulphuric acid per 100,000; this acidity value is therefore tentatively proposed as a limiting standard for potable waters of moorland origin. Dr. T. W. Hime read a paper on the effects of copper on the human body, in which he sought to show that the agitation against the use of articles of food containing small quantities of copper salts is unjustifiable, because a large number of well-known food stuffs contain copper as a normal constituent and because such articles of food exert no poisonous action at all. Reports were received from the committees on the bibliography of spectroscopy and on the preparation of a new series of wave-length tables of the spectra of the elements. Prof. H. B. Dixon and Mr. F. W. Rixon, in a paper on the specific heat of gases at temperatures up to 400°, showed an apparatus for making such determinations at constant volume in which a steel cylinder containing the gas is heated and dropped into a calorimeter; the preliminary results obtained with carbonic anhydride were stated. Mr. F. H. Neville communicated a report on the chemical compounds contained in alloys of which the following is a brief abstract. Intermetallic compounds may be compared with the unstable compounds of the halogens with each other and with sulphur; they often bear a great superficial resemblance to their constituent elements and appear to show marked dissociation, or to form systems in true equilibrium with the liquid mixture of their components.

The intermetallic compounds may be isolated from an alloy (1) by filtration, (2) by volatilisation of excess of a volatile metal, or (3) by removing the excess of metal by means of a suitable solvent. Method (1) has been used by Heycock and Neville, who, on filtering a partially solidified solution of gold and cadmium in tin, obtained a crystalline residue having the composition AuCd; method (2) was applied to the preparation of the same compound by distilling the excess of cadmium from an alloy of gold and cadmium. Lebeau prepared the compounds $SbNa_3$, $BiNa_3$ and $SnNa_4$ by distilling the excess of sodium from alloys in ammonia and nitrogen gas. Debray isolated the compounds $PtSn_4$, $RhSn_3$ and $RuSn_3$, and Le Chatelier obtained Cu_3Sn by the action of dilute hydrochloric acid on alloys containing excess of tin; by methods of a similar nature Heycock prepared $PtAl_3$ and Stead isolated the crystalline substances Au_4Pb, Au_5Pb_2, SnSb and Sn_3As_2. There is, in the application of this method, considerable risk of the solvent attacking the crystals, and Stead has found that the formation of crystals having a core differing in composition from the outside constitutes a serious drawback to the method of partial solution regarded as an independent method of investigation. In the systematic study of intermetallic compounds may be placed first that of the chemical equilibrium of the binary system; this is generally expressed by the freezing-point curve, and has been mainly investigated by Roozeboom and Le Chatelier. Next, and perhaps of equal importance, is placed the microscopic examination of the solid alloys; whilst thirdly, and more limited in applicability, comes the determination of the difference of electrical potential existing between a metal and its alloys. On determining the freezing-points of a series of mixtures of two metals and plotting the freezing-points as ordinates against the compositions as abscissæ, a freezing-point curve is obtained which in its simplest form consists of two branches meeting at an angle—the eutectic angle—lying at a minimum point on the curve. In other cases the freezing-point curve shows a maximum point, but this is not cusped and lies on a gradual change of curvature; the freezing-point curve may thus consist of a series of branches connected by summits and eutectic depressions. It is pretty generally recognised that the eutectic alloy is merely a conglomerate and not a compound, but it is a remarkable fact that the position of the eutectic point on the curve often corresponds closely with some simple molecular composition; cases of this have been observed, not only with alloys, but also amongst organic compounds, by Paternò and Ampolla. The branches of the curve upon which summits lie are caused by the separation of compounds of definite chemical composition from the solidifying magma; the maximum points lie at positions corresponding to the composition of the compound, but Le Chatelier considers that the summit does not necessarily lie exactly at the point indicated by the molecular composition, owing to dissociation occurring in the liquid state. This point, however, needs further investigation. The points upon the freezing-point curve merely denote the temperatures at which solid begins to separate from the magma, but Roozeboom has shown that valuable results may be obtained by plotting, not only the temperatures at which solid begins to separate, but also the temperatures at which complete solidification occurs; in general, the one curve lies below the other, but they intersect or become one whenever the alloy solidifies as a whole. The microscopic examination of the pattern shown by the polished surface of an alloy which has, if necessary, been etched or heated to produce oxidation colours has been worked at principally by Osmond, Charpy and Stead. The existence of coated crystals is made evident by this method, as in the case of the bronzes rich in tin, in which Stead has shown that the Cu_3Sn crystals are coated with CuSn. Le Chatelier has pointed out that in these cases the solid alloy is not in equilibrium, and that annealing will, in general, cause considerable change. Charpy and Stead also consider that evidence of the existence of series of mixed crystals is obtained by microscopic examination. Röntgen ray photographs of thin sections of alloys which contain one transparent metal and one more opaque often give good views of the

crystals in the alloy; they were introduced by Heycock and Neville. Laurie and Herschkowitz have studied the potential difference set up between an alloy and the more electro-positive metal contained in it, using a salt of the electro-positive metal as the electrolyte. It is shown that if the alloy consists of a conglomerate of the two metals, the potential of the alloy is that of the more electro-positive constituent; if, however, the two metals are mutually soluble in the solid state, the potential of the alloys will change very gradually with change of composition. Lastly, the existence of intermetallic compounds is indicated by a sudden and large change in potential when the composition of the alloy attains that of the compound. The author notes that although the molecular depressions of the freezing-point of one metal by solution in it of a second point in general to the molecular and atomic weights of the second metal being identical, the evidence is not complete because the second metal may exist combined with the first in the solution. The reading of this report was followed by a lively discussion, in which Sir W. Roberts-Austen, Mr. J. E. Stead, Mr. W. J. Pope, Mr. Stansfield and Dr. H. E. Armstrong took part. Mr. J. E. Stead then read a paper on the mutual relations of iron, phosphorus and carbon when together in cast iron and steel, which was illustrated by a very excellent series of drawings and photomicrographs. Prof. J. A. Ewing and Mr. W. Rosenhain gave a paper on the crystalline structure of metals, in which it was shown that the crystalline character of metals like lead, zinc, tin and cadmium is altered by subjecting them to a severe plastic strain at moderate temperatures; evidence was also adduced in favour of the solution theory of annealing. Prof. Barrett read a paper on the electric conductivity of the alloys of iron, and Mr. C. S. Bradley spoke on some new chemical compounds discovered by the use of the electric furnace. The sixth report of the Committee on electrolytic methods of quantitative analysis was presented; it consisted of papers on the determination of bismuth by Prof. J. E. Reynolds, and on the electro-deposition of iron, by Dr. C. A. Kohn and others. A paper on a simple method for comparing the "affinities" of certain acids was contributed by Messrs. H. J. H. Fenton and H. O. Jones. Oxalacetic acid is decomposed by dilute sulphuric acid into phenylpyrazolonecarboxylic acid in accordance with the equation :—

$$C_{10}H_{10}N_2O_4 = C_{10}H_8N_2O_3 + H_2O,$$

whilst water converts it into the hydrazone of pyruvic acid with evolution of carbonic anhydride. Using decinormal solutions of various acids, it is found that the amounts of carbonic anhydride evolved are inversely proportional to the concentration of the hydrogen ions and hence afford a measure of the affinity constants of the various acids. Mr. H. J. H. Fenton and Miss M. Gosling gave a paper on derivatives of methylfurfural, and Mr. H. M. Dawson spoke on the influence of pressure on the formation of oceanic salt deposits. A paper on recent developments in stereochemistry was read by Mr. W. J. Pope, in which it was pointed out that until a year ago the only known substances exhibiting optical activity in the amorphous state contained an asymmetric carbon atom. Last year, however, Pope and Peachey described a compound which owes its optical activity to the presence in the molecule of an asymmetric nitrogen atom, that is to say, a nitrogen atom which is directly attached to five different groups of atoms. On treating optically inactive methylallylphenylbenzylammonium iodide with silver dextrocamphorsulphonate in a nearly water-free solvent and evaporating the solution, a crystalline mixture of the dextrocamphorsulphonates of dextro- and lævo-methylallylphenylbenzylammonium is obtained which is easily resolved by fractional crystallisation; on treating the aqueous solutions of these salts with potassium iodide solution, crystalline precipitates of the iodides of the two optically active substituted ammonium iodides are obtained. This result proves that ammonium salts are not mere molecular compounds of ammonia with an acid, but are true atomic compounds, in which five atoms or groups of atoms are directly attached to the nitrogen atom. The use of strong optically active acids has also been applied during the present year to the preparation of compounds owing their optical activity to the presence of an asymmetric tin atom. On treating methylethylpropylstannomethyl iodide with silver dextrocamphorsulphonate and evaporating the solution, dextromethylethylpropylstannomethyl dextrocamphorsulphonate is obtained in the crystalline state. On treating the aqueous solution of this salt with potassium iodide solution, dextromethylethylpropylstannomethyl iodide separates as a yellow oil under certain conditions, although under others the iodide becomes inactive owing to the occurrence of racemisation. Similarly, dextromethylethylthetine platinochloride was prepared from optically inactive methylethylthetine bromide, proving that the asymmetric sulphur atom gives rise to optical activity in the same way that the asymmetric carbon, nitrogen or tin atom does. Further, these results prove that the sulphonium compounds contain quadrivalent sulphur, and are true atomic compounds. Since the four elements which we now recognise as able to give rise to optical activity in appropriate compounds are representatives of three groups of the periodic classification, it may be concluded that all the quadri- and quinque-valent elements of the carbon, oxygen and nitrogen families can act as centres of optical activity. Dr. J. B. Cohen, Dr. Divers, Mr. W. Barlow, Dr. H. E. Armstrong, and Dr. F. S. Kipping took part in the discussion which followed the reading of this paper. Dr. A. Lapworth presented a report on our knowledge of the constitution of camphor, in which he showed that the constitutional formula proposed for camphor by Bredt,



is the only one which is in accordance with the facts, and that the Perkin-Bouveault formula must be considered as erroneous. The President, Dr. H. E. Armstrong, Dr. F. S. Kipping and Mr. W. J. Pope joined in the ensuing discussion. A paper was read in which Prof. J. Bredt quoted further evidence in support of the constitution which he has proposed for camphor. Prof. Ossian Aschan, of Helsingfors, gave a paper in which it was shown that on replacing the ketonic oxygen atom in the camphor molecule by two hydrogen atoms the material becomes optically inactive, as it should do if Bredt's formula is correct. The Committee on isomeric naphthalene derivatives, of which Dr. H. E. Armstrong is secretary, reported that Mr. W. A. Davies has continued the study of the action of bromine on betanaphthol, and has obtained two isomeric tribromonaphthols, melting at 155° and 159° respectively. The report of the Committee on isomorphous derivatives of benzene, drawn up by Dr. H. E. Armstrong, was presented. A number of series of homologues of formanilide of the composition $C_6H_5{\cdot}NX{\cdot}COY$, where X and Y are alkyl groups, have been crystallographically examined and numerous crystallographic relationships established by Mr. L. P. Wilson. Dr. Jee has further investigated the isotrimorphous series of 1 : 3 : 4-dihalogenbenzenesulphonic chlorides and bromides, and has proved a relation between the stability of the crystalline modifications of the various compounds and their position in the series. Dr. S. Ruhemann and Mr. H. E. Stapleton gave papers on the synthesis of benzo-γ-pyrone and on the combination of thiophenol and guaiacol with the esters of the acids of the acetylene series. Dr. J. B. Cohen and Mr. H. D. Dakin read a paper on the chlorination of the aromatic hydrocarbons and the constitution of the dichlorotoluenes, in which it is shown that the chief products of the chlorination of toluene are the 1 : 2 : 3- and 1 : 2 : 4- and possibly a little of the 1 : 2 : 5-dichlorotoluene. Mr. C. F. Cross gave a paper showing that Caro's reagent acts on furfural with formation of a hydroxypyromucic acid. Mr. H. T. Brown gave an account of his recent work on the diffusion of gases and liquids. Dr. J. B. Cohen read a paper on smoke prevention, contending that the production of smoke should be regulated by some system of Government inspection. Mr. T. Fairley read a paper on the heating and lighting power of coal gas, and stated that in populous districts from 20 to 50 per cent. of the gas produced is consumed for heating purposes or by gas engines. Dr. A. Liebmann contributed a report on recent improvements in the textile industries, in which he observed that the inflammability of artificial silk, which constituted so serious an objection to the use of the material, has now been entirely prevented; the use of artificial silks is, however, limited by their brittleness and susceptibility to damage by damp. Major-General Waterhouse gave a paper on the sensitiveness of silver to light, whilst Dr. J. H. Gladstone and Mr. G. Gladstone contributed some thoughts on atomic weights and the periodic law. Mr. F. W. Richardson gave a paper on Bradford sewage and its treatment, in which it was noted that the presence of large quantities of wool-grease and nitrogenous impurities make the Bradford sewage peculiarly difficult to deal with; the grease soon chokes up the filters and, if it were absent, the sewage could readily be

treated biologically. Mr. W. Leach, in a paper on wool-combers effluents, also referred to the unsatisfactory character of the purification methods at present applied to the sewage. Mr. W. B. Bottomley discussed the utilisation of the sewage sludge, and contended that the sludge should be pressed and dried, when it forms a valuable manure. Dr. Letts and Mr. R. F. Blake gave a simple and accurate method for estimating the dissolved oxygen in fresh water, sea water, sewage effluents, &c.

SCIENTIFIC SERIALS.

American Journal of Science, September.—The gas thermometer at high temperatures, by L. Holborn and A. L. Day. This is a further study of the nitrogen thermometer with platinum-iridium bulb, which is superior to the porcelain bulb. The correction for expansion is 10° at 500°, 30° at 1000°, and 40° at 1150°. The authors make an elaborate comparison of the gas thermometer with the thermocouples, and determine anew the melting points of a number of metals. Those of silver and gold are 955° and 1064° respectively.—Monazite, by O. A. Derby. A single granule of the mineral, no matter how minute, can be securely identified by moistening it with sulphuric acid on a slip of glass and burning off the sulphuric acid over a spirit lamp, when the residue shows the characteristic crystallisation of cerium in radiating needles or isolated crystals of the shape of cucumber seeds.—The spectra of hydrogen and the spectrum of aqueous vapour, by J. Trowbridge. When a condenser discharge is sent through a rarefied gas confined in a glass vessel, the gas cannot be considered dry, for aqueous vapour is liberated from the glass. The four-line spectrum of hydrogen in the solar atmosphere is an evidence of aqueous vapour, and therefore of oxygen in the sun. Conclusions in regard to the temperature of the stars exhibiting hydrogen spectra are misleading if purely based upon conditions of pressure and temperature, for electric dissociation plays a determining part. X-Ray phenomena produced by a steady battery current strongly suggest an electrical theory of the origin of the sun's corona.—A new effect produced by stationary sound-waves, by B. Davis. When a small cylinder, closed at one end, is placed in the stationary sound-wave of an organ pipe, it will not only arrange itself perpendicularly to the motion of the wave, but will move across the wave in a direction perpendicular to the stream-lines. When four such cylinders are mounted in the shape of an anemometer on a needle point, they rotate while the pipe is sounded.—Some interesting developments of calcite crystals, by S. L. Penfield and W. E. Ford. The crystals described show a great diversity of habit, often on a single hand specimen, due to different methods of twinning, together with peculiarities in the development of certain crystal faces. Some peculiar cases of rhombohedral twinning are described.—Method of measuring surface tension, by J. S. Stevens. The surface tension is measured by floating an iron wire on the surface of the liquid, and suspending a piece of soft iron by it. The iron is pulled into a magnetising coil immersed in the liquid by currents which increase until the surface is broken through.

Annalen der Physik, No. 8.—Structure, system and magnetic behaviour of liquid crystals, and their mixture with solid ones, by O. Lehmann. The author has succeeded in proving that all the characteristics of crystallisation which the "liquid crystals" described by him do not possess, cannot logically be made part of the definition of a crystal. The only general characteristics of crystals are that they are not isotropic, and that they possess a molecular directive force which governs their shape, and the manner in which their constituent particles are deposited. The directive force is preserved by means of the surface tension, and crystals may therefore be liquid or solid, but they cannot be gaseous. Liquid crystals may be produced by depositing solid crystals on the cover glass of a microscope and gently heating them above the fusing point.—Generation of electricity in liquid air, by H. Ebert and B. A. Hoffmann. A body suspended above liquid air acquires a strong negative charge. This electrification is due to the friction of minute particles of very cold ice suspended in the air vapour. The authors constructed a kind of electrifying machine by means of a tube containing a piece of wire gauze through which the vapour of liquid air was driven.—Spectrum of radium, by C. Runge. The author has located three of Demarçay's lines with the precision necessary to distinguish them from neighbouring solar lines. The lines located have wave-lengths of 4826·14, 4682·346 and 3814·591 respectively.—Influence of a spark-gap upon the generation of Röntgen rays, by A. Winkelmann. The maximum gaseous pressure at which X-rays can be produced may be raised by introducing a spark-gap into the circuit, the best position for it being next the kathode. Hydrogen yields X-rays at greater pressures than air or carbonic acid.—Fall of potential and dissociation in flame gases, by E. Marx. The author proves that an apparent failure of Ohm's law in flame gases is due to the fact that owing to the scarcity of ions the saturation current is soon attained.—Hall effect in flame gases, by the same author. Owing to the great speed of the ions in flame gases, and the difference in the velocities of the positive and negative ions, a Hall effect is much more appreciable in flames than in electrolytes. The author demonstrates the existence of such a Hall effect in the case of a flat Bunsen flame into which a fine spray of a solution of some alkaline salt is blown.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 24.—M. Maurice Lévy in the chair.—Nature of the combustible gases found in the air of Paris, by M. Armand Gautier. The author has shown in previous papers that the ratio of carbon to hydrogen found by his method of combustion in dilute mixtures of methane and air is 2·4, instead of the theoretical 3. The much higher value of this ratio found in the air of Paris proves that there must be present gaseous substances richer in carbon than methane, such as benzene vapour or its analogues. The experimental results obtained are in accord with the assumption that in 100 litres of Paris air there are 19·5 c.c. of hydrogen, 12·1 c.c. of methane, 1·7 c.c. of benzene vapour and 0·2 c.c. of carbon monoxide.—Experiment in wireless telegraphy with the human body and metallic screens, by MM. E. Guarini and F. Poncelet. The electric waves were generated by a Wimshurst influence machine and were allowed to act directly upon a coherer. It was found that the human body acted perfectly as a screen.—On crystallised calcium aluminate, M. Em. Dufau. The crystallised aluminate is obtained by heating a mixture of calcined alumina and lime in an electric furnace. Its formula is $CaAl_2O_4$; it forms transparent needles which do not scratch glass.—On Russian flour, by M. Balland. Proximate analyses of three samples of Russian flour are given.

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