THURSDAY, AUGUST 29, 1907.

THE CONSTITUENTS OF THE EUROPEAN FAUNA.

European Animals: their Geological History and Geographical Distribution. By R. F. Scharff. Pp. 14+258; illustrated. (London: Archibald Constable and Co., Ltd., 1907.) Price 7*s.* 6*d.* net.

CHOOSING a suitable and expressive title is not unfrequently one of the most difficult tasks (next to writing a preface) in preparing a work relating to natural history, and in this particular instance we venture to think that the author has not done himself anything like justice in the one he has selected. "Animals" in popular estimation are still regarded (and to a certain extent we think justly so) as forming only one section of the animal kingdom; while, altogether apart from this, the title, "European Animals," which alone appears on the cover, suggests a work of a nature totally different from the one before us. At any rate, such was the impression in our own case, and we expected to find something in the shape of a text-book of at least the mammalian section of the European fauna. When the full title is read the situation is of course changed, although even then there seems something lacking. As a matter of fact, the volume, which is based on a course of (we believe much appreciated) lectures delivered at South Kensington, may be regarded as a sequel to and amplification of the author's previous work on the "History of the European Fauna."

After an introductory chapter, in which general matters affecting zoological distribution and the value of land mammals and molluscs as a basis for zoological geography are discussed, the author, as perhaps in duty bound, commences with Ireland, directing special attention to and attempting to account for the absence in that island of many types common in Great Britain. Scotland, England, and Wales form the subject of the next two chapters, after which the Spanish peninsula, the Alps, eastern Europe and the Caucasus, the western plain of Europe, and, finally, the east and west Mediterranean provinces are discussed in turn. Having expressed his belief in the supreme value of mammals and land-snails to the student of distribution, the author, as might be expected, takes these groups as his text, using other sections of the animal kingdom as collateral evidence whenever occasion may require. A special feature is formed by a series of maps of the geographical distribution of a number of mammals and land-molluscs, these being illustrated by insets displaying a portrait either of the animal itself or of its shell. Assuming these maps to be trustworthy (and such of them as we have examined appear to be so), they have a very considerable value, for few things are more difficult than to obtain accurate information in such matters.

The mention of the insets in these maps naturally leads to a few words with regard to the illustrations generally. Where photographs of shells, like the one of Clausilia on p. 95, have been reproduced, nothing can be better than the result. With regard to most of the other illustrations, we regret, however, that we are unable to congratulate the author. They start with the disadvantage that they are taken from stuffed specimens—a style of illustration which does not appeal to our taste. Added to this is the circumstance that they have been largely "faked" by the addition of false backgrounds. The least unsatisfactory is the frontispiece, representing a group of blue hares and grouse in the Dublin Museum, but even this is blurred and indistinct; while the group of badgers on p. 24, taken from a case in the British Museum, with an added background, is hopelessly bad. Worst of all is the portrait in the inset to the map on p. 78 of an apparently enraged hippopotamus careering on a mountain-top!

Lack of space prevents detailed reference to the views of the author as to the factors which have combined to form the modern fauna of Europe; but this is a matter of less moment since most of these are familiar through his previous work. An especially interesting chapter is the one dealing with the Caucasus and east Europe, in which the view of a former connection between the polar ocean and the Aralo-Caspian system is stoutly maintained; much importance in this respect being attached to the crustaceans of the genus Pontoporeia, which are common to the Caspian and the Arctic Ocean. The distinctness of the fauna of the Caucasus from that of south Russia generally (due, it is supposed, to a connection between the Caspian and Black seas) and its affinity to that of Asia Minor is another feature on which special stress is laid.

In conclusion, we may endorse the opinion of Sir E. Ray Lankester, that the lectures (whether or no we accept all the views therein expressed) on which this volume is founded contain so much valuable information that their publication was practically a duty owed by their author to the scientific world. The volume should be in the library of every naturalist. R. L.

THE GEOGRAPHY OF AUSTRALIA AND NEW ZEALAND.

Stanford's Compendium of Geography and Travel. (New issue.) Australia. Vol. i. Australia and New Zealand. Second edition, re-written. By Prof. J. W. Gregory, F.R.S. Pp. xxiv+657. (London: E. Stanford, 1907.) Price 15*s.*

ONE of the characteristics of the age of synthesis in which we live is a desire on the part of the people of Great Britain for a better knowledge of the Britains beyond the seas. Hence spring Imperial conferences and schemes for reciprocal education; hence, also, a crop of volumes dealing with the geography, history, and conditions of the colonies. Among these not one has been written with a deeper insight into the problems which confront a young nation than Prof. Gregory's work on Australia and New Zealand. It is too much the custom for writers to judge the measures of a new country by old-world standards, and to commend or condemn them according to the degree of their correspondence. But a moment's

reflection will disclose the fallacy of such a criterion. If the problem of colonial administration could be satisfactorily solved by imitating ancestral patterns, what is the reason for the frequent failure of nations which systematically follow this course? why should it be thought necessary to utter warnings against the attempt to import Berlin into Uganda? and how is the success which attends the experimental and empirical methods of Great Britain to be explained?

Readers of NATURE are aware that evolution depends on the power of adaptation to environment, and will have no difficulty in recognising that the secret of the British Empire lies in the plasticity which permits the free play of variation, so as to fit novel functions to new requirements. A perusal of Prof. Gregory's book will disclose numerous experiments in social and industrial legislation which have been made to meet Australian conditions; and his appreciation of many of these departures presents an interesting contrast to the undiscriminating denunciations of most British observers. The volume is a compendium of geography; but the geography of to-day is a much wider subject than the dry-bone catalogues which formerly stood for that science, and which were so repulsive to students of the previous generation. Under the heading of Physical, Economic, and Political Geography, the author has succeeded in presenting a life-like picture of the countries he describes.

Isolation, according to Prof. Gregory, is the explanation of the physical, biological, and political features of Australasia. The strange forms of fauna in Australia are due to its long separation from other continents. The unique aspect of its vegetation is similarly due to development in what is happily called "a biological backwater"; but it is a mistake on that account to regard the flora as primitive in character; it is in reality highly specialised, and the author quotes with approval Spencer Moore's statement that in adaptation of plant life to a dry climate "the Australian flora is without a parallel the world over." It is also a common error to regard the Australian aborigines as archaic. They are closely allied to the hill tribes of Southern India; and here, again, the evidence of specialisation is abundant. The social system of the aborigines is elaborate, and on their own plane they have attained a fair degree of civilisation. Their mental capacity is considerable, and their disposition is described as "kindly, peaceful, and amiable." They are possessed of poetical imagination, and have an intense belief in the immanence of the spiritual world.

Prof. Gregory regards the prevailing aspect of Australian scenery as hopefulness, and this quality is reflected in the temperament of the inhabitants. Although Australians are happy in their dispositions, they are accustomed to make some present sacrifice of comfort for the sake of the future. This has been repeatedly shown by the labour party, to whose efforts advanced temperance legislation is largely due. Although, as a conservative in British politics, Prof. Gregory went to Australia with the "bogey" idea of the Australian Labour Party, he sees much to admire in their ideals. His observations on the White Australia policy show both sympathy and discernment. He remarks that "no nation has yet become great which left aliens to do its manual labour." Labour in Australia, though high-priced, is cheap because it is so efficient; dividends are paid out of deep quartz mines producing 2 dwts. of gold to the ton, and Australia holds the record of cheap and rapid deep-shaft sinking. The arguments for an Australian navy are fairly stated, as also are those for the Alien Immigration Acts. The chapters on the exploration and discovery of Australia are full of interest, and there is a concise description of Australian federation. Prof. Gregory's volume will well repay perusal, and is a welcome addition to descriptive works on Australasia. JOHN A. COCKBURN.

AIR CURRENTS AND VENTILATION.

Air Currents and the Laws of Ventilation. By Dr. W. N. Shaw, F.R.S. Pp. xii+94. (Cambridge: University Press, 1907.) Price 3*s.* net.

THIS book contains the substance of a course of lectures delivered by Dr. Shaw at Cambridge in 1903. The author's reputation as a physicist will naturally lead those who open these pages to expect a scholarly treatment of the subject, and they will not be disappointed; and although we are told in the preface that "this volume is in a sense my last will and testament on the subject of ventilation," we venture, after a careful perusal of the book, to express a hope that Dr. Shaw may find time to extend so judicious and original a treatment of this difficult branch of applied science.

Writers on the subject of ventilation are apt either to deal with individual schemes which have come under their notice, leaving useful general inferences to be constructed by the reader, or, armed with mathematics, to plunge *in medias res* among all the factors of the problem in a manner which entirely obscures the main issue. It is the more satisfactory, therefore, to find a book free from such shortcomings.

While admitting the many and complex problems which deserve consideration, the author of this volume brings us, by a wise process of selection and rejection, to issues which, while admittedly approximate to truth, are at the same time most valuable generalisations, and this with a mathematical restraint which should considerably increase the field in which the utility of his work will be felt.

The leading feature of the book is the development of the subject by the utilisation of an analogy between pneumatic and electrical flow and resistance, originated by Dr. Shaw some years ago. We are shown, for example, the relation of air flow to "head," or "aëromotive force," and how to deal with pneumatic resistances in parallel and multiple arc, and the analogy is even taken so far as the use of null methods in such determinations. In this spirit we are conducted through a network of difficulties in a manner which anyone with the most elementary knowledge of the laws of electricity will much appreciate. This analogy is not confined to mere theorising. Actual

apparatus consisting of thin plate orifices, large connecting boxes and delicately poised vanes, is figured and described by which the fundamental pneumatic laws may be demonstrated. For example, if H be the head or aëromotive force, R the resistance, or sum of resistances, and V the volume of air delivered, using comparable units, the relation $H=RV^2$, corresponding with Ohm's law $E=RC$, is shown to exist.

The book is divided into three chapters comprising respectively 26, 19, and 33 pages. The first deals with the laws of flow in air circuits and their verification, in the manner already referred to. The second with the physical principles applicable to the ventilated space, in which the important effects of changes of temperature and the convection currents resulting therefrom are discussed, and some sketches of delicate and simple apparatus used by the author in his investigations, together with some real and ideal thermal diagrams, are given. In the third chapter are discussed the essentials for practical ventilation, and, so far as the limits of the book permit, the various systems in general use. Here again the electrical analogy is given full play, and applied to the consideration of the open fire, the cowl, the vacuum and plenum systems, and to simple cross-ventilation.

The diction throughout the book is so clear and concise that we cannot even quarrel with Dr. Shaw when he refers to a draught along the floor as likely to set up "the reversed correlative of the therapeutic action" of putting one's feet in water, and we heartily endorse his suggestion that this important subject should receive more attention at the hands of those engaged in scientific research in our technical institutions.

OUR BOOK SHELF.

The Aim and Achievements of Scientific Method: an Epistemological Essay. By Dr. T. Percy Nunn. Pp. x+144. (London: Macmillan and Co., Ltd., 1907.) Price 3*s.* 6*d.* net.

THIS essay is an expansion of a paper read before the Aristotelian Society in February, 1906, and was in its present form printed in September, 1906, and presented to the University of London as a thesis for the degree of Doctor of Science. The results described were reached in the course of a study of the problems of science teaching in schools, but its pedagogical applications are not considered in the present volume.

The essence of the doctrine presented by the author is the view that a large part of the contents of our consciousness from moment to moment consists of elements which exhibit themselves as having a certain unique "priority" to our conscious processes. These elements constitute what he describes as the objective. The aim of the scientific process is to render objective facts intelligible to an individual consciousness by building up the primary facts into "secondary constructions" by means of ideas drawn from other contexts of experience. No hypothesis is considered essentially incapable of making primary facts intelligible on the ground of the context of experience from which it is drawn, while the hypothesis is in no case to replace (in the sense of accounting for the "reality" of) the objective facts which it has been employed to render intelligible. The extent to which unification of the various provinces of scientific inquiry can be brought about is identical with the range over which hypotheses drawn from a single context of experience can be applied to illustrate facts.

The author examines briefly the most systematic of the attempts that have been made to render the whole range of sensible facts intelligible by means of the concepts of "mass" and "motion," which are themselves drawn only from one province of primary facts. Huygens, in his discussion of the collision of elastic bodies, made use of what Mach calls an "instinctive perception," that the centre of gravity of a system left to itself cannot rise; this was by the Bernoullis developed into the principle of *vis viva*, upon which Helmholtz based his wider principle of the conservation of energy, which first brought the facts of heat into a line with those of mechanics. But though temperature changes are thus connected with mechanical facts, the doctrine does not effect a reduction of the former to the latter, nor is Lord Kelvin's absolute thermodynamic scale more successful, as it makes no attempt to deduce from dynamical data the experiences to which the notion of temperature refers. Even the theory of Helmholtz is only partially successful. The modern science of energetics expressly declines to attempt to explain one set of objective phenomena in terms of another, contenting itself with trying to bring physical facts into a form of unity without reducing them to one type. In doing so it exhibits a practice that accords with the philosophical tenets of Dr. Nunn's essay. The hypothesis has, as he shows, merely a transient function, to point the way to new facts, including relations between things, and should then efface itself.

The Principles and Practice of Brewing. By Dr. Walter J. Sykes. Third edition, revised by the author and Arthur R. Ling. Pp. xviii+588; illustrated. (London: C. Griffin and Co., Ltd., 1907.) Price 21*s.* net.

THE publication of a new edition of this well-known book, which has been thoroughly revised by its author, the late Dr. Sykes, in conjunction with Mr. Ling, and brought well up to date, should be welcomed by all interested in the scientific aspect of the brewing industry. In one respect we think the late author and his colleague have lost an opportunity in not revising the original plan of the book, together with the matter it contains, for we have always considered that the book suffered to some extent in usefulness from the manner in which it was arranged; but, however this may be, the work in its present form stands easily first among books in our language devoted to a consideration of the complex scientific problems underlying the brewer's art.

The present edition, like the previous ones, is essentially a treatise on the scientific principles which underlie brewing technology, and although the word "practice" is included in its title, the space actually devoted to a description of the various processes of brewing and malting is comparatively small. In a book which deals in a somewhat encyclopædic manner with many different branches of science, naturally some unevenness is noticeable in the treatment of the various subjects included, but none of the more recent investigations of importance which bear on the subjects discussed appears to have been overlooked, and the references which are given add much to the value of the book. The strongest part of the book is undoubtedly the one which deals with the chemistry of the carbohydrates, more especially the chemistry of starch, and the author's *résumé* of the investigations which have been made in this country and abroad in connection with the transformation of starch by diastase is the most complete account of the subject

we have yet seen. We recommend the book not only to those directly interested in the scientific aspect of brewing, but also to those chemists and biologists whose work in any way trends in the direction of brewing or malting problems.

Oberharzer Gangbilder. By Dr. Phil. B. Baumgärtel. Pp. 23+six plates. (Leipzig: Engelmann, 1907.) Price 7 marks.

THE text of this book describes the geological features of the Upper Harz, and the mineral veins that, according to von Koenen, were injected into the old rocks of the region as recently as Miocene times. It serves as an introduction to six very beautiful photographs of large rock-surfaces in the mines. The various minerals of the lodes have been coloured in effective but harmonious tints, so that the relations of each can be traced out precisely. This combination of photographic accuracy with diagrammatic clearness may serve as a model for reproductions in other branches of science. The old coloured geological landscapes of the days of Weaver and Delabeche occur to one's mind, and might thus with advantage be revived.

G. A. J. C.

LETTER 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.]*

Atmospheric Absorption of Wireless Signals.

IN the *Electrical Review*, May 11 and 18, the writer has given curves which show that telegraph messages exchanged between Scotland and Massachusetts are received on some nights with practically no absorption, while on other nights and in daytime nine hundred and ninety-nine one-thousandths (0·999) of the energy is absorbed.

The fact that the daylight absorption was largely reduced between two stations 150 miles apart in Brazil by the use of a longer wave-length suggested that the masses of ionised air which are supposed to produce the absorption are broken up somewhat as clouds are. During the past six months experiments have been made between Massachusetts and stations at Porto Rico, Cuba, Washington (D.C.), and New York which seem to point to the same conclusion.

Two types of transmitting apparatus were used.

The first was an alternating-current dynamo giving 250 sparks per second and generating feebly damped waves. The energy used was between 10 and 12 kw., and the frequencies used were 200,000 per second and 81,700 per second.

Messages sent with the higher frequency from Massachusetts were received very strongly at night-time at Porto Rico and Cuba, and were officially reported on several occasions as having been received by naval vessels in the neighbourhood of Alexandria, Egypt (a distance of nearly 4000 miles), but no messages were received during daytime. The absorption comes on very suddenly, and in the West Indies increases sometimes nearly a thousand-fold in fifteen minutes as the sun rises.

With the longer frequency, however, though at night signals were considerably weaker, probably on account of the receiving stations not being adapted for such a long wave-length, the daylight signals were many times stronger, and it was found possible to work in daylight between Massachusetts and Cuba (a distance of nearly 1700 miles) when using the lower frequency without any increase in sending power. Tests between Boston and Washington now continuing for nearly six months show the same phenomena, *i.e.* that there is great daylight absorption at a frequency of 200,000, but almost no absorption at a frequency of 81,700.

The second type of apparatus used consisted of a high-frequency alternator capable of giving a frequency of 100,000, but for the purposes of this test run at a frequency of 81,700. The open-circuit voltage at this frequency is 150 volts, and its armature resistance six ohms. This apparatus is used for telephoning wirelessly between Brant Rock, Massachusetts, and the City of New York. A detailed description of a similar but less powerful apparatus used for telephoning between Brant Rock and Plymouth, Massachusetts, will be found in the *Electrical Review* of February 15, 22, and March 1, and in the *American Telephone Journal* of January 26 and February 2. The current used in the antennæ is from four to six amperes, and the speech received by the New York station is approximately five or six times louder than the limit of audibility. Tests have now been made with this apparatus over a period of nearly a month, wireless telephonic communication having been first established between these points about July 17. While this apparatus has not been tested for so long a period as the former type, the results obtained are in substantial agreement.

If the masses of ionised air were continuous there is no apparent reason why there should be less absorption with a long wave-length. The above experiments seem to point to the conclusion that the masses of ionised air which are supposed to produce the absorption are not continuous but are broken up in somewhat the same manner that water vapour is into clouds.

The fact that the wave-lengths must be increased as the transmission distance is increased in order to overcome the absorption does not necessarily indicate that the masses are of larger size as the distance above sea-level increases, though it is possible that this is the case.

The writer has found that the absorption at night-time varies with the direction from which the waves are received, and has obtained some results which seem to indicate that measurements of this phenomenon may have a meteorological value, and may assist in extending the range of weather forecasts.

REGINALD A. FESSENDEN.

Brant Rock, Mass., August 9.

PRACTICAL TELEPHOTOGRAPHY.

EARLY in 1881 I described in NATURE (vol. xxiii., p. 334) an experimental apparatus for the electrical transmission of pictures to a distance, in which use was made of one of the sensitive selenium cells devised a few months previously (*ibid.*, p. 58). Fig. 1 shows the arrangement diagrammatically. The transmitting cylinder T is mounted upon a screwed spindle, which moves it laterally through 1/64 inch at each revolution; a selenium cell S is fixed behind the pinhole H, 1/20 inch in diameter, and is electrically connected through the spindle with the line wires L, E; the picture to be transmitted—about two inches square—is projected upon the front surface of the cylinder by the lens *l*. The brass receiving cylinder R is of the same dimensions as T, and is similarly mounted; F is a platinum stylus, which is pressed vertically against the metal by the flat spring G; W is a variable resistance, and B_1, B_2 are batteries at the transmitting and receiving stations respectively. A piece of paper moistened with a solution of potassium iodide is wrapped round R, and, the pinhole H having first been brought to the brightest part of the focussed picture (thereby reducing the resistance of S to its minimum value), the resistance W is adjusted so that no current passes along the "bridge" C D, which, assuming the two batteries to be equal, will be the case when the resistance of W is the same as that of S. If now the Se cell is darkened, its resistance will be increased and a current will pass through the receiver in the direction C D, liberating iodine at the point of the stylus F.

To transmit a picture, the two cylinders are caused to rotate synchronously, at the same time moving from end to end of their traverses; in the course of

its spiral path the pinhole H covers successively every point of the focussed image, the illumination of the Se cell being proportional at any moment to the brightness of the spot occupied by the pinhole; the consequent variation in the resistance of the cell causes the stylus F to trace upon the paper a brown line which is lighter or darker in correspondence with the illumination of the Se. The close spiral line with breaks in its uniformity constitutes a picture, which should be a counterpart of that projected upon T. The earliest achievement of the apparatus consisted in the reproduction of the image of a hole cut in a piece of black paper; after some improvements simple black and white pictures painted upon glass were very perfectly transmitted, as was demonstrated upon several occasions when the apparatus was exhibited in operation.[1] It was, however, unable to cope with half-tones, and owing to pressure of work the experiments were shortly afterwards discontinued.

The problem of telegraphic photography has recently been attacked with conspicuous success by Prof. A. Korn, of Munich, whose work is described in a little book entitled "Elektrische Fernphotographie und Ähnliches" (Leipzig, 1907). His latest

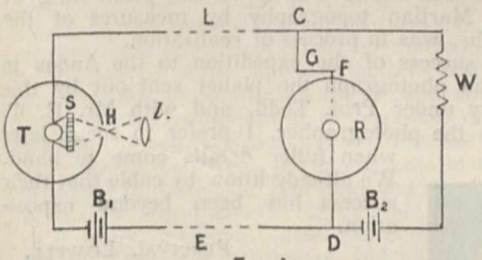


FIG. 1.

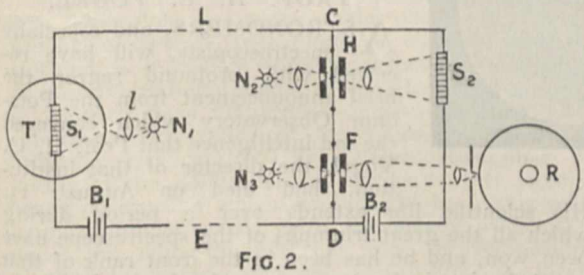


FIG. 2.

method is indicated in Fig. 2. The transmitting and receiving cylinders T, R turn synchronously on screwed axes, the regulating mechanism of the receiver is situated in the bridge C D, and a suitable resistance is placed at S_2. A celluloid film negative of the picture to be transmitted is wrapped round the cylinder T, which is made of glass. The light of a Nernst lamp N_1 is concentrated by a lens upon an element of the film, through which it passes more or less freely according to the translucency of the film at the spot, to the Se cell S_1, which is fixed in position, and does not, like mine, move with the cylinder; thus the resistance of the Se is varied in correspondence with the lights and shades of the picture. The receiving cylinder R is covered with a sensitised photographic film or paper, upon a point of which light from a lamp N_3 is concentrated. Before reaching the paper the light passes through perforations in two iron plates at F, which are, in fact, the pole-pieces of a strong electromagnet; between these is a shutter of aluminium leaf, which is attached to two parallel wires or thin strips forming the bridge C D. When there is no current through C D, the opening is covered by the shutter; when a current traverses the wires, they are depressed by electromagnetic action, carrying the shutter with them, and a quantity of light proportional to the strength of the current is admitted through the perforations. By means of this "light-relay," as it is termed, the intensity of the light acting at any moment upon the sensitised paper is made proportional to the illumination of the selenium in the transmitter.

It remains to mention a device of admirable ingenuity which has rendered it possible to transmit half-tones with fidelity. In its response to changes of illumination selenium exhibits a peculiar kind of sluggishness, to which reference was made in my old article: "Some alteration takes place almost instantaneously with a variation of the light, but for the greater part of the change an appreciable period of time is required." Prof. Korn has succeeded in eliminating the effects of the sluggish component by substituting for my box of resistance coils R a second


FIG. 3.

Se cell S_2, which is as nearly as possible similar to S_1, and which, by means of a second light-relay H, placed in series with the first, is subjected to similar changes of illumination. Thus any subpermanent fall in the resistance of S_1 due to the action of light is compensated by an equal fall in that of S_2, and only such changes as respond immediately to the varying illumination of S_1 are utilised for regulating the transmission current.

Such is in brief outline the nature of the new process. As regards the many carefully considered details which have made it a practical success, those interested will find ample information in the pamphlet mentioned above. The apparatus has been worked with excellent effect over long distances; a specimen of its performance, for which I am indebted to the kindness of Prof. Korn, is given in Fig. 3. The parallel lines traced by the point of concentrated light —in this case about 50 to the inch—are easily recognisable.

SHELFORD BIDWELL.

[1] Among others, at the Telegraph Engineers' *soirée* in 1881 (*see* NATURE, vol. xxiii., p. 563).

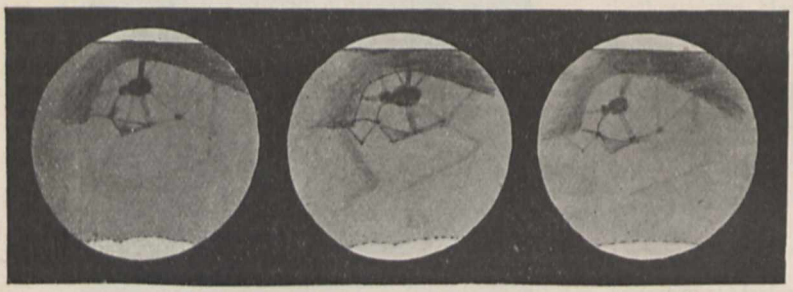
MARS IN 1907.

OBSERVATIONS AT THE LOWELL OBSERVATORY.

IN answer to the request of the editor of NATURE for an authoritative statement of the observations so far made here at this opposition, I have the honour to communicate two or three of the more important results obtained. They exceed what seemed likely, in view of the unfavourable declination of the planet, a position so southern as to render it practically unobservable in England, France, or the northern part of the United States.

The first of these relates to the polar caps. From the fact that the observations were begun in March, three months and a half before opposition, it was possible to catch both caps at an interesting phase of their careers—the southern one at its maximum, the northern at its minimum, extent. The moment was more propitious than has ever been the case before at the times at which the planet has been observed, because it was then upon an even keel as regards the earth, the equator lying nearly in the plane of sight. The southern cap at this epoch stretched across ninety-five degrees of latitude, counting from one side of it to the other; the northern only over eight.

From that date the dwindling of the southern cap and the making of the northern has been carefully watched to a complete confirmation of the curious manner in which the latter is formed, as witnessed here at the two previous oppositions.[1]



Photographs of Mars in 1907.

The next point has been the observed development of the canal system in the antarctic and south temperate zones. After the melting of the south polar cap had got well under way, canals began to make their appearance about it, running thence down the disc. These canals left its edge and joined the rest of the system in lower latitudes. Connected with such polar phenomena was the appearance of the most southern of the light regions of the planet, Thaumasia. This region, lying around the Solis Lacus, or Lake of the Sun, first showed symptoms of awaking activity. The Solis Lacus stood composed of two portions, a large oval patch on the east and a smaller round one to the west; from both of which canals ran into the dark areas. Now those on the south, such as the Ambrosia and the Bathys, were darker and more pronounced than those running north, the Tithonius, for example, which showed evidence of being in its dead or skeleton condition, while the former were in full tide of development. Meanwhile, the equatorial canals were steadily fading out. The process of evolution was in keeping with the method of development found here for the northern canals in 1903. The fact is of the nature of a prophecy fulfilled, and not only supports the previous observations, but proves the theory deduced from them to have been correct. It is a direct *sequitur* from this that the planet is at present the abode of intelligent, constructive life.

I may say in this connection that the theory of such life upon Mars was in no way an *a priori* hypothesis on my part, but the deduced outcome of observation, and that my observations since have fully confirmed it. No other supposition is consonant with all the facts observed here.

Another result of this opposition has been the success of the photographs taken of the planet. These have proved delineatory beyond expectation. The increased size of disc has enabled the method worked up by Mr. Lampland to be put into even more effective practice than at the last opposition. Plates have been taken by both Mr. Lampland and myself, and the amount of detail they show may be judged from the fact that I have already counted fifty-six canals on my plates, that the twin Gihon has been photographed double, and that such delicate markings as the Fons Juventae and the little canals leading to it appear unmistakably in the prints. Such grosser matters as the dwindling of the southern snow-cap show beautifully, and it looks as if a result in which Mr. Crommelin was much interested, the positioning of points of Martian topography by measures of the photographs, was in process of realisation.

Of the success of the expedition to the Andes to observe and photograph the planet sent out by this observatory under Prof. Todd, and with Mr. E. C. Slipher as the photographer, I prefer to speak later when fuller details come to hand. We already know by cable that their success has been beyond expectation.

PERCIVAL LOWELL.

[1] *See* Lowell Observatory Bulletin 30.

PROF. H. C. VOGEL.

ASTRONOMERS, and especially spectroscopists, will have received with profound regret the brief announcement from the Potsdam Observatory which conveyed the sad intelligence that Prof. H. C. Vogel, the director of that institution, had died on August 13. His scientific life extends over a period during which all the great triumphs of the spectroscope have been won, and he has been in the front rank of that energetic band of astronomers who have given new direction and increased interest to the science of astronomy. Hence to sketch his life would be to trace the history of spectroscopy from the time that Ångstrom published the map of the normal spectrum, or from that of the epoch-marking Indian eclipse, when the riddle of the chromosphere was first read; when the application of the Doppler principle was first applied to star spectra; or when cometary spectra were first studied. Men's minds were still excited over these novel pursuits, and the possibilities they suggested, when Vogel took charge of the Bothkamp Observatory and began that career of continued and successful observation which only terminated with his death. How much has been accomplished since will be appreciated if we recall the fact, that Vogel's earliest work gave us accurate information of the peculiarities of the planetary spectra, and showed the effect of solar rotation in displacing the Fraünhofer lines.

In 1874 came the foundation of the Potsdam Observatory, and Prof. Vogel was seen in a new light as the director of the first purely astrophysical observatory. The staff was small, and the instruments

were modest, but enthusiasm was great, and the outcome has been of the widest interest. One of the early fruits from this new observatory was the spectrum catalogue of 4051 stars, important, not only because it illustrated the manner in which large masses of work could be dealt with in the new institution, but for the extensive application of the method of classifying stellar spectra to which the name of Vogel is particularly attached. He early appreciated the probability that the phase of development of a particular star was in general mirrored in its spectrum, and that any rational classification of the stars could only be obtained by giving prominence to that central fact.

Another class of work which largely occupied Prof. Vogel's attention was his investigation by means of photography of the motions in the line of sight of all the brighter stars visible in Potsdam. If he was not the first to apply photography in this particular direction, he was certainly among the most successful. This success was due in a great measure to the fact that he recognised, more fully than was generally the case thirty years ago, the necessity of constructing an instrument to a definite end, of making it exclusively available for one particular object. The possession of the most suitable apparatus not only gave improved and consistent values for the motion of stars in the line of sight, but satisfactorily explained the cause of the variability of Algol and stars of that type. His determination of the elements of that spectroscopic binary is typical of an immense amount of work which Vogel effected in the case of many other binaries. In observing variable and temporary stars his energy found another large field for its display, but it is impossible to enter into details. His was a busy life with many interests, and he assisted science in various directions.

Although aided by able and zealous colleagues, he was responsible as director of the observatory for the conduct of several large pieces of work. It will be sufficient to refer here to his participation in the work of the International Chart of the Heavens, to which in its early days he devoted much attention. The rigorous determination of the magnitude of all the brighter stars in the *Bonn Durchmusterung* by means of the Zöllner photometer is another piece of heavy observation which he brought to a successful issue. Simultaneously with the steady progress of these and other inquiries has gone the remodelling of the observatory, and the substitution of larger and more powerful instruments for those which tended to grow obsolete. The mounting of the 80-centimetre refractor offers a proof of the care and foresight which he devoted to this part of his duties.

We believe that when the effect of Vogel's work is considered and judged, his capacity as a director must be fully and generously recognised. As guardian of a new institution for which there were no traditions to guide the future development, as a conductor of an untried experiment, uncertain in what direction progress might be anticipated, he has maintained the observatory at a uniformly high level, and produced a quantity of work of the most accurate character. This has been shown to some extent by his election into many learned societies, the members of which have appreciated his work and acknowledged his influence. He has left an example to be followed, and a reputation to be honoured. To his colleagues, some of whom have served with him many years, and who have suffered the loss of his experience and his kindly assistance, we offer our respectful sympathies.

W. E. P.

NOTES.

IT is announced in the *Electrician* that the "John Scott Legacy Medal and Premium" of the Franklin Institute has been awarded to Prof. J. A. Ewing, F.R.S., and Mr. L. H. Walter for their method of detecting electrical oscillations.

THE programme of proceedings of the forthcoming meeting (on September 23 and 24) of the Iron and Steel Institute in Vienna has now been issued; from it we learn that the following papers may be expected to be submitted:—on the development of the iron industry of Austria since 1882, by W. Kestranek; on the Styrian Erzberg iron-ore mines, by Prof. H. Bauerman; on steel and meteoric iron, by Prof. F. Berwerth; on the determination of the quantity of blast-furnace gas for a given make of pig iron, by Prof. Josef von Ehrenwerth; on the application of the laws of physical chemistry to the metallurgy of iron, by Baron H. von Jüptner; on case hardening of mild steel, by C. O. Bannister and J. W. Lambert; on a new blue-black paint as a protective covering for iron, by F. J. R. Carulla; on the hardening of steel, by L. Demozay; on the structure of hardened steel, by Percy Longmuir; on case hardening, by G. Shaw Scott; on the ageing of mild steel: further notes, by C. E. Stromeyer; and on the economical distribution of electric power from blast furnaces, by B. H. Thwaite.

PRINCE HENRY ZU SCHÖNAICH-CAROLATH has consented to act as president of the fourteenth International Congress for Hygiene and Demography, which is to take place in Berlin next month, and Dr. Rubner, Privy Councillor of Medicine and professor of hygiene at the Royal University of Berlin, and Prof. von Mayr, Under-Secretary of State, Munich, will be vice-presidents.

THE eleventh congress of Flemish naturalists will be held from September 21 to 23 at Malines under the presidency of Prof. C. de Bruyn, professor of botany and zoology in the University of Ghent. The secretary of the congress is Dr. de Bruycker, place du Grand-Canon, Ghent.

AN International Exhibition is to be held in Tokio from April 1 to October 15 of next year. The estimated cost is 2,000,000*l.*, towards which the Japanese Government has set aside 1,000,000*l.*

ACCORDING to a telegram in the *Times*, two sharp shocks of earthquake occurred at 4.32 of the afternoon of August 22 at Kingston, Jamaica.

PARTICULARS of the preparations in progress for the Wellman Polar Expedition are given in a Reuter message dated from Spitsbergen, July 25, from which we learn it was expected that the expedition would be ready to start for the far north by the middle of August. One of the many difficult pieces of work which had to be accomplished was the packing and making ready for the *America* of the two "serpents" which form an important part of the project. One of the serpents—a pipe of strong, water-tight leather, 6 inches in diameter and 123 feet long, its outside surface covered with more than 29,000 steel scales, each about as big as a silver quarter, very thin, and riveted to the leather, overlapping like the scales of a fish—has been designed to have the smallest possible resistance in sliding over the ice or snow, or floating on the water, in which element it is buoyant. The retarder serpent, on the other hand, is designed to make the

greatest possible resistance in proportion to its weight in dragging over the ice-floes, which are usually covered with a snow-crust and rarely present a smooth surface. The function of the retarder is to drag like a drag-anchor when the wind is adverse to the course and it is wished to drift gently with it, and without losing either too much headway or burning too much fuel in the motor. Hence this serpent is covered with 1875 steel scratchers, each with six sharp points about 1 inch in length, or a total of 11,250 points on the 75 feet of body. The equilibrer is intended always to have more or less of its length upon the surface of the earth; the retarder is to be let down to touch the earth only when necessary. Reserve supplies of food to the amount of 1438 lb. have been packed in the interior of the serpents.

THE Prince of Monaco has arrived at Tromsö on board the *Princess Alice*, having left the *Hjalmar*, the vessel conveying the Johansen expedition, at Kved Fjord about the middle of August. The *Hjalmar* left for Prince Charles Foreland, where it is the intention of Johansen to meet the Bruce expedition, and which will probably be the winter quarters of the explorers.

MR. W. F. DENNING writes to say that a rather fine meteor, presumably from the Draconid radiant, to which he referred in a letter in our last number, was seen at Bristol on August 26, 9h. 18m. The curious feature about the object was its fluctuation in brilliancy. At first nearly equal to Jupiter, it quickly dropped to about two magnitudes, and finally burst out with a lustre rivalling that of Sirius. Its path was from about 231°+57° to 213°+50°. As viewed from Wales, the meteor must have been very conspicuous and striking, and Mr. Denning will be glad of any descriptions of it.

THE secretary of the Kite Committee of the Royal Meteorological Society has written to the Press to say that, of the twenty-four meteorographs sent up in July last in connection with the international investigations of the upper air, only a few have been returned. He thinks it possible that some may have fallen among the standing corn and other crops, and so have not yet been seen. The secretary requests that a sharp look-out may be kept for the cylinders containing the meteorographs, and that if any be found they may be carefully handled and returned to the address given on the label or to himself at the Royal Meteorological Society. The next special series of ascents will take place from September 4 to 6 next.

WITH a view to supplying Paris with electric energy for its railways and lighting, three Paris engineers have drawn up a project for establishing an immense power station by barring the Rhône Valley, at Gresin, near Bellegarde. The enterprise has, says the *Engineer*, received the support of the French authorities. The estimated cost is 2,400,000*l*.

WE are sorry to learn from the annual report on the British Museum that there has been a falling off in the number of persons visiting the institution during the year 1906. The total number of visits paid to the museum at Bloomsbury was 691,950, showing a decrease of nearly 122,000 from the number in 1905. The Sunday total of 55,738 was less by 4369 than that of the previous year. Not since the year 1900, with its 689,249 visits, has the total been so low as that of the past year. The report upon the Natural History Museum also shows a decline in the number of visitors. In 1905, 566,313 visits were paid, and in 1906 only 472,557. The attendance on Sundays was, in 1906, 61,151, and in 1905 70,084. The gifts to the Natural History Museum in 1906 numbered 2057, against 2092 in 1905; the principal donors were the Government of India (collections of Tibetan insects), the Duke of Bedford (zoological specimens from Japan and Korea), Mr. C. D. Rudd (specimens in continuation of his systematic survey of South African fauna), and Mr. W. E. Balston (natural history specimens from Western Australia).

PROF. F. A. FOREL has favoured us with a note of a very unusual shifting of the wind observed by him during a storm at Morges (north of Lake of Geneva) on August 15. At 6h. p.m. the wind, which was blowing strongly from S.W., veered during a succession of violent squalls to N.W., N.E., and S.E., back again to S.W. by 10h. p.m., making a complete gyration in four hours. The weather in north-west Europe was very unsettled; a cyclonic disturbance which had passed across England lay over the Skager Rack at 6h. p.m., and a heavy thunderstorm was in progress at Berlin. Prof. Forel thinks that the sudden changes of wind could only have been caused by thunderstorms which occurred in various quarters in the vicinity of Morges. The barometer, which previously had been slowly falling, rose 0·2 inch between 6h. and 10h. p.m.

IN an editorial article in *Symons's Meteorological Magazine* for August, objection is taken to the way in which meteorological papers are dealt with at the British Association meetings. Several papers this year were of special interest, *e.g.* examples of modern methods of treating observations, by W. P. Elderton, and recent developments of the methods of forecasting by means of synoptic charts, by Dr. W. N. Shaw, but they were sandwiched with papers on astronomy and other subjects with which meteorologists were not particularly concerned. The difficulties in the way of hearing and discussing the papers were aggravated this year owing to the bewildering acoustic properties of the hall, and Dr. Shaw's paper was cut cruelly short owing to want of compression in the case of a previous astronomical paper. The writer of the article considers that unless at least a subsection is devoted to the subject in future, it will not be worth while for meteorologists to contribute papers to the British Association.

IN the same magazine Colonel Bentley refers to a very severe thunderstorm which occurred in County Clare on July 22. On the east of the Kilbane Mountains, near Killaloe, gaps of 10 feet and one of 30 feet deep were made in the road, and five large stone bridges and one wooden bridge were carried away by the floods in a district three miles long and one mile wide. During the storm hail fell in large rugged lumps, and the damage to property is estimated at 6000*l*.

FROM the annual report of the principal chemist on the work of the Government Laboratory, we learn that during the past year there has been a notable increase in the number of samples analysed in the two branches of the laboratory (Customs and Inland Revenue). The total number of analyses and examinations made was 173,606, against 158,939 for the previous year, the increase being mainly in respect of tobacco examined under the various fiscal regulations. Among other points of interest, we note that manufacturers appear fully to appreciate the advantages of the new or "industrial" variety of methylated spirit, which, by reason of its lower price and greater purity compared with that formerly used, is ex-

pected to find increasing employment in manufacturing operations. The use of pure duty-free ethyl and methyl alcohols in the science laboratories of universities and colleges is also extending, 4017 proof gallons having been utilised last year against 2277 in 1905. In addition, 3783 bulk gallons of the denatured (industrial) alcohol were used for ordinary teaching purposes. For departments other than the revenue branches some 7000 samples were analysed. To check the importation of adulterated butter, legal proceedings were instituted in a number of cases, and it is satisfactory to learn that, as a result, there has been a great improvement in the character of the butter emanating from certain parts of the Continent. An interesting examination of dog-fish eggs was made for the Board of Agriculture and Fisheries in connection with the depredations committed by these fish along the coasts of Devonshire and Cornwall. With the view of ascertaining their economic possibilities, the eggs were analysed, and found to contain about one-fourth of their weight of protein and the same quantity of fat, or about twice as much of the two substances together as is found in an ordinary hen's egg. It is remarked that, apart from the question of using the eggs for food—as to which there is an obstacle in their fishy odour—the utilisation of the protein matter and oil would be quite feasible if some enterprise were shown in obtaining a regular and sufficient supply of the eggs.

REFERRING to a note published in NATURE (this vol., p. 280) on the recent series of determinations of fundamental atomic weights by Prof. Richards and his colleagues, Prof. Bohuslav Brauner, of Prague, writes to say that he considers that there can be no doubt as to the correctness of the recently advocated low value of the atomic weight of nitrogen (14·01); the physico-chemical researches of Leduc, D. Berthelot, Lord Rayleigh, Guye, and Gray, as well as those of Scott in 1901, all tend to show that the atomic weight of nitrogen does not exceed 14·009. Prof. Brauner refers to a paper which he read before the Bunsen Gesellschaft in May (reprinted in the *Chemiker Zeitung*, No. 38) for a full discussion of the question, and to his article on the atomic weight of nitrogen in Abegg's "Handbuch der anorganischen Chemie." The new value for the atomic weight of nitrogen has the advantage that it is directly related to the atomic weight standard O=16, whereas that of silver is related very indirectly and only by imperfectly determined ratios to the oxygen standard. The recent work of Guye would indicate that potassium chlorate always contains potassium chloride, the quantity of the latter being sufficient to reduce the atomic weight of silver from 107·93, as found by Stas, to 107·89. Prof. Brauner considers that the results of Prof. T. W. Richards should be stated as follows:—"The atomic weight of nitrogen cannot be higher than 14·10 and lower than 14·08, and so the atomic weight of silver must lie between Ag=107·880 and 107·883. The atomic weight of sulphur cannot be higher than S=32·069, and therefore the atomic weight of silver cannot be higher than Ag=107·88."

A REPORT by Dr. Leslie Mackenzie on the teaching of school and personal hygiene to students in training as teachers in Scotland has been issued by the Scotch Education Department. The object of the course of instruction which has been instituted is to assist the teacher in discovering such gross mental or physical defects as may unfit, or tend to unfit, the child for school work. The methods of instruction include lectures and demonstrations on elementary anatomy, physiology, and hygiene, and visitation of schools with inspection of classes and premises. Among other matters, the place of the subject in the curriculum, the relation of the course to medical inspection, and tests of proficiency are discussed, and selected illustrations of the work done in various training colleges are given. The Department has also issued a memorandum on systems of physical training, viz. military drill and physiological and hygienic exercises, and their relation to the personal hygiene of school life. The special education of the teacher for this is insisted upon, and it is recommended that a medical officer ought to be in charge of this branch at every training centre.

THE annual report of the British Consul at Dakar gives particulars of the steps which are being taken by the French Government in French West Africa to safeguard and develop the rubber resources of the country. A special survey is being made of the chief rubber-producing districts, and when the investigations have been completed the worst districts will be closed to rubber collection so that the plants may have time to recuperate. It is expected that a beginning in this direction will be made in 1908. For the purpose of stocking plantations with rubber-producing trees, a credit of 3200*l.* has been provided for the present year, with which sum it is expected that from 300,000 to 400,000 trees will be planted, in addition to nursery plantations for succeeding years. The intention is to set apart from 4800*l.* to 6000*l.* each year for this purpose, and to plant on an average 500,000 trees every year.

ACCORDING to the *Agricultural News* of Barbados, a plant has been discovered in Portuguese West Africa possessing a fleshy, tuberous, turnip-shaped root, the entire substance of which is permeated with laticiferous ducts, that yield a supply of rubber latex. The plant belongs to the natural order Asclepiadaceæ. Rubber has been obtained from the tubers by slicing them, applying pressure, and coagulating with alcohol. Tubers two years old weighed nearly 1½ lb., and yielded rubber of half of 1 per cent. of the total weight. It is estimated that more than 180 lb. of rubber per acre can be produced at the end of two years.

AMONG the various subjects dealt with in the Journal of the Royal Horticultural Society, vol. xxxii., an article by Mr. M. H. F. Sutton furnishes practical directions on the formation and care of lawns and golf greens. The author attributes great value to manuring the soil when laying out a lawn. In connection with the choice of seeds, a list of grass seeds is given, also the use of clover is discussed and its disadvantage for tennis lawns or putting greens is explained. Growers of campanulas will find a useful list of species and synonyms prepared by Colonel R. H. Beddome. A method of checking black-currant gall mites by the application of grease is described by Mr. Massee. The substance of a lecture by Sir George Watt on the cultivation and manufacture of tea is published, also an account of the West Indian lime by Mr. A. J. Brooks, and a description by Mr. J. C. Umney of the source and extraction of perfumes.

WITH regard to the flowering of bamboos, it has been noted that this takes place only after a period of years, that some species show sporadic or partial flowering, while the flowering of others is simultaneous or complete, and is always or nearly always followed by the death of the plant. Mr. W. J. Bean has collated in the *Kew Bulletin* (No. 6) some data regarding species that have flowered under cultivation within the last thirty years.

Arundinaria Falconeri flowered sporadically in localities in England and India in 1876, and partial flowering occurred in other localities in 1875 and 1877. Another partial flowering has been proceeding for the last three years; the author suggests that the present more protracted period may be due to cultivation. *Arundinaria Simoni*, after partial flowering for some years, flowered completely in 1904–5, and then the plants died off. Most of the varieties of *Phyllostachys nigra* have also succumbed to the efforts attending complete flowering.

To the popular series of garden pamphlets issued by the Agricultural and Horticultural Association has been added one by Mr. S. Arnott on hardy garden bulbs and how to grow them. The precise notes on planting details will be found useful, as also the selection of hardy and choice species. Another pamphlet, on the weather, by Hon. H. A. Stanhope, the president of the association, is not of such direct interest, but contains a number of facts that the weather-wise—and with good reason many gardeners have such a reputation—should know.

TEACHERS of geology and travellers in India will alike welcome Mr. Vredenburg's pamphlet of seventy pages, entitled "A Summary of the Geology of India" (Calcutta: Thacker, Spink and Co., 1907). It is a summary that is full of information, and yet it is both readable and attractive. The most recent work of the Geological Survey of India is included, as may be seen from the account of the Cretaceous Deccan Trap and the references to Burma and Baluchistan. The recession of the sea at the close of Cretaceous times is regarded as a "universal" phenomenon, while the "Glacial period" is spoken of lightly, as resulting in a "temporary glaciation of high latitudes." In both these statements we note a little more dogma than is prudent in an abstract, where discussion is impossible. Mr. Vredenburg is, however, no mere abstractor of the work of others, but an observer and a discoverer, whose personality adds weight to the present lucid summary.

A NEW gem is reported to have been discovered in San Benito County, California. It is described as a clear, transparent, blue stone with violet tints in the deeper-coloured portion, and to be about as hard as chrysolite and harder than moonstone or opal. Under heat it turns a bright red, but on cooling it resumes its normal colour. It has been given the name of Benito, from the county in which it was found.

A LARGE and remarkable cave was, according to the *Scientific American*, recently discovered in the Santa Susanna Mountains, some fifty miles from Los Angeles, California, U.S.A. The cave contains many halls, some of very large extent, and the walls of one are covered with rude drawings, some of which are almost obliterated, but others are quite clear. The drawings, says our contemporary, represent incidents of the chase, showing Indians on foot pursuing bear, deer, and other animals. One wall-drawing shows the bear pursuing the hunter. The work is executed by soft red stone.

THE connection between radium and the safe working of collieries does not at first sight appear to be a very intimate one, but the discovery announced by Profs. Elster and Geitel in *Die Welt der Technik*, that fire-damp contains six or seven times the amount of radium emanation that is generally found in the air of coal mines, brings the two into close relation with each other. Comparative tests of the electrical conductivity of the air due to the presence of the emanation can readily be made by means of a simple aluminium foil electroscope, and as only a comparatively small sample of the gas is necessary, the tests may be carried out outside the mine. It will be interesting to see the electroscope become part of the normal equipment of a colliery.

IN the July number of the *Bulletin de la Société d'Encouragement pour l'Industrie nationale*, M. O. de Faria gives a description and an account of the tests of his alternating electric current rectifier. The electrodes are of aluminium and an alloy of lead and antimony respectively, and the electrolyte a solution of phosphate of soda. The cell is so arranged that during working a rapid circulation of the electrolyte is maintained. In one of the tests of which details are given a rectifier intended for 10 amperes was run for five hours at 15 amperes on a 100-volt circuit, and showed an efficiency of 66 per cent. with a final temperature of 47° C. The efficiency appears to be independent of the temperature of the cell.

THE origin and relationships of the so-called Atlantic animals and plants of western Norway are discussed at considerable length by Dr. L. Stejneger in vol. xlviii., part iv., of Smithsonian Miscellaneous Collections. The mammals include the west Norwegian red deer (which the author regards as inseparable from the Scottish representative of the species, although markedly distinct from the Swedish race), the so-called Celtic horse or pony, the reindeer, lemming, and Arctic fox. It is concluded that if the more characteristic types of this "Atlantic biota" came from Scotland, they travelled by way of a land-bridge connecting that country with western Norway to the northward of lat. 59°. This bridge existed subsequent to the first great (Scandinavian) glaciation, and this portion of the "biota" certainly survived the second glaciation. The red deer and Arctic animals reached Scotland from Central Europe, whence they migrated first into Ireland and then into Scotland. Reindeer, on the other hand, appear to have reached Scandinavia by several routes, one stock having probably entered Sweden from the south and a second from the north-east *via* Finland and Russia, while the Norwegian stock arrived from the west. If well founded, these conclusions absolutely cut away the ground from Dr. Scharff's theory that reindeer reached Europe from Greenland, a theory controverted by several other considerations.

IN a paper on the birds of Labrador, forming No. 7 of vol. xxxiii. of the Proceedings of the Boston Society of Natural History, Messrs. C. W. Townsend and G. M. Allen take occasion to refer to the appalling destruction of birds and their eggs which is still allowed to go on in Newfoundland, Labrador. The fishermen, who use single-barrel, muzzle-loading guns, make no secret of the fact that they take every bird and egg upon which they can lay hands. If efficient means of protection are not promptly put in force, the authors are of opinion that the bird-nurseries of the district will become things of the past.

HAVING observed sand-martins in Hampshire during the winter—November to January—Mr. H. Beeston, in the July number of the *Zoologist*, confesses himself unable to explain where these birds passed the nights during the period in question. As there appear to be no sand-banks in the district where the observations were made, it seems impossible for the birds to follow their usual practice of sleeping in their nesting-burrows.

IN the *Entomologists' Monthly Magazine* for August, the attention of collectors is directed to the possibility that the south European wingless earwig (*Forficula decipiens*) may be indigenous to England, since two earwigs with aborted wings recently taken in the Isle of Wight appear indistinguishable from that species.

AN elaborate cloth-bound illustrated catalogue (in English) of the physical apparatus made by the firm of E. Leybold's Nachfolger, of Cologne, has been sent to us. It contains full descriptions of many pieces of apparatus, with instructions for use, and should be seen by all science teachers.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN SEPTEMBER :—

Sept. 3. 8h. Mercury and Venus in conjunction. Mercury 0° 26′ N.
4. Daniel's comet in perihelion.
12. 11h. 15m. Minimum of Algol (β Persei).
14. 13h. Venus in superior conjunction with Sun.
15. 8h. 4m. Minimum of Algol (β Persei).
,, 14h. 1m. Transit (egress) of Jupiter's Sat. III. (Ganymede).
16. 11h. 13m. Mars in conjunction with Moon. (Mars 4° 27′ S.).
17. 14h. Saturn in opposition to the Sun.
21. 7h. 10m. to 7h. 59m. Moon occults 30 Piscium (mag. 4·7).
,, 9h. 4m. to 9h. 37m. Moon occults 33 Piscium (mag. 4·6).
22. 14h. 42m. to 18h. 20m. Transit of Jupiter's Sat. III. (Ganymede).
23. 18h. Sun enters Libra. Autumn commences.
24. 12h. 51m. to 13h. 46m. Moon occults μ Ceti (mag. 4·4).
,, 18h. 1m. Transit (ingress) of Jupiter's Sat. IV. (Callisto).
26. 11h. 57m. to 12h. 59m. Moon occults δ^2 Tauri (mag. 4·7).
29. 18h. 58m. Transit (ingress) of Jupiter's Sat. III. (Ganymede).

DANIEL'S COMET (1907*d*).—The following is an extract from the continuation of Dr. Stromgren's ephemeris for comet 1907*d* as published in No. 4196 of the *Astronomische Nachrichten* (p. 337, August 23).—

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

1907	α (true) h. m.	δ (true) ° ′	log r	log Δ	Brightness
Sept. 1	8 50·8	+13 34·6	9·7144	0·0534	19·1
,, 3	9 4·0	+12 59·3			
,, 5	9 16·8	+12 22·6	9·7123	0·0847	16·7
,, 7	9 29·4	+11 44·6			
,, 9	9 41·5	+11 5·7	9·7250	0·1139	13·7

An observation at Padua on August 18 gave corrections of +30s. and −0′·7 to this ephemeris.

On September 1 the comet will be 81′·5 N. of α Cancri, whilst on September 8 it will be 66′·4 N. of *o* Leonis.

The comet will rise about 2¼ hours before the sun on September 1, and about two hours before the sun on September 9.

FURTHER OBSERVATIONS OF MARS.—The August number of the *Bulletin de la Société astronomique de France* contains an interesting paper by M. Jarry-Desloges giving the results of observations of Mars made during July last at a temporary observatory erected on the summit of the Revard at an altitude of 1550 metres.

M. Jarry-Desloges and his collaborator, M. G. Fournier, confirmed the doubling of the Solis Lacus announced by Mr. Lowell. They also comment upon the cloudy appearance of the Martian landscape in the northern hemisphere as compared with the clear-cut features of the southern hemisphere of the planet.

The faint canals were difficult to observe, but the Ganges was seen to be very broad and appeared double, the two points where it emerges from the Auroræ Sinus being seen quite sharply; the observer states, however, that this observation needs confirming.

On July 19 the region north of Lacus Niliacus was clear, but twenty hours later, on July 20, details of white spots could be seen; thus it appears that in less than twenty hours the clouds or mists which covered this part of the planet vanished.

A SUSPECTED, LARGE PROPER MOTION.—Having occasion to measure the places of three B.D. stars (B.D. +1°·2720, +1°·2722, and +0°·2957) on his star photographs, Prof. Barnard found that the positions determined by him for two of the stars differed considerably from the B.D. positions. That of 1°·2720 is unusually discordant with the B.D., though the difference may be due to an error in the latter; but in the case of 0°·2957 the difference between Prof. Barnard's position and that determined at Bonn amounts to nearly a second of time. Therefore, if the observations are correct, the star B.D. +0°·2957 must have a considerable proper motion (*Astronomische Nachrichten*, No. 4195, p. 313, August 7).

THE ASTROGRAPHIC CHART.—From No. 386 of the *Observatory* (p. 329, August) we learn that the Potsdam Observatory does not intend to take and distribute the long-exposure photographs (chart plates) of the zone (+32° to +39°) allotted to it. The work will be done at the Royal Observatory of Belgium, which is being reorganised on a somewhat liberal scale.

THE SIMULTANEOUS INVISIBILITY OF JUPITER'S SATELLITES.—On March 7 we referred in these columns to the simultaneous invisibility of Jupiter's four major satellites on October 3 next. In the August number of the *Bulletin de la Société astronomique de France* (p. 356) M. Flammarion gives fuller details of the phenomenon, and shows, by means of a diagram, the disposition of the four satellites, in regard to Jupiter, between the hours of 19h. 56m. and 20h. 6m. on the date named. As Jupiter does not rise until after midnight, European observers will not be able to watch this unusual spectacle; it will, however, be visible in Asia and Oceania.

The first observation of this phenomenon was made by Galileo on March 15, 1611, and only on eight occasions since then has it been observed.

LATITUDE-VARIATION AND LONGITUDE DETERMINATIONS.—Part i., vol. ix., of the *Annalen der Sternwarte in Leiden* contains accounts of a series of latitude-variation observations made by Father J. W. J. A. Stein during the period June, 1899, to July, 1900, and of a determination of the difference of longitude between Leyden and Ubagsberg made by the director of Leyden Observatory, Dr. H. G. van de Sande Bakhuyzen, and M. J. H. Wilterdink.

Father Stein employed the Horrebow method, making 1590 observations on 117 nights. He discusses the observations, the instrument, and the reductions at some length.

Ubagsberg is a geodetic station situated in the province of Limbourg, between Maastricht and Aix-la-Chapelle, and is an important point from the fact of its having been made a station in three distinct triangulations. The difference of longitude between the geodetic pillar at Ubagsberg and the meridian circle at Leyden was found to be +5m. 52·314s. ±0·015s.

THE COLOURS AND SPECTRA OF STARS.—A paper by Mr. W. S. Franks, appearing in No. 8, vol. lxvii., of the Monthly Notices (R.A.S.), discusses the relation between the colours and spectra of star classes.

He tabulates 1360 stars under colour, as observed by members of the B.A.A., and spectra as given in the Harvard publications, and finds, in general, a very close connection between the two features. Of 282 helium stars, 125 belong to the white or O colour class, whilst 168 of the 377 hydrogen stars come under the same heading. On the other hand, 210 of the 241 solar stars come under the colours between Y^2 and Y^3.

Whilst making the investigation Mr. Franks was impressed by the marked affinity of helium and bright-line stars (types B and O) with the galaxy. All the bright-line spectra met with were in or near the Milky Way, and when one remembers that the Wolf-Rayet stars, all the Novæ, and the majority of short-period variables are also galactical, it is obvious that the Milky Way is, in some way yet undetermined, probably the seat of cosmical actions of primary importance.

THE BRITISH ASSOCIATION.

SECTION D.

ZOOLOGY.

OPENING ADDRESS BY WILLIAM E. HOYLE, M.A., D.Sc., PRESIDENT OF THE SECTION.

(*Abridged.*)

THE impression left upon my mind by a score of Presidential Addresses to this Section, which it has been my privilege to hear, is that the speaker who treats of the subject matter of his own researches has the best prospect of making his remarks interesting and profitable to his audience. It is, therefore, in no spirit of egotism that I invite your attention this morning to the small and economically unimportant group of the Cephalopoda.

Some of my predecessors have been men who walked, so to speak, on the heights; who undertook the culture, or at all events the surveillance, of large domains. The extensive views and broad principles which they have thus been able to lay before the Section have been such as at once to compel the attention of all who are interested in any department of biology, or indeed of any branch of science at all. My own case has been far different; the plot I have tried to cultivate has been a very small one, and I have had but little leisure to peep over the fence and see what my neighbours were doing. I come before you, therefore, as a specialist, and not only so, but as that most humble kind of specialist—a systematist (a "mere systematist" is, I believe, the common phrase)—one whose main work has been the discrimination and definition of genera and species. I feel that some apology is necessary in asking zoologists of all departments to step for an hour into my particular allotment and see what has been going on there during the last few decades.

Before inviting you to enter, however, I should like to plead that even the systematist has his uses; for, properly considered, what is the systematic arrangement of any group of animals but the condensed formal expression of our present knowledge regarding its morphology, ontogeny, and phylogeny? Furthermore, how could the varied and complex problems of geographical distribution be attacked without the materials prepared by the systematist?

Having said this much by way of apology and defence, let me invite you without further prelude to consider two or three questions suggested by the study of the Cephalopoda.

Just half a century ago (August 1, 1857), there appeared in the *Annals and Magazine of Natural History* the translation of a paper by the late Prof. Steenstrup, of Copenhagen, which has ever since been regarded as marking an epoch in our knowledge of the Cephalopoda. The consideration of the scope and significance of this memoir may profitably engage our attention for a short time. In researches which were then comparatively recent, Vérany and Vogt and Heinrich Müller had shown that, in the genera *Tremoctopus* and *Argonauta*, the hectocotylus, a supposed parasitic worm which had been found in the mantle-cavity of the female, was in reality one of the arms of the male which had become detached and found its way thither, bearing with it the fertilising element—a procedure quite unique, not only among the Cephalopoda, but also among the Mollusca, if not in the whole animal kingdom. The gist of Steenstrup's discovery was that, although the separation of an arm was peculiar to very few forms, the modification of one or other of the arms for reproductive purposes was of common occurrence among the Cephalopoda; and, furthermore, that the situation of the particular arm, which was so modified, varied with the systematic position of the genus in question, and was constant through the main divisions of the class. To this less extensive modification of the arm he gave the name "hectocotylisation."

Stimulated by this discovery, other zoologists examined the Cephalopoda in their possession, and described the modifications in various genera, and now it is universally recognised that no definition of the Cephalopod is complete which does not include a description of the position and form of the hectocotylised arm. The descriptive anatomy of this organ is fairly well known. Out of twenty-two families, which may be regarded as well established, its structure is known in a number of genera in no fewer than twelve, whilst of the remaining ten it has been more or less conclusively shown that in seven no modification of the arm takes place, so that there are only three families in which we are still without any information regarding it.

Our knowledge of the physiology of the apparatus has not, however, advanced with anything like the same rapidity. Even in the case of those forms where a true hectocotylus is found (*Argonauta, Tremoctopus,* and *Ocythoë*) it is not known for certain whether the fertilising arm is deposited by the male in the mantle-cavity of the female (as I think is most probable), or whether (as is stated by some writers) the arm breaks off when mature and finds its own way to its destination. This much is certain, that for some time after its detachment it possesses the power of independent movement.

As regards the function of the modified but not detachable arm, we have the important and interesting observations of Racovitza made at Roscoff and Banyuls on the genera *Polypus* (*Octopus*) and *Sepiola*. It appears that in the first of these forms the extremity of the hectocotylised arm of the male is introduced into the mantle-cavity of the female, both individuals resting on the sea-bottom and at some distance from each other (about 25 cm. in the case of a male measuring 1·25 m. in total length). Although after an encounter the female appeared to flee the embraces of the male, and although the males, when two were placed in the same tank, fought with each other, there was no sign of any combat between the sexes as was described by Kollmann. In *Sepiola* the female is roughly seized by the male, and held with the ventral surface uppermost; the two dorsal arms are introduced into the mantle-cavity, whilst the other three pairs hold the female firmly. The efforts of the male are directed to keeping the female from attaching herself to any firm support. It would appear that the introduction of the arms of the male into the mantle-cavity interferes with the respiration of the female, and that she makes desperate efforts to escape as soon as she can attach herself to any neighbouring object. In this respect there is a marked contrast between the behaviour of these two genera, and it is greatly to be desired that observations should be made on other forms, but the difficulties in the way of this have hitherto proved insuperable.

Although, as we have seen, but little is known of the actual working of the hectocotylised arm, there are differences in the structures set apart in the female for the reception of the spermatophores, which correspond with the different arrangements of the hectocotylus in the male. For example, in *Polypus* (*Octopus*) the spermatophores are deposited in the termination of the oviduct; in *Rossia* there is a large plicated area surrounding the mouth of the oviduct for their reception; whilst in the nearly related *Sepiola* there is a pouch-like depression of the integument lying beside the mouth of the oviduct for the same purpose (von Maehrenthal). In *Sepia, Loligo,* and the other Myopsids in which the ventral arms are hectocotylised the spermatophores are received upon a specially modified area lying just to the ventral side of the mouth.

From this all too brief sketch of the function of these organs we may now return to the question of the systematic value of the modified arm of the male. Prof. Steenstrup was firmly convinced of the paramount importance of the hectocotylisation as a classificatory character, and he seemed to cling to this belief almost with the ardour of a devotee for a religious principle. In 1881 he published a memoir in which a new classification of the genera *Sepia, Loligo, Rossia,* and some other forms was propounded, based avowedly on the position of the hectocotylised arm; and when this scheme was attacked by the late Dr. Brock of Göttingen, he defended it vigorously in a further communication, placing at its head the following thesis, much in the same spirit as Luther nailed his famous theses to the church door at Wittenberg: "Hectocotylatio bene observata et rite considerata divisionibus naturae semper congruit; incongrua divisionibus, eas arbitrarias et factitias esse indicat."

Steenstrup further explains that the point of most conse-

quence is which pair of arms is affected by the hectocotylisation, whether the first, third, or fourth pair; next in importance comes the nature of the modification; while the question whether the right or left arm is affected is quite insignificant. It will be our business to consider how far the Danish naturalist's position is justified in the light of our present knowledge.

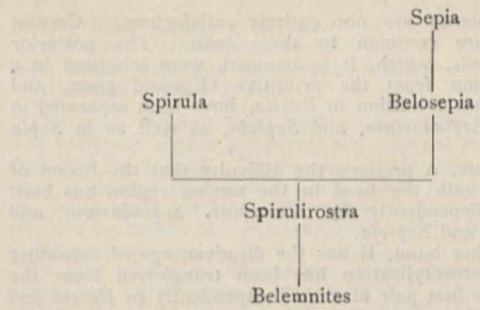
An inspection of the facts known up to the present time shows, first of all, that where hectocotylisation is known to take place it affects either the first, third, or fourth pair of arms; no instance is yet known where the second pair is modified, except in subsidiary relation to another pair, or in one or two rather doubtful cases in which all the arms are said to be modified. It appears, furthermore, that hectocotylisation of the third pair is confined to the Octopoda, while the first and fourth pairs are affected in the Decapoda, so that, as far as the main divisions of the Dibranchiata are concerned, the position of the hectocotylus is a correct index to them. We may, however, go a step further still, and point out that in every family, with one exception, the position of the hectocotylised arm is constant within the limits of the family, so that there is a very strong *prima facie* case for the truth of Professor Steenstrup's dictum. The difficulty arises when we come to consider the family Sepiolidæ and its allies, and endeavour to form an idea of their relationships to each other.

Steenstrup was so convinced of the truth of his thesis that he divided the Myopsida into two main divisions according to whether hectocotylisation affected the first or fourth pair of arms, and placed the four genera *Sepiadarium*, *Sepioloidea*, and *Idiosepius* (notwithstanding their *Sepiola*-like form) with *Spirula*, apart from *Sepiola* and *Rossia*, and along with *Sepia* and *Loligo*. It becomes necessary now to inquire how far this classification is justified by what we know of the morphology of the forms concerned.

It will be convenient to deal in the first place with *Spirula*, which has always been of great interest on account of the unique structure and position of its shell. It still belongs to the greatest of zoological varieties, only a dozen specimens with the soft parts having been obtained, of which one alone proved to be a male. This was examined by Sir Richard Owen, who described the hectocotylisation as affecting both the ventral arms, which are much enlarged, exceeding the others both in length and thickness: they are quadrangular in section, devoid of suckers, and the right is much larger than the left. The other arms appear to have a round truncated extremity which may be a secondary modification. The relationships of *Spirula* have recently been made the subject of inquiry by Prof. Paul Pelseneer, who completed the memoir in the *Challenger* reports begun by Prof. Huxley, and by Dr. Einar Lönnberg of Stockholm, who dissected a specimen obtained for him from Madeira by the late Captain Eckman. These two investigators arrived at different conclusions regarding its systematic position.

Pelseneer regards it as an Œgopsid, Lönnberg as a Myopsid, but the anatomical characters on which they are agreed are enough to show that, at any rate, these two forms cannot be so closely related to each other as to belong to the same sub-family, or even family.

With regard to the question at issue between them as to the Œgopsid or Myopsid nature of *Spirula*, I think, on the whole, that its resemblance is to the former rather than to the latter; but I believe that the branch of the ancestral tree which terminates in *Spirula* was given off from the main Cephalopod stem before the Œgopsida and Myopsida, as we now know them, had been separately evolved. Palæontology reveals a possible descent of *Spirula* from a Belemnitoid through such an intermediate form as *Spirulirostra*; and from this, on the other hand, it is easy to conceive of the descent of *Sepia* through a form resembling *Belosepia*. Such a relation could be expressed by the following diagram, which is, however, only a rough illustration of possibilities, for *Spirulirostra* is a Miocene form and *Belosepia* an Eocene, so that the former could hardly be the ancestor of the latter. It is only contended that these forms indicate a possible line of descent.



Unfortunately, in the present state of our knowledge, it is impossible to correlate the above diagram with one based upon the study of the soft parts of recent forms. It is sufficient if they do not contradict each other. We know nothing of the soft parts of the fossils, and there is no recent form, which exhibits shell characters, bridging over the gulf between *Sepia* and *Spirula*. To sum up, *Spirula* must be regarded as, at all events, the representative of a distinct family: it is not unlikely that it may one day become the type of a division coequal with Myopsida and Œgopsida, and it does not appear to me that the structure of its hectocotylised arms would be any argument against such a view.

We may now consider the genera *Idiosepius*, *Sepiadarium*, and *Sepioloidea*, regarding which there can be no doubt that on morphological grounds these three genera are more nearly allied to the Sepiolidæ than to the Sepiidæ or Loliginidæ; in fact, practically the only character of any importance which points in the opposite direction is the hectocotylisation. This portion of the subject has been very fully and clearly handled by Dr. Appellöf of Bergen, and to his memoir I refer those who desire more detailed information. We have here, then, a case in which forms the ventral arms of which are hectocotylised are more nearly related to forms with dorsal hectocotylisation than to others with ventral, and this shows that the position of the modified arm (or arms) is not by itself an infallible guide to systematic affinity. It is a striking instance of an aphorism of the late Prof. Rolleston, that "no single character can be regarded as a safe basis for a natural classification until it has been proved to be so."

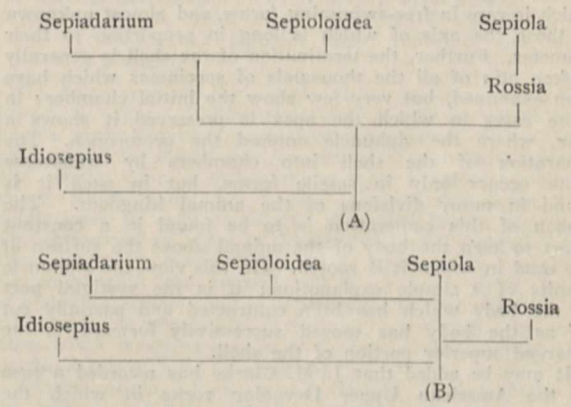
It may, however, be worth while to look a little further into the relationships of these forms, and to see whether the hectocotylisation of the dorsal arms is quite as sporadic and irregular as it at first appears.

After the separation of *Idiosepius* two possibilities present themselves as to the further evolution of this group.

A. The main stem divided into two branches leading to *Rossia* and *Sepiola* on the one hand, and to *Sepiadarium* and *Sepioloidea* on the other.

B. The stem gave off first a branch leading to *Rossia*, and subsequently divided into two, one leading to *Sepiola* and the other to *Sepiadarium* and *Sepioloidea*.

These two alternatives may be expressed graphically thus:



These schemes are not entirely satisfactory. Certain difficulties are common to them both. The posterior salivary glands, which, it is assumed, were inherited in a fused condition from the primitive Œgopsid stem, and remain in that condition in *Rossia*, have been separated in *Idiosepius*, *Sepiadarium*, and *Sepiola*, as well as in *Sepia* and *Loligo*.

Furthermore, A presents the difficulty that the fusion of the mantle with the head in the nuchal region has been acquired independently by *Idiosepius*, *Sepiadarium* and *Sepioloidea*, and *Sepiola*.

On the other hand, B has the disadvantage of assuming that the hectocotylisation has been transferred from the fourth to the first pair of arms independently in *Rossia* and *Sepiola*.

If, as I believe to be the case, scheme A is admitted to offer the lesser of the two difficulties, it has the advantage of indicating that the hectocotylisation of the ventral arms has been directly inherited from the main stem common to Myopsids and Œgopsids, and has only been transferred to the dorsal arms in the branch common to *Rossia* and *Sepiola*.

Hence we reach the conclusion that, although the variations in the structure and position of the hectocotylus follow pretty closely the systematic divisions of the Dibranchiata, we are not justified in maintaining that the position of the hectocotylised arm is by itself a sufficient guide to the systematic position of a doubtful form; it is only one of many characters that must be taken into consideration.

The subject of fossil Cephalopoda has not formed any part of my own special researches, but a contribution has recently been made to our knowledge of these forms to which it seems desirable to allude, because it deals, not with systematic or stratigraphical facts, but with conclusions which may be drawn from shell structure as to the life-history and habits of certain important and interesting forms. Prof. Jaekel, formerly of Berlin, now of Greifswald, the author of the memoir referred to, lays down a number of theses regarding the organisation and mode of life of these extinct species, and I venture to give an abstract of his views, premising that my acquaintance with palæontology does not justify me in expressing a definite opinion as to the validity of his conclusions, though they seem extremely reasonable.

His opening statement is that *Orthoceras* and its allies were not free-swimming but sessile organisms, and this is based on the following arguments amongst others. The shells were thicker and heavier than any that are found in pelagic organisms; the external sculpture shows that the shell was not embedded in the soft parts, and if it were exposed the annulate arrangement of many forms is inconsistent with their easy passage through the water; the "lines" (in the naval architect's sense of the word) of an organism intended for navigation are always smooth and not wavy; otherwise undue friction against the water would be created; whilst the straight transverse margin of the aperture of the shell shows that it was not carried by a creeping body like that of a snail. Their sessile nature is further shown in the first place by the radial symmetry, which is rare in free-swimming forms, and almost unknown in those the axis of which is long in proportion to their diameter. Further, the termination of the shell is generally broken off: of all the thousands of specimens which have been examined, but very few show the initial chamber; in those cases in which the apex is preserved it shows a scar, where the siphuncle entered the protoconch. The separation of the shell into chambers by transverse septa occurs only in sessile forms, but in such it is found in many divisions of the animal kingdom. The reason of this cameration is to be found in a constant effort to keep the body of the animal above the surface of the mud in which it is rooted. On this view the siphuncle admits of a simple explanation; it is the vestigial part of the body which has been contracted and partially cut off as the body has moved successively forward to the enlarged superior portion of the shell.

It may be added that J. M. Clarke has recorded a case in the American Upper Devonian rocks in which the majority of the large Orthoceratidæ were fossilised in a vertical or but slightly sloping position.

The forms such as *Phragmoceras*, &c., in which the aperture of the shell is contracted, and often shows bilaterally symmetrical notches, are interpreted as having lived buried in the mud. The notches served for the protrusion of the arms, vent, and siphon, which latter were probably elongated tubes stretching up through apertures excavated in the mud, much in the same way as the heart-urchin (*Echinocardium*) among the sea-urchins lives buried in the mud, and obtains nourishment by stretching its tube feet up to its surface. The arrangement of the arms was probably like that seen in the embryos of Dibranchiata, or of the circumoral appendages of *Nautilus*.

Turning to the extensive and interesting group of Belemnites, Prof. Jaekel enunciates the view that these were not, as has been commonly believed, active free-swimming forms, the rostrum (guard) serving as the pointed ram of a battleship, but stationary, the rostrum playing the part of a pile by which they were rooted in the mud at the sea-bottom, like the pointed base of a *Flabellum* or other deep-sea coral, or the anchor-spicules of a glass-rope sponge. In favour of this view may be adduced the size, weight, and solidity of the rostrum, which, if the animal moved about in a horizontal attitude, would have thrown its centre of gravity too far towards that end of the body: its circular section, which points to a radial, not a bilateral, symmetry, and hence, as above mentioned, to a sessile rather than a free-swimming habit. The pointed form of the rostrum would be admirably adapted to fixation in a muddy bottom, whilst its weight would render it a very effective anchor. Further, it is to be noted that Belemnites are found abundantly in strata of argillaceous origin.

This view has a strong recommendation in the fact that it presupposes gradual progress in the Cephalopoda in the direction of greater mobility as evolution advanced, thus:

A. Orthoceras—firmly attached.
B. Belemnites—anchored in the mud.
C. Recent Dibranchiata—free-swimming.

Another interesting discovery of Prof. Jaekel is that of a slab of Solenhofen stone, upon which are certain specially arranged impressions, apparently made by the hooks on the arms of a Cephalopod. If this determination is correct, the fact is of the greatest interest, for it would show that these animals walked upon the ground with the head downwards and the distal extremity of the body elevated; that in them the arms were not merely morphologically, but also functionally, the equivalent of a foot.

In conclusion let me direct your attention to a subject which is almost entirely the growth of the last fifteen years. I mean the discovery and investigation of luminous organs in the Cephalopoda. These have now been observed in no fewer than twenty-nine out of about seventy well-characterised genera of Decapoda, and have been found to present a most interesting variety in position and in structure.

Before passing on, however, to consider the structure of these organs, it may be well to lay before you the evidence on the strength of which a photogenic function has been ascribed to them. The actual observations are remarkable chiefly for their paucity; indeed, it may seem to some that the foundation of solid fact is too slender for the superstructure raised upon it, but still due consideration will show that this is not the case. The first recorded occurrence of phosphorescence in the Cephalopoda is due to Vérany, and dates back rather more than seventy years, though it was not published till 1851. The description is so definite and concise as to be well worth quoting:

"As often as other engagements permitted, I watched the fishing carried on by the dredge on the shingly beaches which extend from the town of Nice to the mouth of the Var. On the afternoon of September 7, 1834, I arrived at the beach when the dredge had just been drawn in, and saw in the hands of a child a cuttle-fish, unfortunately greatly damaged. I was so struck by the singularity of its form and the brilliance of its colour that I at once secured it, and, showing it to the fishermen, asked whether they were acquainted with it. Upon their replying in the

negative I called their special attention to it, and offered a handsome reward for the next specimen secured, either alive or in good condition, and then passed on to other fishermen and repeated my promise. Shortly afterwards I was summoned and shown a specimen clinging to the net, which I seized and placed in a vessel of water. At that moment I enjoyed the astonishing spectacle of the brilliant spots, which appeared upon the skin of this animal, whose remarkable form had already impressed me: sometimes it was a ray of sapphire blue which blinded me; sometimes of opalescent topaz yellow, which rendered it still more striking; at other times these two rich colours mingled their magnificent rays. During the night these opalescent spots emitted a phosphorescent brilliance which rendered this mollusc one of the most splendid of Nature's products. Its existence was, however, of short duration, though I had placed it in a large vessel of water. Probably it lives at great depths."

The species thus referred to was *Histioteuthis bonelliana*, which we shall have occasion to refer to in the sequel.

The next observation, so far as I am aware, was made by Prof. Chun, on board the *Valdivia* during the German deep-sea expedition, on a form which he has called *Thaumatolampas diadema*. The specimen captured lived long enough to allow of a photograph being made of it whilst in a state of functional activity, and the appearance it presented is thus described by the observer:

"Among all the marvels of coloration which the animals of the deep sea exhibited to us nothing can be even distantly compared with the hues of these organs. One would think that the body was adorned with a diadem of brilliant gems. The middle organs of the eyes shone with ultramarine-blue, the lateral ones with a pearly sheen. Those towards the front of the lower surface of the body gave out a ruby-red light, while those behind were snow-white or pearly, except the median one, which was sky-blue. It was indeed a glorious spectacle."

Finally we have the genera *Heteroteuthis* and *Sepiola*, the phosphorescent properties of which were seen last year by Dr. W. T. Meyer and Dr. W. Marchand in the Zoological Station at Naples.

This short list comprises all the actual observations on the luminosity of these animals; in these, however, the photogenic function has been definitely associated with special organs, and it is by comparison with these that other organs in other species have been regarded as having the same significance.

The history of the anatomical examination of these organs dates back only to the early 'nineties, and, so far as I can ascertain, the right of priority of the discovery rests with Prof. Joubin, who made a communication to the Société scientifique et médicale de l'Ouest at Rennes on February 3, 1893, a brief account of which was published by the Société de Biologie of Paris on the 10th of the same month: this communication related to *Histioteuthis rüppelli*, and in it attention was called to Vérany's observation quoted above. Sections of the organs of *Abraliopsis* were exhibited at the Göttingen meeting of the German Zoological Society and at the Nottingham meeting of this Association in the same year. Successive memoirs by Joubin and others followed, and in 1903 Prof. Chun delivered an address to the German Zoological Society at Würzburg, in which he gave a masterly survey of the whole subject, brought forward instances of similar organs previously overlooked, and showed the great variety in structure, not only in the organs of different species, but even in organs of one and the same individual.

More or less adequately authenticated luminous organs have now been recorded in no fewer than thirty-three species of Cephalopoda, and they have been found to occur in the following situations:

(1) Ventral surface of mantle.
(2) Ventral surface of body-wall within the mantle-cavity.
(3) Ventral surface of siphon.
(4) Ventral surface of head.
(5) Ventral surface of arms (usually confined to the ventral and ventro-lateral, rarely found on the dorso-lateral, and very rarely on the dorsal).
(6) Ventral surface of eyeball.
(7) Ventral surface of tentacles.
(8) Dorsal aspect of the dorsal arms.
(9) Dorsal surface of fin.

The most striking fact apparent from this summary is that luminous organs are practically confined to the ventral aspect of the animal. Another remarkable fact is the existence of organs concealed beneath the mantle and beneath the integument covering the eyeball, which can only be effective by reason of the transparence of the tissues in the living creature.

To give a detailed description of the structure of these many and varied organs would be out of place on the present occasion; it must suffice to group them into more or less well-defined classes and take an example from each.

The luminous organs of Cephalopoda may be divided in the first instance into

A. Glandular.
B. Non-glandular.

A. *Glandular Organs.*—In this class we have to deal only with the type of structure found in *Heteroteuthis*, *Sepiola*, and *Rossia*, which has been investigated by Dr. W. T. Meyer, of Hamburg, a pupil of Prof. Chun. When working at the Naples Zoological Station he was fortunate enough to obtain a specimen of *Heteroteuthis dispar*, and Dr. Lo Bianco called his attention to its luminous properties. On examination in a dark room it was easy to see the organ lying on the ventral surface of the body, just behind the funnel, showing through the transparent mantle with a pale greenish light like that of the glowworm. It appeared, further, that when the animal was irritated it shot rapidly through the water, leaving behind it a trail of luminous secretion which floated in the form of separate globules, and were afterwards drawn out by the currents into long threads. Dr. Meyer was able to repeat this exhibition of fireworks several times.

In *Sepiola* the luminous secretion is not ejected, but remains attached to the surface of the gland; and, furthermore, the light is only given off on powerful stimulation, as, for example, when the mantle is cut open. The structure of these organs has as yet been only very briefly described by their discoverer: they consist of paired glands, situated as above described one on either side of the anus, and partially concealed by the lateral margin of the ink-sac, which forms a recess for their reception. Beneath and to the inner side of the gland there is a reflector, and above it is a rounded gelatinous mass, fibrous in structure, transparent during life, covered with a delicate muscular layer. Dr. Meyer hesitates as to the function of this mass; but I think, in view of the structure of the luminous organs in other species, we may hazard the suggestion that it is some kind of lens. This organ is of particular interest, because it is the only instance yet recorded of a luminous organ among the Myopsida and the only glandular luminous organ in the Cephalopoda. Glandular luminous organs are, however, known in many species of fish, and in *Pholas* among the Mollusca.

B. *Non-glandular Organs.*—These may perhaps be divided into

(i.) Simple, without special optical apparatus.
(ii.) Complex, with more or fewer of the following structures: pigment layer, reflector, lens, diaphragm.

(i.) As a type of the simpler kind we may take the branchial organ of *Pterygioteuthis giardi*, in which we have a central mass of parenchymatous tissue, with a delicate superficial membrane (consisting of two thin layers), and resting upon a rather thick layer of close, compact tissue, which stains very deeply; beneath this organ is a single layer of cells containing a reddish-brown pigment. The corresponding organ in the nearly allied *Pyroteuthis* (or *Pterygioteuthis*) *margaritifera* is a degree more complex, for underneath the central cell mass is a thick layer of scale-like bodies, similar in structure to that regarded in other cases as a reflector ("tapetum" of Chun). In both these cases it seems necessary to regard the central cells as the source of light (see Fig. A).

Another organ, almost equally simple, is that found in the tentacles of *Thaumatolampas*, where the central por-

tion of the stem of the tentacle for about 2 mm. of its length is occupied by a large rounded cell-mass whose diameter is more than half that of the tentacle. The nerve which usually occupies this position is pushed to one side and flattened out like a ribband. Most curious is the fact that on the side opposite to the nerve a second organ is superposed on the first, which is of more complex structure, inasmuch as it has in its centre a mass of photogenic cells surrounded by a system of radiating fibrils with a pigment layer and tapetum at one side (see Fig. 1 (ii.)) As an example of the complex organs we may conveniently take those of *Histioteuthis rüppelli*, where they are scattered over the ventral surface of the mantle, siphon, head, and arms, forming in particular a definite ring round the ventral half of the margin of the ocular aperture. The organ itself is an ovoid body, about 1 mm. in length and somewhat less in diameter. The deeper three-fourths of this cup are covered with a thin layer of pigment, which is lined with a thick coating made up of small lenticular bodies packed closely together and forming a kind of mirror. The space within this, equal in diameter to about half the diameter of the organ, is filled with a mass of large deeply staining cells with large distinct nuclei. The more superficial portion of the organ is made up of what seem to be refractive structures. The deeper portion is conical, fitting into a hollow in the photogenic mass, whilst the upper part is bounded by a definite convex surface, the function of which is obviously lenticular. Nerves have been traced passing through the mirror to the light-producing cells in the centre. This ovoid body is situated at the posterior end of a somewhat hollowed patch of an elongated oval shape, which may measure as much as 10–12 mm. in its antero-posterior diameter. A consideration of the form and position of this hollowed patch and of its relation to the axis of the organ shows pretty clearly that it is an external mirror, destined to throw the rays of light downwards and forwards (see Fig. D).

One of the most complicated organs known is that found in the mantle of *Abraliopsis*. Here the whole apparatus is spheroidal in form and surrounded by a black coating, derived apparently from a number of confluent chromatophores. The photogenic cells lie rather in front of the centre, and before them again a ring of black cells seems to discharge the functions of an iris diaphragm. Behind the source of light is a reflector consisting of two parts: the deeper is concave, spheroidal, and made up of numerous concentric layers; the more superficial portion is conical, and also composed of concentric lamellæ. Partly in front of and partly behind the diaphragm is a lenticular mass of tissue. These little lanterns are scattered in considerable numbers over the ventral surface of the mantle, funnel, head, and arms, and the appearance of the animal when they are functionally active must be brilliant in the extreme (see Fig. C).

If we examine the organs just described and the others above enumerated, we see that certain conditions are fulfilled in all cases—namely, the presence of a mass of deeply staining, active cells with distinct nuclei, supplied with blood-vessels and nerves. These, then, are the essential parts of the apparatus, though even here differences obtain: for example, in *Thaumatolampas* the cells are polyhedral, highly refractile, and clearly defined, with spherical nuclei and distinct nucleoli. In *Chiroteuthopsis* the cells are few and large, and partially fuse one with another. In *Pterygioteuthis* the fusion has proceeded so far that the cell-boundaries are no longer recognisable, and there is present a finely granular mass in which numerous nuclei of varying size may be distinguished. In other cases the cells branch out into fibres and form a reticulate structure (*Calliteuthis*). In rare cases, as, for instance, the tentacular organ of *Thaumatolampas*, above described, this essential part constitutes the whole organ; but generally other structures are superadded, such as a pigment coat, reflector ("tapetum" of Chun), lens, and diaphragm, as has been mentioned in the complex organs just described.

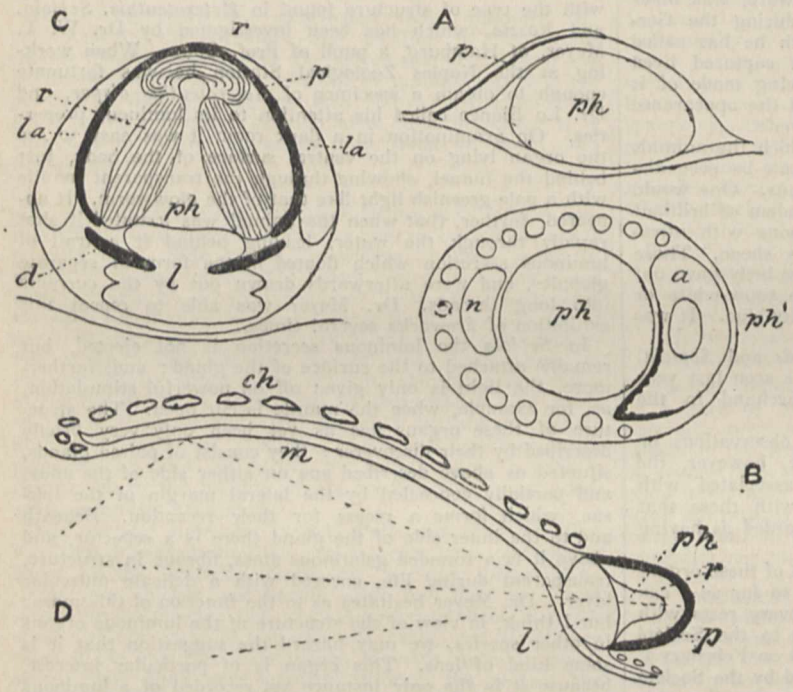


FIG. 1.—Semi-diagrammatic sections of typical luminous organs:—A, Branchial organs of *Pterygioteuthis giardi*. B, Tentacular organs of *Thaumatolampas*. C, Pallial organ of *Abraliopsis*. D, Pallial organ of *Histioteuthis rüppelli*. *a*, Accessory tentacular organ. *ch*, Chromatophores. *d*, Diaphragm. *l*, Lens. *la*, Lacuna. *m*, Mirror (external). *n*, Nerve. *p*, Pigment. *ph*, Photogenic cells. *ph'*, Photogenic cells of accessory organ. *r*, Reflector (internal).

Numerous interesting questions at once suggest themselves in regard to these structures, and it is very disappointing to admit that in regard to almost every one the answer is a confession of ignorance.

The first inquiry is: What is the origin of these organs, and from what primitive structures are they evolved? Here it is possible to say but little; there is no instance in which the development of these organs in the embryo has as yet been studied. A larva, believed to be that of *Histioteuthis*, came into my hands a short time ago, and full of hope I had a portion of the mantle cut into sections, but with no result whatever; there was nothing which I could interpret as the rudiment of such an organ.

Those organs occur in so many and such scattered families that it seems clear they must be polyphyletic. Furthermore, even in one and the same species the different organs are not all constructed on the same plan. In *Abraliopsis*, for example, the pallial organs are quite different from the ocular; but the most striking example of this sort of complexity is found in the remarkable *Thaumatolampas*, which has altogether twenty-two organs constructed on no fewer than ten different principles. It seems difficult in such a case to resist the conclusion that these organs have been separately evolved at different times, and perhaps from different origins, during the phylogenetic history of the species.

This variety in the structure of these organs naturally suggests the query: Do these differently designed lamps give out different kinds of lights? Here we have the observation of Prof. Chun on board the *Valdivia* to guide us, according to which in the living animal the middle

ocular organ shines with an ultramarine light, whilst the middle of the five ventral organs is sky-blue and the anal organs are ruby-red. It may also be observed that even in preserved specimens, when examined in a strong light, the different organs seem to shine with different colours, although there is under such conditions no actual emission of light. Furthermore, in some forms (*e.g.*, *Calliteuthis*) there are chromatophores in the superficial layers of the integument over the luminous organs, through which the light admitted must pass. A somewhat similar arrangement obtains in the curious structures in *Chiroteuthis*, which were regarded by Joubin at the time of their discovery as "thermoscopic eyes," but which are, I think rightly, in the present state of our knowledge, considered to be a special kind of luminous organ. In these instances the function of the superficial chromatophores may be to colour the light which passes through them.

The question of the utility of these variously coloured lights to the creature possessing them admits of an answer which is, at all events, extremely plausible. It was suggested in the case of deep-sea fishes by Brauer, and has been adopted by Chun in reference to the Cephalopoda. They serve as recognition marks by which the various species can identify their fellows; just as certain colour patches in the plumage of birds enable them to find their mates, so in the darkness of the ocean abysses do these fairy lamps serve their possessors. Another and perhaps even more obvious utility is suggested by the general distribution of these organs. It has above been pointed out that they are, almost without exception, on the ventral aspect of the body, that is, the inferior surface in the position in which the animal habitually swims. It must happen, therefore, that when the creature is moving over the floor of the ocean in the quest for food, this must be illuminated by its lamps, and the advantage of a series of searchlights playing over the ground will be at once apparent.

Finally we have the question: How is the light produced? To this we can only say that this is an instance of the transformation of one kind of energy into another. We are quite familiar with the production of heat in the animal body by the processes of oxidation which go on in it; we are also familiar with the production of kinetic energy when a muscle contracts under a nervous stimulus; and we are also aware that electric discharges are produced under similar conditions in certain organs of the Torpedo and other fish. The production of light is a phenomenon of the same kind. When we can explain how stimulation applied to a nerve causes contraction in a muscle, then, and not till then (so far as I can see), shall we be within reasonable distance of explaining the action of these living lamps.

One point is worthy of notice which has been ascertained, not by experiments on the Cephalopoda, but on other animals, namely, the remarkable economy of this illuminant. A perfectly infinitesimal proportion of the energy expended is wasted on the production of heat. From this point of view animal phosphorescence puts to shame our most modern devices. Whether we shall ever be able to rival Nature in this respect remains to be seen.

We have thus shown how rapid has been the growth of our knowledge regarding the distribution and structure of these fascinating organs, and yet how little we have learned of the mode of their operation, and we end, as all scientific inquiries end when pursued far enough, with a confession of ignorance.

What I have ventured to lay before you are a few of the fruits of the little garden plot in whose culture I have been privileged to take a humble share. If it has appeared to you that the labour spent upon their production by a few enthusiastic workers has been well expended; if they show that in this, as in any other group of animals, the study of small details conscientiously carried out leads to problems of the deepest interest, my object in the preparation of this Address will have been fully achieved.

MATHEMATICS AND PHYSICS AT THE BRITISH ASSOCIATION.

ON Thursday, August 1, at 10 a.m., Prof. A. E. H. Love, F.R.S., read his presidential address, which has already appeared in full in these columns (see NATURE, August 1). A vote of thanks, moved by Sir D. Gill and seconded by Sir G. Darwin, was carried with acclamation.

The Hon. R. J. Strutt commenced the ordinary proceedings with a paper on helium and radio-activity in common ores and minerals. He was inclined to attribute the helium which can be obtained from minerals, not to a radio-activity of the rocks themselves, but to the radium which they contain. The evidence on which this conclusion was based is that the ratio of radium to helium present is nearly constant. A great exception occurs in the case of beryl, which shows no radio-activity, but contains a large quantity of helium. Prof. Rutherford suggested that thorium should be looked for in beryl as a source of the discrepancy. In his reply, Mr. Strutt stated that he had found thorium in granite but not in beryl in sufficient quantities to afford an explanation of its peculiar behaviour.

Lord Kelvin followed with a paper on the motions of ether produced by collisions of atoms or molecules containing or not containing electrions. To him it seems extremely improbable that differences of grouping atoms all equal and similar should suffice to explain all the different chemical and other properties of the great number of substances now commonly called chemical elements. The impossibility of the transmutation of one element into any other he declared to be almost absolutely certain. The ether he takes as an elastic, compressible, non-gravitational solid. It is, however, only under the *enormous* forces of attraction or repulsion exerted by atoms on ether that augmentation or diminution of its density is practically influential. Purely dynamical reasoning leads him to infer generally similar theorems for an atom to those worked out by Heaviside for an electron. The association of atoms with electrions (or atoms of resinous electricity), and the interaction of both with the ether, form the basis of a general explanation of physical phenomena.

In a paper on secular stability, Prof. Lamb explained the difference between ordinary or temporary stability, *i.e.* stability as asserted by the method of small oscillations, and secular stability, *i.e.* stability when account is held of possible frictional forces; and he gave an experimental illustration of the latter kind. A pendulum hangs by a Hooke's joint from the lower end of a vertical shaft which can be made to rotate by a pulley with constant angular velocity ω. The effect of the rotation is that its two circular component vibrations have different periods, that one being the faster the direction of revolution of which agrees with that of the shaft. The criterion of secular stability imposes a limit to the speed for which the vertical position of the shaft is stable; for speeds higher than the limiting one a new position of equilibrium is possible in which the pendulum rotates at a constant inclination θ given by $\cos\theta = Mgh/(A-C)\omega^2$, where A and C are the two principal moments of inertia of the pendulum at the joint.

The beginning of the session on Friday had been allotted to a discussion on the constitution of the atom, and the committee of the section had not been in error in expecting that this would be of intense interest. Prof. Rutherford, whom we now have permanently in this country, opened it with a speech which was specially intended to suggest lines for discussion rather than to be a dogmatic statement of his own views. It was perfectly clear, however, that he regarded the electron as having come to stay, although at present it is impossible to decide whether the electrons which are set free in radio-activity or are revealed by the optical properties of an atom are merely an outer circle or are a revelation of the internal constitution of the inner core of the atom. He declared in favour of a kinetic view of the atom in opposition to statical views such as that developed by Lord Kelvin. Only on a kinetic theory could the great velocity of the β particles be explained. Sir O. Lodge in his contribu-

tion to the discussion took up a very definite line: "The electrical theory explains both inertia and radiation; and when a satisfactory explanation is given it ought to be supposed to be the right explanation, inasmuch as it is unlikely that two different systems will both fit the facts." One difficulty that has to be faced is that dispersion, absorption, and radiation (which are all connected) appear to indicate that the electronic constituents of an atom are few, but the electrons so tested may be only those which are comparatively free, and are not completely encased or submerged in an opposite charge. Such deep-seated or constitutional electrons would be inaccessible to light vibrations, and would take no part in dispersion unless violently shaken by chemical clash. The real difficulty is our present ignorance of the nature of positive electricity. Sir Wm. Ramsay urged that the chemist is at present more interested in the detachable electrons, and leaves the nature of the constitution of the atom as non-essential from the point of view of chemistry. These detachable electrons are the cause of valency, and chemical elements of the metallic class must be regarded as compounds; for example, HE may represent an atom of hydrogen the E of which is an electron; for hydrogen chloride, dissolved in water, gives as one of its products H, while the E is transferred to the chlorine atom. He referred to Prof. Rutherford's statement that no profound change had been discovered to take place in matter by the *loss* of electrons, and he pointed out that nickel under combined bombardment by electrons is partially transformed into a radio-active body belonging to that series of metals which yield insoluble sulphates. A *gain* of electrons, therefore, produces a permanent change in matter.

To Mr. F. Soddy, the philosophic unification for which Sir O. Lodge had pleaded seemed "unphilosophic and strained." It was possible to retain the idea of the inertia of electricity as being due to the magnetic field around the moving charge without taking the further step of supposing that matter was ultimately electrical in character. The subject is being approached from both the speculative and experimental sides, and the hypotheses of the former side often failed when subjected to the supreme test of prediction, and were sometimes little more than an ingenious mimicry of known facts. Mr. G. A. Schott considered that it was too soon to expect the mathematical physicist to predict new phenomena, since it is only within the last few years that he has been supplied with the materials necessary for his method, *e.g.* the electron. He adduced one positive result which may help to decide between the static and the kinetic view of the atom. A uniform magnetic force acting on a *rotating* ring gives a periodic mechanical force capable of producing resonance. In consequence, a rotating ring is capable of yielding a magnetic moment very much larger than it would do if at rest relatively in the field. Prof. Larmor claimed the right of physicists to make hypotheses even with regard to the atom. He considered that our views about the electron would have been just the same as they now are if radio-activity had not been discovered, and he gave a short historical account of the development of electronic theory from Faraday through Maxwell to modern times. Lord Kelvin preferred to regard the atom as a big gun loaded with an explosive shell. The firing of a shell does not cause the destruction of the gun; the electron, however, changes its nature in a way analogous to the bursting of the shell after explosion.

The discussion throughout was very stimulating, even if few decisive statements could be made. It was noteworthy that no allusion was made to the latest optical papers of Drude, in which he allocated the parts played by bodies the mass of which is that of an electron, and bodies the mass of which is comparable with the mass of an atom, in determining the optical dispersion of solids, *e.g.* fluorspar.

A paper was next read by Sir Wm. Ramsay detailing the remarkable discoveries announced in a letter to NATURE, July 18. Briefly stated, it appears that helium, neon, or argon is formed from radium emanation according as it is dry, dissolved in water, or dissolved in a strong solution of a copper salt. Simultaneously, lithium and perhaps sodium are formed, the presumption being that they are formed at the expense of the copper. The importance of the former discovery is that this is the first time the nature of the products of radio-active disintegration has been found to be controllable.

In a paper by Mr. F. Soddy and T. D. Mackenzie (Carnegie research scholar) on pseudo-high vacua, it was shown that the electrical characteristics of a high vacuum occur in helium (purified by calcium and subjected to further purification by the passage of the discharge) at pressures between $\frac{1}{4}$ mm. and $\frac{3}{4}$ mm. of mercury, whereas in hydrogen the same holds at 1/25 mm. These pressures are far higher than is commonly supposed. The absorption of helium, argon, and neon in spectrum tubes after continuous running occurs mainly in the volatilised film of aluminium deposited from the electrodes. The gas can be mainly recovered by dissolving the film in mercury or heating the tube.

Prof. Larmor gave a very brief summary of a paper on the range of freedom of electrons in metals. It was remarked that a hopeful plan for elucidating the mechanism of the transfer of electricity (electrons) from molecule to molecule is to study the time relations. The optical phenomena of metals introduce times, viz. the periodic times of the vibrations which are small enough for this purpose. Hagen and Rubens's experiments on the connection between infra-red radiation and electric conductivity show that the time required to establish conduction completely is a small fraction of the period of such waves. If the semi-free electrons to which conduction is due have a velocity of mean square determined by the gas laws, this restricts their range of freedom almost to the interspaces between the molecules. On the other hand, the fact that the square of the quasi-index of refraction of light for the nobler metals is not far removed from being a real negative quantity, indicates that the number of such free electrons is of about the same order of magnitude as the number of molecules.

The proceedings on Monday, August 5, opened with a paper by Dr. L. Holborn on optical pyrometry, in which he outlined the various radiation methods of measuring temperature. The most recent optical experiments give for the melting point of platinum the value 1790° C. if the melting point of gold (1064° C.) is taken as the fundamental point. Prof. C. Féry followed with a discussion of the various difficulties which are met with in connection with the subject. He mentioned that an apparatus had recently been devised in which there is nothing electrical. In this the thermometric receiver, instead of being a thermo-element, is a bimetallic spiral which deflects a pointer over a scale attached to the instrument.

Dr. Harker, who had in recent years obtained a considerably lower value for the melting point of platinum, pointed out some of the defects to which the optical method was liable. In particular, there is an uncertainty arising from the absorption of the light by the vapour given off the walls of the furnace.

After the end of this discussion the section divided into two departments. In the department of mathematics Prof. Forsyth led the way with a brief review of the progress of the calculus of variations during the last century, and in particular of the work of Weierstrass. After referring to later developments of the subject, he gave an outline of the set of four conditions to be satisfied by an integral involving a derivative of the first order of a single dependent variable, and discussed the necessity and sufficiency of these conditions.

Dr. W. H. Young gave an outline of some new results reached by himself in the theory of functions of a real variable. He proved that there could be no difference between the right- and left-hand discontinuities of a function except at a countable number of points, and that a similar result held good for non-uniform convergence. Dr. W. de Sitter, in a paper on a remarkable periodic solution of the restricted problem of three bodies, showed that one of the orbits worked out by Sir G. Darwin is very nearly of the type called by Poincaré a periodic solution *de seconde espèce*.

Mr. H. Bateman followed with a paper on essentially double integrals, and the part which they play in the theory of integral equations. Starting with the integral

equation of the first kind, $f(s)=\int_a^b \kappa(s,t)\ \phi(t)dt$, in which the forms of κ and f are known and ϕ is to be determined, he showed that the solution of this equation was unique if no solution could be found of the so-called "homogeneous" allied equation

$$0=\int_a^b \kappa(s,t)\ \phi(t)dt$$

if

$$\int_a^b\int_a^b \kappa(s,t)\ \omega(s)\ \omega(t)dsdt$$

is essentially positive whatever the form of the (continuous) function $\omega(t)$. Types of such functions $\kappa(s,t)$ are given in the paper, and also a simple proof of a theorem of Hilbert.

Major MacMahon read a paper on operational invariants, in which he obtained several interesting and elegant results in this abstruse department of analysis.

Prof. Love read the first of a group of papers on the best methods of introducing certain fundamental results in analysis. In this he detailed a method of proving the fundamental properties of the exponential function. Starting from the attempt to differentiate a^x, he introduced the number e as the limit of $(1+1/n)^n$ when n is infinite, and by applying the theorem of the mean value to the expression

$$\phi(x)=e^b-e^x-(b-x)e^x-\frac{(b-x)^2e^x}{\lfloor 2}-\frac{(b-x)^{n-1}e^x}{\lfloor (n-1)}-\frac{(b-x)^n}{b^n}\mathrm{R}$$

where R is the difference between e^b and the first n terms of the series for e^b, he obtained readily the exponential theorem. In the interesting discussion which followed this paper Dr. Young suggested that the concept of an infinite series was really simpler than that of a limit, since the former involved only a countably infinite number of steps, which was not necessarily true of the second. Dr. Hobson emphasised the value of Prof. Love's method as making the student familiar with a type of proof of great generality and power, but Mr. C. S. Jackson deprecated the too early introduction to beginners of difficult mathematical concepts.

In the department of general physics, which proceeded simultaneously with the above, Mr. Sidney Russ read a paper on the transmission of the active deposit from radium emanation to the anode. He showed that, whereas the amount of active deposit obtained on the negative electrode diminishes as the pressure of the air is diminished, as has already been found by Makower, it is found that the amount obtained on a positive electrode simultaneously increases. Experiments have also been made in various gases on the amount of active deposit on the two electrodes, and it is shown that between the pressures of 0·1 mm. and 1 mm. hydrogen behaves differently from air.

Miss I. Homfray detailed a series of experiments on the absorption of argon by charcoal. Miss Homfray finds that a formula of the same type as Bertrand employed for vapour pressures holds for the equilibrium pressures of the absorbed gas at various temperatures and constant concentration. The constants in the equation change with the concentration, and moderately simple equations are obtained expressing the mode of dependence. The resulting equation is much more satisfactory than the experimental formula usually taken.

Sir Oliver Lodge then read a paper on the density of the ether, in which he summarised the arguments for a very high density of the ether which had been given by him in NATURE, March 28, p. 519. His conclusion is that every cubic millimetre of the universal ether of space must possess the equivalent of a thousand tons, and every part of it must be squirming internally with the velocity of light. The latter part of this statement is based on the fact that the existence of transverse waves in the interior of a fluid can be explained only on gyrostatic principles, and the internal circulatory speed of the intrinsic motion of such a fluid must be comparable with the velocity with which such waves are transmitted.

Prof. Trouton showed an electrical experiment illustrating the two modes of condensation of water vapour upon surfaces. If a bell jar be placed over a Bunsen and then placed over a charged gold-leaf electroscope, this often leaks as though the air were ionised. The action is, however, somewhat uncertain. If the insulating shellac of the electroscope is gently dried with a flame, the experiment if made fails, but if the shellac be now moistened and wiped so dry with a cloth as not to conduct, the experiment if made will be successful. The action is therefore due to the moisture, but in the former case it is deposited with difficulty for the same reason that well-dried phosphorus pentoxide absorbs moisture with difficulty.

An important paper was read by Mr. A. O. Rankine on a theoretical method of attempting to detect relative motion between the ether and the earth. If a dumb-bell shaped body shortens in accordance with the Lorentz hypothesis in the direction of the ether drift, its moment of inertia will depend upon its azimuth unless its effective mass changes in a compensating manner. The change in its mass necessary for compensation turns out to be of opposite sign to that which would be indicated by the ratio between longitudinal and transverse mass, as given by any of the current theories. Thus there is either something very wrong in these theories or a real effect arising from motion relative to the ether is theoretically detectable in opposition to the view held by Larmor, Einstein, and others. Unfortunately, it has to be recognised that the effect is too small to be actually detected by experiment. In the discussion Sir Oliver Lodge advised caution amongst the many pitfalls in this difficult subject, and appeared to be in favour of the view that when allowance is made in accordance with a complete theory which holds good for large as well as small velocities, the supposed effect will be found to vanish. Prof. Trouton mentioned another experiment which he was making in collaboration with Mr. Rankine. If a wire changes in dimension with its azimuth, it might be expected that its electrical resistance will simultaneously change. Four coils are connected to form the arms of a Wheatstone's bridge, adjacent arms having their axes at right angles to one another. Balance is obtained, and then the framework on which the coils are mounted is rotated through a right angle. When the temporary disturbance has subsided, the arrangement is again tested for balance. The experiments are in progress, and so far a small positive effect has been obtained, but it requires confirmation before so minute though important an effect can be considered certain.

The afternoon meeting began with a challenging paper by Prof. H. E. Armstrong on the nature of ionisation. This attracted the physical chemists in particular, who appeared with the object of combating Prof. Armstrong's views. These may be summarised as follows:—

We do not "need to imply more by the term *ionisation* than that the medium is in a state in which it will conduct electricity." "The doctrine of electrolytic dissociation is destitute of common sense." Ohm's law is consistent with a modified Grotthus hypothesis. "The assumption that any electromotive force, however small, will condition sensible electrolysis" is a fact which cannot be regarded as established, as it is impossible to avoid some polarisation. Electrolytic conductivity and chemical activity *se confonde* (Arrhenius). Chemical interactions are dependent on "mutual attractive relations of the particles." In effecting hydrolysis in the case of sugars, "enzymes act selectively; therefore their action cannot be attributed to dissociated hydrogen ions." "The mistake has been made that liquids are comparable with gases—a preposterous contention." "'Ionised' molecules are complex, reversible systems formed of solvent and solute under the influence of the force of residual affinity." "As such systems break down under the influence of the current new ones to take their place must arise spontaneously in the solution: the molecules, therefore, would draw one another apart at a rate proportional to the polarisation," and hence Ohm's law would be satisfied. In the discussion Sir O. Lodge emphasised the distinction between the terms "electrolyse" and "ionise." Electrolyse signifies decomposition, ionise means making

ready for decomposition, or, if we like, to decompose and to leave the products of decomposition in the fluid instead of getting rid of them at the electrodes. It really means converting a substance into an electrolytic conductor, and for that process the term is wanted. As to the nature of ionisation, the facts to be expressed are that the atoms are perfectly free to travel, that an extremely minute force will set them in motion. They are either free, therefore, or else potentially free. The merest trace of E.M.F. suffices to practically transfer them in one direction. To account for this, we may suppose a certain proportion of the atoms are either continually or persistently free, which is improbable; or that they are constantly interchanging with others, in such a way that they are free between their combinations; or else that they are combined into such a loose and large aggregate that the attraction in all directions is equal—which is really a case of potential freedom barely distinguishable from actual freedom. If the instinct of chemists really prefers this view to the idea of actual dissociation, then great weight should be attached to that instinct, and the aggregation mode of specification should be preferred; but for practical purposes it makes very little difference, and in treating the matter mathematically, actual dissociation is the idea most easily expressible.

He was not surprised that Prof. Armstrong prefers this hypothesis of aggregation, inasmuch as he has for twenty years preached the doctrine of residual affinity as explanatory of solution, of molecular combination, and of many other such things, as distinct from simple and undivided units of valency. Now this doctrine is entirely consistent with the electrical theory of chemical attraction. For the single bond with which, say, sodium is attached to chlorine is, on the electrical view, not a unit of which no fractions are possible, as perhaps it used to be regarded, but a group or bundle of lines of force which can be split up into any number of fractions, a few lines being easily diverted. Thus a few are thrown off to encounter any water molecules which may come into the molecular neighbourhood; and although the attraction of each water molecule for the sodium or the chlorine must be much less than the attraction of sodium and chlorine for each other, yet in a dilute solution, when the water molecules are numerous, the cooperation of a lot of them may exert a pull sufficient to balance the attraction of the atoms of the salt itself, and either actually or potentially to tear the salt molecule asunder. But whether it is really torn asunder or not, or whether it goes about with an aggregate of water molecules hanging on to it, ready to be torn asunder by the slightest addition of applied electric force, is a matter on which as a physicist, at least from the electrolytic point of view, he would express no opinion. It is possible that some of the phenomena now known to physical chemists may afford a criterion for distinguishing between these two extremely adjacent hypotheses. But he wished to testify to the fact that the residual affinity doctrine, when developed in accordance with the electrical theory of chemical action, is a luminous one, and explains, not only the influence of a solvent, but mass action generally; and that we owe a debt to Prof. Armstrong for keeping the chemical reality of the facts thus able to be explained always before us.

As to the objection to thermodynamical reasoning; he should allow that thermodynamics is a method of arriving at results, but it is not ultimately to be regarded as the most satisfactory method. For it does not pay attention to the process by which the results are obtained: it is rather a method of proceeding blindfold, or in blinkers, and reaching the result by an ingenious scheme of argument without attention to the process involved. It is remarkable that reasoning can be carried on in this way, but it is undeniable that so it is.

So far from chemistry being cold-shouldered by physics, it would appear rather to be the other way; and the great interest of the present state of things is that the facts of chemistry, or at any rate the most fundamental of them, seem now able to be tackled by mathematical methods, and to show signs of being more completely understood than ever before.

This is a process which, however puzzling it may be in its early stages, will surely be welcomed by chemists in the long run; and it will be a great day when such an empirical generalisation as the periodic law really yields up its secret to mathematical analysis—based, as that probably will be, on the hypothesis of the electric constitution of the atom.

With all that had been said about Prof. G. F. FitzGerald he heartily concurred, but he seldom or never found himself in disagreement with that great man; and inasmuch as Prof. Armstrong seems to agree with him too, at any rate to a great extent, there appears to be less difference between the physicist and the chemist than might superficially appear.

Meanwhile, we should not avoid the use of the word "ionisation," but should use it carefully, and should determine the nature of the process which it represents.

Prof. Abegg reminded Prof. Armstrong that combination between solute and solvent is admitted by everyone. But this alone does not explain the duplication of the number of molecules which is indicated by any method of counting, such as lowering of freezing point, osmotic pressure, &c. The difficulty felt by some chemists in realising how simple solution should effect such a thorough change of molecular state is lessened if it is recognised that even in the solid state the molecules are often dissociated. Internal friction is the cause of the small conductivity of solids, not want of dissociation. No theory explains the same number of facts as the dissociation theory. Prof. Werner emphasised the necessity for postulating association as well as dissociation, bringing forward his own work on complex inorganic combinations. Without association there is no ionisation. Dr. T. M. Lowry said he had been led to advocate a hydrate theory of ionisation. The molecule does not fall to pieces, but is torn apart by the affinity of the solvent for the ionic nuclei of which the salt is composed (Trans. Faraday Society, July, 1905). Dr. Burch said chemists and physicists had attacked the subject from opposite ends, like engineers driving a tunnel, and the question was whether they would meet in the middle, and he thought they would.

Dr. Senter directed attention to Werner's demonstration that in such compounds as $Co(H_2O)_4Cl_3$ the water was associated with the positive ion, and that it had also been shown that the positive ions of the alkali and alkaline earth salts were also hydrated to a considerable extent in solution (*cf.* Senter, *Science Progress*, January, 1907). He considered that Armstrong's theory that the variation of electrical conductivity with dilution could be accounted for by hydration alone was opposed to the law of mass action; the requirements of this law will be satisfied only if the molecule splits up into two parts which convey the current.

Dr. N. T. M. Wilsmore claimed that the ionisation theory was a growing one, as was indicated by the recognition to-day of the influence of the solvent. Against a Grotthus theory he urged that, since two molecules are involved, the conductivity would vary as the square of the concentration. Dr. Haber inquired how the theory of a concentration cell could be worked out if no dissociation occurs. He also discussed the bearing of solubility, *e.g.* with regard to the decrement of solubility of AgCl by addition of sodium the quantitative relations are the same as we deduce from conduction experiments. He would express the solution of a salt such as sodium chloride by the equation

$$ClNa + (+)(-) \rightleftarrows Cl(-) + Na(+)$$

where $(+)$ stands for a unit positive and $(-)$ a unit negative charge.

Throughout the discussion the term hydration was employed. We may point out that we believe Prof. Armstrong would not take this term as adequately connoting the formation of the complexes that he postulates.

Two papers were read by Prof. Rutherford, the first on the production and origin of radium, in which he gave evidence that there must be an intermediate substance formed in the derivation of radium from uranium. Sir O. Lodge drew from Prof. Rutherford the statement that he did not know whether or not this substance was radioactive. The second paper, in collaboration with J. E. Petavel, was on the effect of high temperatures on the activity of the products of radium, in which they detailed

experiments made with radium inside an explosion chamber, proving that a *sudden* rise of temperature does not affect the rate of disintegration, but that subsequent effects are due to a change as if of B and C together.

In the discussion on the latter Mr. Makower stated that the experiments afforded a confirmation of his own experiments and those made by him in conjunction with Mr. Russ. The only point in which the experiments do not agree with the view that it is radium C which is affected by temperature is that after the diminution of activity succeeding the explosion the rate of recovery is too slow. This might be accounted for by assuming a sudden change in the activity of radium C accompanied by a change in its period instead of assuming a change of activity in both B and C.

Mr. H. Stansfield read a note on the echelon spectroscope and the resolution of the green mercury line, in which the detection of several faint new components is described; and a paper by Mr. L. F. Richardson, on a freehand potential method, had to be taken as read owing to lack of time.

The proceedings on Tuesday, August 6, opened with a discussion on modern methods of treating observations. This was initiated by a paper by Mr. W. Palin Elderton expository of the methods developed by Prof. Karl Pearson. After defining the principal quantities involved in the new methods, the paper dealt with correlation and its calculation. Examples were given examining possible correlation between rainfall in different districts, rainfall and typhoid in Surrey districts, and other meteorological questions. In the case of rainfall and typhoid, the statistics made use of indicated so little correlation that "it is impossible to assert definitely that there is any relation" between them. In the discussion Dr. W. N. Shaw emphasised the present need of a consideration of "departures from the mean." He directed attention to other methods of treating observations besides that of Prof. Pearson; for example, Prof. Schuster's periodogram method and the "method of residuation" adopted by Prof. Chrystal in discussing the component periods of oscillation of the seiches of Scottish lochs. He showed diagrams, prepared in the Meteorological Office, which illustrated the relation of the mean to the frequency of occurrence of the various values. Mr. G. Udny Yule explained that to be content with the arithmetic mean was to neglect all the other characters in which two frequency distributions might differ. The standard deviation was the most convenient measure of "scatter," but the difference between the two values, which were just exceeded by one-quarter and three-quarters of all the observations respectively, was the most readily calculated. The correlation coefficient was a measure of the approach towards a simple linear relation between two variables, and could be extended to cover more complex cases.

Mr. A. R. Hinks, who was somewhat sceptical as to the general applicability of the new methods, inquired what meaning could be attached to the value 0·3 of the correlation coefficient in such cases as $y=\log x$. He also gave an example in which questionable conclusions had been arrived at by the method, the reason being that certain groups of stars had been studied for special purposes, while others had been neglected. The choice of observations introduced a fictitious law of distribution. The discussion was continued by Mr. Hooker, Prof. Turner, and Prof. Edgeworth.

Prof. Hicks then read a paper on the use of calcite in spectroscopy. In order to be able to make use in spectroscopy of the large dispersion in the ultra-violet produced by calcite, Prof. Hicks first polarises the light in order to do away with the duplication of the spectral lines. When a quartz lens is employed in the collimator it is made a compound lens of right- and left-hand quartz; the polariser for very short wave-lengths (down to λ 2300) was a small Foucault fixed like a comparison prism. The Hon. R. J. Strutt pointed out the great advantages that fused quartz would have.

A series of papers on astronomy and cosmical physics were now taken. Dr. O. Backlund detailed the work done in determining the variation of latitude. Dr. W. N. Shaw read a paper on some recent developments of the method of forecasting by means of synoptic charts. These are the methods of M. D. Gréville, of Paris, and M. Guilbert, of the Meteorological Society of Calvados, for obtaining an approach to a second approximation in forecasting weather. Mr. C. Michie Smith gave an account of the Kodaikanal Observatory in South India. The Rev. A. L. Cortie, S.J., read a paper entitled "The Variability in Light of Mira Ceti and the Temperature of Sun-spots," the purport of which was to indicate the relatively low temperature of sun-spots from the behaviour of the bands of titanium oxide in *o* Ceti, when the star is at two different temperature levels represented by a whole magnitude in luminous power. Concomitant evidence of the variation of temperature of the star was furnished by the character of the hydrogen lines.

Prof. H. H. Turner read a paper descriptive of a method which is being tried at Oxford for improving the constants of the plates for the Astrographic Catalogue. He also read one on the determination of periodicity from a broken series of maxima. For example, observations of the light curve of a variable such as U Geminorum are generally absent altogether near a minimum, and cannot be supplied; moreover, the maxima are often lost from cloudy weather, &c. The paper suggests a method of examining these for the detection of periodicity. Let E_1, E_2, E_3 be the epochs of maxima. Find the differences between these and the *nearest* theoretical maxima E_0, E_0+2n, E_0+4n, &c., where $2n$ is a period to be tried. Find (*a*) the algebraic mean of these differences, (*b*) the sum of their squares. In certain circumstances (*b*) should be a minimum when we have hit on a real periodicity. If (*a*) comes out sensibly different from zero, we must alter E_0 until (*a*) is small enough. When there is no periodicity near $2n$, (*b*) will approximate to $mn^2/3$, m being the number of maxima treated. Miss M. White, T. V. Pring, and J. E. Petavel communicated a note on an analytical study of the meteorological observations made at the Glossop Moor kite station during the session 1906–7, and a preliminary note by W. A. Harwood and J. E. Petavel was read on the recent international balloon ascents (Manchester station). A paper by T. J. J. See, on results of recent researches on the physics of the earth, was taken as read.

Meanwhile, the mathematical department had been meeting separately, continuing the group of papers on the elements of analysis with one by Dr. W. H. Young on the introduction of the mathematical idea of infinity. Dr. Young stated that, of the three types of mathematics, viz. the logical, formal, and practical, his sympathies were with the first and third rather than with the second. He pointed out a number of instances in which learners were brought into contact with the notion of infinity, and advocated the policy of boldly facing the difficulty instead of trying to avoid it. A paper by Mr. C. O. Tuckey on the teaching of the elements of analysis unfortunately had to be cut short owing to lack of time.

Mrs. Boole-Stott exhibited a series of beautifully constructed models of three-dimensional sections of regular hyper-solids in four dimensions, and models illustrating the rotation of a four-dimensional body about a plane. Prof. Schoute showed some lantern slides in connection with this subject. He also exhibited three models of developable surfaces the tangent planes of which are given by the equations

$$u^3+3u^2x+3uy+z=0$$
$$u^4+6u^2x+4uy+z=0$$
$$u^6-15u^4+15u^2x+6uy+z=0$$

and indicated certain results when the parameter u in the equation of the plane occurs to a higher degree. Prof. A. M. Worthington showed a series of slides, directing attention to the fact that the impact of a drop excavates a perfectly spherical hollow which reaches its greatest depth at apparently the same time that the water thrown up attains its maximum height. The volume of this pit is enormously greater than that of the drop. The object of the paper was to obtain suggestions from mathematicians explanatory of this phenomenon, but none were forthcoming. Prof. Hilton gave an account of a new property of Abelian groups, and Lieut.-Colonel A. Cunningham read a paper on the factorisation of the terms τ_n, v_n, of the Pellian equation $\tau_n^2-Dv_n^2=1$.

Besides these papers, reports were presented by various committees nominated by the section. Owing to the plethora of papers, these, as a rule, were taken as read, printed copies being distributed to members present.

The committees presenting reports were those denoted by their well-known abbreviated names of "electrical standards," "kites," "Ben Nevis," "Bessel functions," "teaching of elementary mechanics," "Falmouth," and "seismology." An account was given of the last by Prof. Milne.

ANTHROPOLOGY AT THE BRITISH ASSOCIATION.

THE most noticeable feature about the proceedings of the Anthropological Section was the great predominance of papers of an archæological character, those on physical anthropology and general ethnography being far fewer in number than usual. The general level of the papers was, however, quite up to the usual standard, and several of the communications were of the first importance.

As the archæological papers were so much the more numerous, it may be advisable to deal with them first. On the Monday morning an important discussion on the Iron age was initiated by Prof. Ridgeway in a paper on the beginnings of iron. He argued that Central Europe was the true centre of the use of iron as a metal, and that it was first diffused from Noricum. He considered that the general opinion as to the early knowledge and use of iron in Egypt is explained by the fact that hæmatite was known and used, but that it was not treated as a metal, but as a stone. That iron was worked from a remote period in Central Africa he considered unlikely, as it only became known for the first time in Uganda some five hundred years ago, and there was no reason to suppose that it was worked much earlier in the more central part of the continent. As it was also certain that the peoples beyond the Caspian and along the shores of the Indian Ocean did not use iron until a late date, it seemed clear that its use as a metal was due to Central Europe.

In the discussion which followed Prof. Edouard Naville drew a distinction between the knowledge of iron and its general use. Referring to the two or three cases of iron being found of the time of the Old Empire, he pointed out that, in spite of this, it did not seem to be in common use under the New Empire, and that no iron tools were discovered in the Deir el-Behari excavations. His own feeling was that the general use of iron in Egypt was not anterior to Greek times.

Prof. Petrie emphasised the necessity of keeping clearly in view the distinction between the general and sporadic use of iron. Iron was known for 4000 years before its use became general, and this sporadic use strongly supported Prof. Ridgeway's views of the use of iron in its native state, as, had processes of reduction been known, it was unlikely that it would have taken 4000 years for its adoption to have become general.

Prof. J. L. Myres argued that there was no logical connection between Prof. Ridgeway's view that the knowledge of iron, as a useful metal, spread from a centre in Noricum and his assumption that the question of the early Iron age in Europe was that of the first use of iron at all. He pointed out that materials, for example tobacco and gunpowder, were not infrequently looked upon as mere curiosities in one area, and that their real utility was not discovered until they were transferred to another district. He also dwelt on the effect which the introduction of the blast furnace from the north must have had upon the output.

Mr. Arthur Evans considered that the great objection to Prof. Ridgeway's theory was the comparatively late date of the Iron-age civilisation of Hallstatt. Earlier phases are seen in southern Bosnia, and still earlier in the geometrical and sub-Minoan tombs of Greece and Crete. He considered that the general adoption of iron in the countries of the Ægean corresponded with the break-up of the earlier Minoan and Mycenæan type of culture.

Prof. Bosanquet felt that a great difficulty in the way of accepting the views of Prof. Ridgeway was the impossibility of testing the theory that the general use of iron had made its way into Greece from the north, owing to the very little available evidence as to Bronze-age culture in Macedonia and Epirus.

Mr. Crooke considered that India may have been the seat of an independent discovery of the metal.

As usual, Egypt took a prominent place in the proceedings, and the section had the advantage of numbering Prof. Naville among those who read papers. Besides giving a descriptive account of the excavations at Deir el-Bahari, which have now been brought to a satisfactory conclusion, Dr. Naville read an important paper on the beginnings of Egyptian civilisation. The conclusion at which he arrived was that the Egyptians were a nation formed of a mixture of Hamitic conquerors from Arabia settling among an indigenous stock of Hamitic-African origin, an amalgamation made the easier as both races were of the same stock and had no religious differences. Prof. Petrie also gave a paper to the section describing the excavations carried out by the British School of Archæology, under his direction, at Gizeh and Rifeh. In this communication he described the interesting series of pottery soul-houses, found on the latter site, which are of great importance apart from their religious significance as showing the design and evolution of the ordinary Egyptian house, about which little had previously been known.

Greek archæology was dealt with in papers by Prof. Bosanquet and Mr. R. M. Dawkins. Both of these papers dealt with the work now in progress at Sparta, but while Mr. Dawkins gave a general description of the excavations, Mr. Bosanquet dealt especially with the scourging of the Spartan boys before the altar of Artemis Orthia, which was shown by the excavations to have occupied the same position for more than a thousand years. Prof. Bosanquet traced the history of the scourging festival, and showed that the cruel whippings described by Roman writers are an artificial revival of an old discipline which apparently originated in a rough game played by the Spartan youths, in which at first there was no element of passive endurance so characteristic of the later ordeal. This game itself seems possibly to have originated in a still earlier custom, in which the lads hit each other, for luck, with boughs cut from the sacred tree, the *Agnus castus*.

The recent expedition undertaken by the University of Liverpool to northern Syria and Asia Minor was described by Prof. Garstang. The work done was of very great interest, the most important find being what is apparently an altar of dedication, similar to those discovered in Crete. Many inscriptions were also found, as well as a large sculpture of an eagle standing on three lions.

In English archæology Dr. Auden described a series of objects, referable to the Viking age, recently discovered at York. Several of the objects have not previously been reported as occurring in England, and amongst these the brass chape of a sword scabbard, with an interlacing zoomorphic design, is of peculiar interest. The general consensus of opinion is that the finds may be referred to the first half of the tenth century, at which time Scandinavian influence in York was at its height.

The progress of the excavations at Caerwent, including the discovery of the Forum and Basilica, was described by Dr. Ashby, who also, in a paper on Sardinia, directed attention to the *nurhagi* or stone towers and their resemblance to the brochs of Caithness.

Another important archæological paper, dealing, however, with a very different area, was one in which Dr. Seligmann and Mr. Joyce described a series of prehistoric objects from New Guinea. The objects described consisted of stone weapons, engraved shells, and pottery, and are truly prehistoric, inasmuch as the present natives do not know who made them, and in some cases cannot even say for what purpose they were made. It is interesting to note that some of this prehistoric pottery is superior both in make and ornament to that now in use among the natives.

The most important papers on physical anthropology were those by Mr. Gray and Dr. Shrubsall, which opened the discussion on anthropometrics in schools. This discussion was held conjointly with Section L (Educational

Science), and will be found fully reported in the account of the proceedings of that section. Apart from these two papers, the most noteworthy contribution was one by Messrs. James and Fleure, giving an account of the progress of the University of Wales Ethnographical Survey. It is hoped to extend the survey to all the purely Welsh people, but at present only a limited area has been examined. Still, the results, although purely tentative, are very striking, and the population of the district examined may be said to fall into four distinct groups, of which two may be provisionally identified with *Homo mediterraneus* and the "Northern Race." The survey which has been so auspiciously started is one from which most important and valuable results may be expected, and it is to be hoped that the work will be energetically pushed forward, as the population is rapidly changing, and in a comparatively few years it may be too late.

In papers dealing more or less with ethnography, Mr. J. W. Crowfoot directed attention to the importance of the Anglo-Egyptian Sudan as a field for anthropological research. A great part of the district is virgin soil, and only waits the advent of the anthropologist to produce most important results, while in the northern Sudan the dervish rule has completely changed the conditions, whole tribes having been devastated, transplanted, or mixed with foreign blood. Still, the three main language groups remain, but the problem of the origin of the people using them still awaits solution. It is a matter for regret that Dr. Pirrie was unavoidably prevented from giving his promised account of the Buruns, as his observations would have had an important bearing on Mr. Crowfoot's paper.

Apart from the president's address, on "Religious Survivals," which has been reported in NATURE, the only paper dealing purely with religions was Dr. Farnell's criticisms of Dr. Usener's theories concerning Sonder-Götter and Augenblick-Götter. The divinities of which Dr. Usener treats are those which have no proper personal names, but mere appellatives, to express their functions. Such divinities are found in the Roman and Greek cults, and a few examples have been noted among savage peoples. The system may be regarded as a peculiar form of animism. Dr. Usener's theory assumes that these divinities are relics of a very primitive period, when imagination had not created concrete personal divinities, and that the Greek Pantheon was deeply indebted to this system. Dr. Farnell argued that the Greek evidence did not support these assumptions, and that many of these Greek appellative *numina* may be creations of personal polytheism, mere emanations of concrete divinities.

The subject of totemism was dealt with by Mr. G. L. Gomme in a paper on its origin. Mr. Gomme was of opinion that totemism must have arisen from conditions of human life which are universal, and which are probably supplied by migration. Sex cleavage was produced by the fact that woman was the stationary animal, and in this way became more closely associated with friendly animals, plants, &c., to which she looked for protection and food rather than to the male, who constituted a migratory element; women thus influenced the totem names. Mr. Gomme's conclusion was that totemism began as an artificial association of groups of people, and was not based on a kinship society.

Sociology was also dealt with in two papers by Dr. Rivers, one criticising Morgan's Malayan system of relationship, and the other offering some most valuable suggestions for the definition of the technical terms used by anthropologists, especially with regard to the divisions of society and marriage and descent. He urged the importance of the terms used being strictly defined, and also the necessity of some general agreement in their use being obtained.

A most suggestive technological paper was one by Prof. J. L. Myres on a terminology of decorative art. The necessity of arriving at a terminology was strongly emphasised, as persons would thus be enabled to describe by some recognised terms the arrangement and *motif* of any pattern in the same way as the herald is able to describe, without graphic illustration, the colours and component parts of any coat of arms, however complicated. The basis of any such system must be strictly technological; it must be a description of what the artist did, of the order in which he did it, and of the effect produced, and all minor elements in the design must be located by reference to the major element on which they are based. Such a terminology must, of course, be elaborated gradually, but Prof. Myres's valuable suggestions should serve as an admirable basis on which the work may be built up, and it is to be hoped that all persons interested in decorative art will assist him in his efforts to arrive at a sound scientific terminology, the practical value of which cannot be overestimated.

Attention was directed by Mr. Newbery and Dr. Bryce to what is practically an unworked field, namely, the so-called "door-step" art of the west of Scotland. The patterns, which are drawn solely by women, are of great variety, are purely geometrical and conventional, and are used to decorate doorsteps, hearths, &c. The drawings are very primitive, and represent an early stage of artistic evolution. Mr. Newbery was of the opinion that the designs were the expression of a primitive art instinct, but since they are traditional in character, being handed down from generation to generation, it seems more likely that they are a survival. However this may be, there can be no question as to their interest, both in themselves and as a field for research. Another paper of interest to which passing reference may be made was one in which Prof. Ridgeway sought to identify the origin of the crescent as a Mohammedan badge, not with the young moon, but with the well-known amulet of two boar's or other animal's claws or tusks set base to base in crescent form.

Amongst the reports of committees, reference should be made to that appointed to excavate the Lake Village at Glastonbury, which hopes to be able to complete its long work this month (August), and to the Stone Circles Committee. This committee was able to make the announcement that it had received permission to conduct excavations in the Avebury Stone Circle, from which important results cannot fail to be obtained, results which should go far towards accomplishing the object of the committee, namely, to ascertain the age of these structures.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—University College: In consequence of the removal of University College School to Hampstead, the south wing of the college buildings has been set free for university purposes, enabling the following developments to take place, beginning with the new session:—In the mechanical engineering department a new hydraulic laboratory will be provided in the basement, and also additional space for experimental work in mechanical engineering during the second and third years. A separate laboratory will be set aside for research work, thereby leaving the main laboratory entirely free for undergraduate work. In the department of electrical engineering, the present lecture-room will be replaced by a large new lecture-room with a small demonstration class-room adjoining it. The old lecture-room will be fitted up as an experimental room for advanced students. The electrical engineering department will also contain a research laboratory with apparatus and preparation rooms adjoining. The department of applied mathematics will also receive considerable extensions, providing two special research laboratories and ample accommodation for the work being carried on in the Galton Eugenics Laboratory. New accommodation will be provided for the department of geology, and include a museum, with a research room, and a lecture-room suitably equipped with lantern apparatus. Applications for the prospectus should be made to the secretary of the institution.

LORD KELVIN will open the new science buildings of Queen's College, Belfast, on September 20.

A COMMITTEE has been formed to promote the raising of a memorial to the late Major D. M. Moir, I.M.S., professor of anatomy at the Medical College, Calcutta, who died of septicæmia contracted in the execution of his public duties. It is hoped that sufficient money will be obtained to found a prize or to endow a bed, after providing for a tablet and portrait in the college hospital. The

treasurer of the fund is Dr. Suresh P. Sarbadhicary, 79/1 Amherst Street, Calcutta.

THE Paris correspondent of the *Lancet* states that the Governor-General of Algeria has brought a proposal for the founding of an Algerian university before the financial delegates, who have adopted it. It will be remembered that the late M. Moissan and Prof. Bouchard, having inspected the secondary schools in Algiers, reported favourably on the founding of a university. They proposed the establishment of an institute of natural science, experimental botany, zoology, and hygiene, and pointed out the political and social effects of the foundation of a university which would form a powerful link between the various races which form the population of Algeria.

THE secondary and agricultural school at Bigods Hall, Dunmow, which was established by Lady Warwick ten years ago to provide a scientific education in agricultural affairs for the boys and girls of the district, is to be closed. The Earl of Warwick, in a letter to the chairman of the Essex Education Committee, explains the reasons for the taking of this step. He states that, although the county committee has given the school a grant, it has intimated the possibility of a re-consideration of the educational necessities of the locality, and the headmaster has received the offer of another appointment; complaint is also made that the school has suffered from a lack of cordial support from the committee.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 19.—M. A. Chauveau in the chair.—Presentation of vol. xiii. of the *Annales de l'Observatoire de Bordeaux*: M. **Loewy.** This volume contains an account of the work done at Burgos on the total eclipse of the sun of August 30, 1905, by MM. Rayet and Courty, also actinometric observations made by M. Esclangon at Bordeaux, from a balloon, on the same occasion. The observations made during 1899 and 1900, forming the contribution of the Bordeaux Observatory to the photographic catalogue of the sky, are also given.—Symmetrical dimethylethylene oxide, $CH_2—CH—CH—CH_3$ (with O bridging the two CH groups): Louis **Henry.** A study of the reaction between this oxide and methyl-magnesium bromide. The tertiary alcohol, $(CH_3)_2.C(OH).C_2H_5$, is formed exclusively, from which it follows that this substituted ethylene oxide behaves towards the magnesium compound as though it were first converted into the isomer $CH_3.CO.CH_2.CH_3$.—The comet 1907*d*: Ernest **Esclangon.** Observations with the large equatorial of the Observatory of Bordeaux on August 1, a specially clear night, brought out many details of the comet's structure. The nucleus was brilliant, sensibly circular, and appeared like a star of 5·5 magnitude. No scintillation was noticed, from which it may be concluded that the nucleus has a real sensible diameter, corresponding to the apparent diameter of the image of about 8″. Combining this with the known distance from the earth, the nebulosity forming the head would have a diameter about thirteen times that of the earth. The structure of the tail of the comet is shown in a figure.—The results of observations made at Cistierna, Spain, during the total eclipse of the sun on August 30, 1905: A. **Lebeuf** and P. **Chofardet.** Clouds interfered with observations during totality, but measurements were made of the first and fourth contacts, a reduction of these measurements being given.—The variations of the absorption bands of crystals of parisite and tysonite in a magnetic field at the temperature of liquid air: Jean **Becquerel.** The magneto-optical properties of two crystals of the same family present close resemblances, but with marked difference in details. From the behaviour of the bonds in parisite it is concluded that either there must be an inversion of the magnetic field in certain parts of the interior of the crystal, or positive and negative electrons must exist simultaneously.—The motion of electricity without action between the electric charges and without external forces: T. **Levi-Civita.**—Some modifications which produce the splitting up of the curve of rate of decay of induced radio-activity: Ed. **Sarasin** and Th. **Tommasina.**—The atomic weight of radium: Mme. **Curie.**—The disengagement of the emanation by radium salts at various temperatures: L. **Kolowrat.** It is known that the quantity of emanation produced in unit time is constant. When the salt is in solution, the whole of the emanation is evolved, but in the solid state a part remains in the salt. The author confirms the observation of J. Curie and J. Danysz, that when the radium salt is fused the whole of the emanation is given off. At a fixed temperature the quantity of emanation obtainable from a salt previously deprived of its emanation in a given time is a function of the temperature. It results from this work that, in the application of the method of heating to the estimation of radium in minerals or other solid substances by the disengagement of the emanation, it is absolutely necessary to fuse the material.—The dissociation of calcium carbonate: D. **Zavrieff.** A repetition of the work of H. Le Chatelier, especial care being taken to secure uniformity of temperature. The dissociation pressures are given for six temperatures ranging between 815° C. and 926° C.—The alloys of nickel and tin: Em. **Vigouroux.** Alloys containing between 57·65 per cent. and 66·76 per cent. of tin treated with hydrochloric acid leave residues richer in nickel, approximating to Ni_3Sn_2; treatment with nitric acid, on the contrary, gives alloys richer in tin, tending towards NiSn. All these alloys are brittle, brilliant, and non-magnetic.—Study of the alloys of cobalt and tin: F. **Ducelliez.** Alloys containing less than 50 per cent. of tin behave as mixtures of cobalt and Co_3Sn_2, the latter remaining when the alloys are subjected to the action of dilute nitric acid.—The action of some substances upon potassium iodide: B. **Szilard.**—A new and very sensitive method for the qualitative detection of nickel: Emm. **Pozzi-Escot.** The method is based on the fact that molybdate of nickel is insoluble in presence of an excess of alkaline molybdate, whilst cobalt molybdate is very soluble under the same conditions.—The preparation of unsymmetrical halohydrins and the properties of the corresponding ethylene oxides: MM. **Fourneau** and **Tiffeneau.**—Rhinanthin: Marcel **Mirande.**—The ichthyological fauna and the age of the shell marls of Pourcy (Marne): Maurice **Leriche.**

CONTENTS.