THURSDAY, AUGUST 30, 1900.

RIGHT- AND LEFT-HANDEDNESS.

Rechts- und Linkshändigkeit. Von Dr. Fritz Lueddeckens. Pp. vi + 82. (Leipzig: Engelmann, 1900.)

THE chief interest of the treatise under consideration consists in the exposition of a variety of conditions which, in the author's opinion, are associated with that commonly known as right-handedness, a condition which is generally assumed to refer to a greater physical development and functional employment of that side of the body. Moreover, the author seeks to refer all the phenomena upon which his extended conception of right- (or left-) handedness is based to a common cause, which he finds in the existence of a higher degree of blood-pressure in the vessels of one side of the head (and in the common instance, viz. the right-handed one, in the vessels of the left side) than in those of the other. Dr. Lueddeckens is thus firstly concerned to prove the existence of such an inequality in blood-pressure as has just been mentioned, and the earlier pages of his book are devoted to this part of the subject. From an account of the embryological history of the arterial system, and the departures from original bilateral symmetry which that system presents, we are led (p. 8) to a study of the hydrodynamic conditions obtaining in the aortic arch in the living subject, and in this connection it is argued that the circumstances are such as will produce a higher blood-pressure in the left than in the right common carotid artery. The greater frequencies of cerebral hæmorrhage, and of embolism of the arteria centralis retinæ on the left side of the brain, are urged in further support of this view.

If it be conceded that the cerebral hemispheres may differ in respect of the pressure in their arterial systems, it becomes possible to divide individuals into three classes, viz. those in whom the blood-pressure is higher on the left side; those in whom the pressure is higher on the right side; and, finally, there must be a category in which will be ranged such cases as present a degree of blood-pressure which is the same in each hemisphere. The majority of cases will, it is believed, fall within the first of these divisions, and to such cases (ordinary right-handed persons) our attention is first directed: evidence is drawn from a comparison of the structures supplied by the chief branches of the common carotid arteries of each side, and firstly of the structures in the area supplied by the external carotid artery, including various superficial structures and also the ear (internal maxillary artery), and the conclusion is arrived at that there is a predominance in growth and a more easily excitable nervous sensibility (auditory sensations being especially observed) on the *left* side, such preponderance being directly associated with the higher blood-pressure on that side.

In the second place, a number of observations on the shape of the eyeball, and on the comparative dimensions of the two eyes in the same individual, are discussed. For it is argued that a difference in blood-pressure will find expression in a difference in the shape of the eyeball on the same side, and that this difference in shape will, in turn, be manifested by differences between the two eyes, in respect of sight. And it is finally submitted that observations on the respective refractive powers in the two eyes of a number of persons examined with regard to this point bear out the conclusion which was thus arrived at on *a priori* grounds.

Thirdly, differences in the size of the pupil on the two sides are taken as criteria of differences in blood-pressure, the smaller pupil corresponding to the higher blood-pressure, and *vice versâ*. Thus we should, according to the author's argument, expect normally to observe differences in this respect. But inasmuch as such difference between the pupils is, by many authorities, considered to accompany pathological conditions only, the author is at considerable pains to show that a purely physiological difference in size may exist. And so again, his arguments that the difference in blood-pressure will be manifested by a difference in the pupils, and further that the difference is normally (in right-handed persons, that is) indicative of a higher blood-pressure on the left side of the head, are considered to be justified by the number of cases in which the smaller of two "physiologically" unequal pupils was observed in the left eye.

Turning from the special domain of ophthalmic anatomy and physiology, the relative weights of the cerebral hemispheres next claim attention, and Hamarberg's results are quoted as indicative of a slight excess of weight in favour of the left hemisphere. The conformation of the several cortical areas is then described, in allusion to their well-known connection with the voluntary production of movements (and of speech in particular). Sensory phenomena are next considered, and evidence of a right-sided predominance in nervous excitability is adduced from the results of work by Biervliet (on the muscular sense, taste, hearing, sight); and lastly, psychical events are dealt with, though with much brevity owing to the difficulty of obtaining relevant evidence.

Passing briefly over the category of subjects in whom an equal blood-pressure is presumed to obtain on both sides of the head, the remaining class in which the blood-pressure on the right side of the head exceeds that on the left is dealt with much in the same way, and in nearly as much detail, as the first class; and with very similar results, *mutatis mutandis*: in other words, Dr. Lueddeckens finds in the majority of left-handed persons the various sources of evidence which have previously been detailed, and which indicate in the left-handed persons a higher blood-pressure on the right side of the head, just as they indicated this condition on the left side of the head in right-handed persons. Interesting observations on the psychical phenomena of young left-handed individuals are recorded, and in particular their difficulties in learning to write, their tendency to adopt mirror-writing, and the greater frequency of impediments to speech among the left-handed may here be noted. Finally, the tendency of the left-handed to lie on the left side during sleep is commented upon.

The foregoing sketch will, it is thought, render the

following comments intelligible. Firstly, the demonstration of an essential and fundamental point, viz. the higher degree of blood-pressure in the area supplied by the left common carotid artery, leaves a good deal in the way of direct evidence to be desired: the most important point urged in support being perhaps the comparatively greater frequency of cerebral hæmorrhage on the left side. The author admits that, as regards the brain, the confluence of the two vertebral arteries (to form the basilar) equalises the conditions on the two sides so far as the parts (medulla, pons, and posterior parts of hemispheres) supplied by these are concerned, whereas the equalising effect is not supposed to be felt in other parts of the circle of Willis. We regret that we can find no direct guidance on this point in Hill's important work on the cerebral circulation.

The arrangement of the great vessels springing from the aortic arch is also a subject that admits of a good deal of discussion in the present connection.

With reference to the auditory nerve (p. 16), and the greater sensibility of the auditory centre in the left hemisphere, it may be mentioned that some support is afforded to this view by the earlier date at which the auditory fibres running up to the first temporal gyrus in the left hemisphere acquire their medulla, and presumably attain a fully functional state (Flechsig). In his observations on the eye, the author is to be congratulated on having devised new applications of routine clinical methods to the elucidation of the questions with which he deals. As regards actual differences in the dimensions of the eyes, it is remarkable that no evidence on this subject is forthcoming from the otherwise exhaustive work by L. Weiss on the anatomy of the eye (*Anatomische Hefte*, Bd. viii. 1897). The recognition of non-pathological differences in the size of the pupils is a point on which it is worth while to insist; moreover, the phenomenon will lose little, if any, of its importance as a physical sign in the early diagnosis of certain nervous diseases (*e.g.* general paralysis of the insane). As regards the weights of the hemispheres of the brain, it may be well to remark that there appears to be a mis-quotation on p. 49, where the weight of a left cerebral hemisphere is stated to be 218 gm., and that of the corresponding right hemisphere 133 gm. only; at any rate, if there is not a mistake in quoting Hamarberg's figures, the brain could hardly be regarded as other than pathological, and consequently valueless in this connection. But more important than this is the fact that Braune's extensive weighings show that the difference between the two hemispheres is quite negligible. At the same time we may mention that, according to Bastian, the specific gravity of the left hemisphere exceeds that of the right. Finally, we do not feel inclined to agree with the author in explaining instances of the existence of double personalities on the supposed presence of equal blood-pressure in right and left common carotid arteries.

On the whole, we think that while the amount of evidence in support of the author's main assumption might well be increased, at the same time the clear record of observations, and the deliberate discussion of their significance, will render Dr. Lueddeckens' volume of much interest to biologists.

W. L. H. DUCKWORTH.

MODERN VIEWS ON THE CHARACTERS OF THE CELLULAR ELEMENTS IN THE BLOOD.

Histology of the Blood: Normal and Pathological. By P. Ehrlich and A. Lazarus. Edited and translated by W. Myers, M.A., M.B., B.Sc. Pp. xiii + 216. (Cambridge: At the University Press, 1900.)

NOT much more than a year has elapsed since the first part of "die Anæmie," by Ehrlich and Lazarus, appeared in Nothnagel's "System of Pathology and Therapeutics"; but during that short time the work has taken a foremost place among those dealing with the histology of the blood. Perhaps the most striking feature of the book is its originality, broad lines being laid down along which future investigators may work, and no subject is taken up without being enriched by some suggestive hypothesis based on interesting observations made by Ehrlich himself or some of his pupils. Although comparatively a small book, it may be said, without disparagement to the many other works on hæmatology, to be the one to which the term "epoch-making" may, without exaggeration, be applied. It is only possible to refer shortly to some of the most important subjects discussed in its pages. Although it is undoubtedly with reference to the leucocytes that the most important observations are made, there are also points of great interest treated of in the chapter dealing with the morphology of the erythrocytes. This is especially the case with regard to the authors' views on polychromatophilia as a sign of degeneration, and on the method of transformation of megaloblasts to megalocytes and normoblasts to normocytes. Not less important are the paragraphs dealing with the megaloblastic type of the blood and marrow in pernicious anæmia. But it is when the authors come to discuss the normal and pathological histology of the white blood corpuscles that we find on every page observations that shed light on points that have been long in obscurity.

Although the authors belong to a comparatively small school that believes in the absolutely distinct characters of two types of white blood corpuscles, lymphocytes and granular leucocytes, yet no one, whatever his own opinions may be, can rise from a perusal of these pages without granting that no stronger case could have been presented in support of this view than the one placed before us in this book. Perhaps it is mainly to Ehrlich and Ribbert in Germany, and Muir in this country, that we are indebted for the most powerful arguments against the view that all leucocytes are developed from the lymphocyte. The arguments presented in this book in favour of the view that there are two great types of white cells, are obtained from morphological, experimental, pathological and clinical data. The morphological characters of the different forms of white cells are first described in a very lucid manner. There is an exceedingly valuable contribution to our knowledge of the functions of the spleen in Kurloff's work on the effects of removal of that organ from guinea-pigs. The functions of the lymph glands and bone marrow are described, and additional evidence is given in favour of the two-fold type of the white blood corpuscle.

The chapter dealing with the demonstration of the cell granules and their significance is, of course, one in which Ehrlich, as a pioneer in this subject, naturally finds him-

self at home. He repudiates Altmann's claims to priority with regard to the importance of cell granules. The description of the different types of leucocytosis and leucocythæmia is exceedingly good, and perhaps constitutes the most valuable section of the work. It is unfortunate that the translator has not seized the opportunity, as he has done in the case of Kanthack and Hardy's investigations, of referring to the very important work done by Muir on experimental leucocytoses and leucocythæmia. It is to him that we are indebted in the first place for the recognition of the "leucoblastic" type of marrow in experimental leucocytosis.

Ehrlich's chemiotactic theories with regard to the emigration of different cells from their seat of formation, the marrow, into the blood, and from the blood into the tissues, &c., are presented in a most interesting fashion, although, unfortunately, it is still impossible to speak about the etiology of medullary leucocythæmia in anything but the most indefinite way. To Dr. Myers' translation one can only refer in terms of praise. Perhaps it errs at places by being rather too literal. References to Jenner's eosin-methylene blue mixture, and to Kanthack and Hardy's work, are welcome additions made by the translator and editor. Confirmation and amplification of the very important investigations of Kanthack and Hardy, and Hardy alone, on the solution of oxyphil granules when cells containing the latter come in contact with chains of *B. anthracis*, &c., would be heartily welcomed by all who are interested in the subject of leucocyte secretions. T. H. MILROY.

BIOLOGY AT WOODS' HOLL, U.S.A.

Biological Lectures from the Marine Laboratory at Woods' Holl, U.S.A., for 1899. Pp. 282. (Boston: Ginn and Co., 1900.)

THE present volume, like all its predecessors, is replete with interest and full of testimony to the activity and good work of the Whitman School. It contains the reports of sixteen lectures, of which as many as four are for the first time botanical; and although among the zoological writers we miss the names of Whitman and one or two of the most tried among his earlier collaborateurs, the effects of their teaching and example are all evident. More especially is this the case with the lectures by C. M. Child on "The Significance of the Spiral Type of Cleavage," and by E. Thorndike on "Instinct," in which certain of Whitman's most famous conclusions receive support.

Conspicuous lectures are those by C. B. Davenport on "The Aims of the Quantitative Study of Variation," and by Jacques Loeb on "The Nature of the Process of Fertilisation," each in extension of work for which these investigators are now well known. The latter writer, dealing with facts which show that the process of fertilisation and development may be produced in the egg cell by the action of certain salts, to an advanced stage, would have us believe he has transferred the problem of fertilisation from the realm of morphology into the realm of physical chemistry. There is an important address by Alphæus Hyatt on "Some Governing Factors usually neglected in Biological Investigations," in which the uniformitarian hypothesis receives a check and a defence is set up of a law of "Tachygenesis" or "abbreviated development"; and there is incorporated in it a discussion on heredity, in its bearings on Ribot's argument that it is a "specific memory," and that a form of automatism is the link between memory and habit.

T. H. Morgan continues to write on "Regeneration," and among the lectures there are two which are noteworthy as embodying full bibliographies, of service for reference—viz. those by A. G. Mayer on "The Development of Colour in Moths and Butterflies," and by G. N. Calkins on "Nuclear Division in Protozoa." Interest amounting to novelty is greatest as concerns the work of C. H. Eigenmann on the breeding habits of the blind-fishes, the Amblyopsidæ, of the Mississippi Valley, in which the discovery that the bleached condition is assumed by the young even when reared in the light, is brought forward as evidence of hereditary establishment of an effect of the environment; and as concerning a lecture by H. S. Jennings on "The Behaviour of Unicellular Organisms," in which, from the fact that a multiplicity of causes may bring about similar reactions, it is argued that organisation and not the nature of the stimulus determines the result of experiment. Of the botanical lectures, that by D. H. Campbell on "The Evolution of the Sporophyte" furnishes an argument in favour of the abandonment of aquatic life having had a potent influence in its higher development, while another by D. P. Penhallow will be useful, as giving a succinct account of the alteration and carbonisation processes undergone by vegetable organisms during fossilisation. The remaining lectures are upon the effects of temperature and currents of air upon distribution, the significance of mycorrhizas, the associative processes in animals, and the "Physiology of Secretion"; and the *tout ensemble* gives promise of increased attention in the future to questions of cytology, in both their experimental and physiological aspects, with a leaning to those which involve philosophic principles and abstract ideas. No doubt much of the biological work of the next generation will be of this type, but in view of the probability that that may stand in danger of being overdone, and of the idea that nothing remains possible on the old lines, it may be said that in the very book under review there is reached the conclusion that "it is the individual which is the unit and not the cell." In the future, when everything will need to be gone over again under an advance in methods and a better understanding, the facts of mere anatomy—the value of which there is a growing tendency to depreciate—will assuredly prove as important and instructive as in the past. Our American brethren may do well to bear this in mind.

OUR BOOK SHELF.

Brief Guide to the Commoner Butterflies of the Northern United States and Canada. Being an Introduction to a Knowledge of their Life-histories. With Illustrations of all the Species. By Samuel Hubbard Scudder. Pp. xi + 210; 22 plates. (New York: Henry Holt and Co., 1899.)

OUR notice of the first edition of this work appeared in NATURE for August 10, 1893. This is not before us while writing; but as far as we can tell without actual comparison, the present edition, as regards the letter-

press, is little more than a reprint of the first. But the plates are a welcome addition. They represent seventy-three species, without colour, carefully drawn and easily recognisable, though sometimes badly printed. The small size of the book renders it very convenient for handy reference. A European entomologist will recognise one or two old friends, such as the Camberwell Beauty, the Painted Lady, Red Admiral, and a Small Copper, hardly distinguishable from our own; but the proportions of the various families and genera are very different from what obtains in Europe. A single plate, representing five species, and another representing only six species, are enough to illustrate the Satyridæ, and the Blues and Coppers together; while a much more crowded plate is required for the Hair-Streaks, and two for the Skippers. There are also several very large and conspicuous species, including six large Swallow-Tails, and the northern representatives of several tropical genera. But although the average size of the North American butterflies is much larger than ours, and much of the settled part of the country lies much further south, the number of species in the Northern States is much smaller than in Europe, owing to the comparative absence of Satyridæ and Lycænidæ; and it is not till we reach the frontiers of Mexico that the vast wealth of the tropical American butterfly fauna (almost equalling that of all the other continents put together) begins to dawn upon us.

W. F. K.

Elements of Qualitative Analysis. By G. H. Bailey, D.Sc., Ph.D., and G. J. Fowler, M.Sc. Pp. 115. (Manchester: J. E. Cornish, 1900.)

AMONG the distinctive characteristics of this addition to the already numerous volumes on practical chemistry are: the prominence given to the recognition of common elementary substances by an examination of their simple physical and chemical properties, the attention given to dry methods of analysis, and the series of flame-reactions. These sections provide students of practical chemistry with excellent exercises in manipulation, and will counteract the belief that the best way to analyse a substance is always to dissolve it and go through the usual routine treatment of solutions and precipitates. There is little sympathy with ordinary qualitative analysis at the present time, but where the subject is taught it should be taught intelligently; and as this little book provides a reasonable course of laboratory work, it merits a trial.

LETTERS TO THE EDITOR.

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Railways and Moving Platforms.

ABOUT twenty years ago I was in the habit of speaking with Prof. Ayrton and other friends about a scheme which might increase ten-fold the carrying capacity of the Underground Railway. I prepared a letter for the *Times* newspaper about two years ago, but at the earnest entreaty of a friend I applied for patent protection for the scheme, and did not publish the letter. I have not proceeded with the patent, and wish now that I had published the letter. Indeed, I wish that, instead of merely talking the matter over with friends twenty years ago, I had published what I had to say.

Travelling now on the new Central London Railway, one feels that there is enormous waste of energy and of time in starting and stopping the trains. Again, a train must not be longer than the platform. On my scheme the train does not stop, and the longer it is the better. Indeed, I can imagine an endless train keeping a perfectly constant speed all the time.

My scheme is easy enough to understand now that moving platforms are common. After passengers enter a station I get them gradually into a state of motion, so that moving alongside the train and at the same speed, they may enter and other passengers may leave. There are many ways in which the scheme may be carried out. From a wayside station passengers may enter an express train which does not stop, in the following way. They enter a small train at the station; this train gradually gets up a speed equal to that of the express; it runs alongside the express at a particularly well-laid part of the line; there is an exchange of passengers, and the local train gradually comes to rest again at the station.

For the Underground Railway, the method which most commended itself to Prof. Ayrton and me long ago was this. At a station, say St. James's Park, the platform was a carefully constructed turntable, 500 feet in diameter, the rim of which travelled at 8 miles per hour. The whole area was not really a floor; it was only a skeleton of a turntable, being an outer rim 8 feet broad and many radial passages. The very long train to Mansion House, travelling at 8 miles per hour, was close to the rim of the turntable; indeed geared with it in a rough, simple manner for less than half its circumference; the train from Mansion House did the same on the other side. I need not speak of the automatic opening and closing of the doors of the train.

A passenger, let us say second class for Mansion House, takes his ticket and descends a spiral staircase, which revolves so slowly that even the frailest and most timid of old ladies is not frightened; in fact, it revolves on its own axis once in 134 seconds. At the bottom the passenger sees a few notices; one of them saying second class, Mansion House, has a hand pointing along a radial passage, and this is followed. As the passenger moves radially, he does not notice that he is gradually getting up speed circumferentially. He does not notice that the floor gets slightly inclined as he moves out, to counteract the small effect of centrifugal force. When he reaches the outside of the platform he probably finds a train there, seemingly at rest, with the doors open, and he enters it, moving perhaps along the platform, choosing one compartment rather than another. If he is lucky he has about one minute in which to make his choice. But he will notice near him on the platform an altering time signal which tells him how much more time he has to waste: 50 seconds, 40, or 30, or 20, or 10; if he delays after the signal says 0, an iron railing will come between him and the train; he will see the train moving laterally away from the platform, and he must wait seventy-four seconds before he sees a train coming laterally towards him; the railing goes away, and he has again sixty seconds in which to enter.

If he had a third class ticket to South Kensington, he would have proceeded in exactly the same way. Also every passenger wanting to leave the train at St. James's Park had sixty seconds in which to do it. Trains at 16 miles an hour give only half these times. A platform of only 250 feet diameter would give only half the time if the train speed was 8 miles an hour. I need not dwell upon the details of this and other methods which suggest themselves. It may be soon or syne, but I feel sure—I have felt sure for many years—that my method will have to be adopted.

JOHN PERRY.

August 11.

Snow-drifts on Ingleborough.

IN his interesting letter on "Snow-drifts on Ingleborough in July," Prof. Hughes describes what may be called the first stage in the formation of a glacière. These ice-caves, not very rare in parts of the Alps and Jura, were made by the present Bishop of Bristol the subject of an attractive book (published thirty-five years ago), and have been occasionally noticed in the earlier volumes of NATURE and elsewhere. I have always believed that snow, drifted into caves during the winter, was the initial cause of these natural ice-houses (about half a dozen of which I have visited), and can quote a case from the Alps which is a slight variation of that described by Prof. Hughes. On July 24, 1873, I went up the Pic d'Arzinol (9845 feet) from Evolena in the Val d'Hérens, and on the way down—so far as I remember between five and six thousand feet above sea-level—my guide diverged from the track to show me what he called the Pertuis Freiss. These were two fissures, apparently joints, opened by a slight subsidence. A description of one will serve for both, except that there was hardly any descent to its floor. The fissure extended some four yards into the hill, and was at widest about as many feet. Ice was patched about the floor, and in places

formed a plaster on the walls, its thickness being at most three inches. It showed prismatic structure, though rather small. The air within was cold (I had no thermometer); but as the surface of the ice was wet, it was above 32° F., though I think not much. The guide told me that the fissures in winter-time were filled with snow. This accumulation, probably owing to the shape of the fissure, no longer remained as snow, but was represented by the ice on the floor and walls, which the guide said seldom, if ever, disappeared. The absence of ice from the walls of the Ingleborough "swallow hole" was probably due to some exceptional dryness of the rock; but Prof. Hughes has undoubtedly found a "baby" ice-cave, like that I have described, and it will be worth examining some more of these dry shafts to see whether a slightly better developed specimen may not be lurking in the neighbourhood. T. G. BONNEY.

Permeability of Iron under the influence of the Oscillatory Discharge from a Condenser.

IN your issue of August 2 there is an abstract of a very interesting paper, read by Prof. Trowbridge, on his experiments with a battery of 20,000 secondary cells. In it he mentions that the permeability of iron when under the influence of a very powerful discharge from a large condenser is now under observation.

I should like to draw attention to some experiments I was making over a year ago in Lord Blythswood's laboratory (an account of which has not yet been published), in which I have gone into the subject in some detail.

In my experiments the lowest frequency used was about 5000 a second. I enclose two photographs of sparks taken in

FIG. 1.

the usual way with a revolving mirror. The discharge in photograph (1) took place through a coil of about 5 millihenrys self-induction from a battery of Leyden jars of a total capacity of ·06 microfarads, the potential difference between the coatings, before discharge, being 13,500 volts. In photograph (2) a fine wire core, consisting of 550 No. 28 soft iron wires, was inserted

FIG. 2.

into the coil (which was wound on a hollow paper spindle of about 1·3 cm. internal diameter). The other conditions of discharge were identical in the two cases; the speed of the mirror, however, was 19 revolutions per second for photograph (1), and 16 per second for photograph (2), thus tending to draw out the spark more in the first photograph.

The essential differences are, however, well marked. At the beginning of the discharge we have the "pilot" spark, first noticed by Prof. Boys; and then in the photograph (2), taken with the iron wire cores, a series of oscillations gradually increasing in length. The first half-oscillation, however, is nearly twice as long as the half-oscillations in photograph (1), when there were no iron wire cores in the coil. The increase in the time for a half-oscillation is due, of course, to the increased self-induction of the coil on account of the iron; and the gradually-increasing length is due to the increase in permeability of the iron as the intensity of the discharge dies away. In photograph (1) the frequency of oscillation of the spark taken with the coil having air cores is about 9000 per second, and in (2) the approximate magnitude of the current during the first discharge with the iron cores, 15 amperes.

It would be impossible in the course of a short note to describe in detail the work that has been done, but in numerous experiments (over three hundred spark photographs have been taken) that have been made, the iron has been found to behave in the same way under these oscillating magnetisations as it does when steady currents are used to produce magnetising forces of the same intensity. In most experiments single layer coils have been used in which the magnetising forces due to a given current can be calculated, and it has been possible to determine approximately the forces acting on the iron. From the results, curves showing the variation in permeability with magnetising force have been plotted. In some experiments, the magnetising current due to the discharge has been as large as 1000 amperes. In order to obtain discharges as powerful as this, a very large glass-condenser has been used with a total capacity of 1·5 microfarads, made up of plates of glass (coated with shellac) 1·6 mm. (1/16″) thick. The conducting surfaces are of tinfoil. The glass appears a great deal stronger than that used by Prof. Trowbridge, as it has been tested repeatedly at 20,000 volts. It is possible, however, that the suddenness with which his condenser is charged from his cells may account for the readiness with which the glass breaks. In my experiments the condenser was charged by a large Wimshurst machine of 160 plates, which took almost half a minute to get up the full potential of 20,000 volts. The glass used is known technically as 15 oz. 3rds selected flat sheet, and was obtained from Messrs. Malloch, of Glasgow. E. W. MARCHANT.

Blythswood Laboratory, Renfrew, August 7.

Function of the Whips of the Larva of the Puss Moth.

YOUR correspondent (p. 389) will find a detailed account of the various defensive appliances of the larva of *Cerura vinula* in Prof. Poulton's work on the "Colours of Animals" (International Science Series), and in papers published by him in the *Transactions* of the Entomological Society of London for 1886 and 1887, the latter papers being illustrated by beautiful coloured plates.

It is usually believed by entomologists that the function of the "whips" in the caudal appendages of the larva is to drive away, or frighten away, Ichneumon Flies or other enemies, but there is still room for further inquiry; and although the larva is highly protected, it is liable to the attacks of some species of Ichneumon Flies, though it may be able to defend itself against others, for the protection of no animal is absolutely complete.

The appendages are doubtless homologous with the retractile fleshy fork in the neck of the larvæ of the Swallow-tailed Butterflies (Papilionidæ), which probably fulfils a similar function. W. F. KIRBY.

Hilden, Sutton Court Road, Chiswick.

The Migration of Swifts.

ON the morning of Friday, August 10, I witnessed a large flight of Swifts travelling westward along the Sussex coast. The birds were passing this place in a continuous though thin stream for several hours; I saw them myself from 10 a.m. when I first visited the shore, and watched them till 12 noon. A few birds were also noted travelling in the same direction between 5 p.m. and 6 p.m. The day was bright but showery, and a fresh W.N.W. breeze was blowing at the time, so that the birds were flying almost against the wind; they flew low, seldom rising fifteen feet in the air, and often passing within two feet of my head as I lay on the shingle; they kept to the coast-line and for the most part over the top of the fringe of tamarisks that here stretch for miles just above the shingle. Since that day I have not seen a single Swift in the neighbourhood, in spite of having travelled on my bicycle as far west as the mouth of Chichester Harbour along the coast, and to various places north of this line as far as Chichester and Arundel inland. It would be interesting to know if other observers witnessed any similar flights on August 10, and also if Swifts are still to be seen in any places in our islands at the present time. I have on two previous occasions seen Swifts arrive on the east coast of Norfolk as late as the first week in September (after a complete dearth of the birds for some three weeks), and depart again after a few days' sojourn—these perhaps are migrants from the European continent. As many of your readers are now doubtless at the seaside, it seems a favourable opportunity to ask them to keep their eyes open and record any facts that they may observe bearing on the movements of these birds. OSWALD H. LATTER.

East Preston, near Worthing, August 19.

UNITS AT THE INTERNATIONAL ELECTRICAL CONGRESS.

AT the suggestion of Prof. Hospitalier, Section I. of the Congress agreed that the following should be the members of the Commission on Units:—Messrs. Ayrton (Great Britain), De Chatelain (Russia), Dorn (Germany), De Fodor (Hungary), Eric Gérard (Belgium), Hospitalier (France), Lombardi (Italy), Kennelly (United States); and at the first meeting of the Commission, on August 21, which was attended also by Prof. F. Kohlrausch and Sir W. Preece—whose names had been added to the list of the Government delegates for Germany and England—a report presented to the Congress by the American Institute of Electrical Engineers was taken into consideration. This report had been drawn up for that Institute by a committee appointed for this purpose, and it contained the following resolutions:—

(1) We consider that it is necessary to give names to the absolute units in the electromagnetic and electrostatic systems, as well as convenient prefixes to designate the decimal multiples and submultiples of these units in addition to those already in use.

(2) The International Congress of Electricians, which will take place this year in Paris, should be invited to choose the names and the prefixes.

(3) A great advantage would be gained by a rationalisation of the electric and magnetic units, and the Congress should be invited to find ways and means to obtain such a rationalisation.

The proposition to rationalise the units—that is, to change them so that the coefficient 4π should not appear—was withdrawn by Dr. Kennelly on behalf of the United States; as well as the suggestion regarding the employment of prefixes, and it was resolved that:—

The Commission will only deal with propositions that will introduce no change in the decisions arrived at at previous congresses.

A long discussion then took place as to whether it was really necessary to give names to the C.G.S. units either in the electrostatic or the electromagnetic systems, and finally it was agreed to withdraw the proposition so far as it dealt with the electrostatic system.

The desirability of giving a name to the unit of magnetic field and to the unit magnetic flux was strongly urged, and as the names of *Gauss* and *Weber* had been employed for some years in America for these units respectively, the advantage of adopting these names for the C.G.S. units of field and flux was advocated. On the other hand, the resolution arrived at by the Electrical Standards Committee of the British Association in 1895 to employ these names respectively for other units was pointed out. Finally, the Commission, at the end of their second sitting, on August 22, recommended the following:—

"The Commission is not of opinion that it is necessary to give names to all the electromagnetic units.

"However, in view of the use already of practical instruments which give the strength of a magnetic field directly in C.G.S. units, the Commission recommends that the name *Gauss* be assigned to this unit in the C.G.S. system.

"The Commission proposes to assign to the unit of magnetic flux, of which the magnitude will be subsequently defined, the name of *Maxwell*."

These resolutions were brought before Section I. of the Congress on August 24, and led to a long discussion. M. Mascart opposed the giving a name to the C.G.S. unit of magnetic field. The employment of practical instruments for the direct measurement of the strength of magnetic fields in C.G.S. units was not, in his opinion, a sufficient reason for assigning a name to that unit. Besides, this decision of the Commission appeared to be contrary to the spirit of the Congresses of 1881 and 1889, which did not give the names of men to the C.G.S. units. He admitted that the name of a man might be given to the practical unit. In any case, the name of "Gauss" seemed to him liable to give rise to confusion, for Gauss was the originator of the first absolute system employed, viz. that of the "millimetre-milligramme-second" system, and that system, as distinguished from the "centimetre, gramme, second" system, was still in actual use in certain cases—for the measurement of the earth's field, for example.

Prof. Kohlrausch said that the "absolute units" were enough for the physicists, but that, if the engineers felt the need of practical units, Dr. Dorn and he did not see that any inconvenience would arise from names being given to them, such as those of Gauss and of Maxwell, for example. The German delegates could not, however, commit their Government in the matter, and they considered that the Congress should limit its recommendations to the use of these new names without seeking that legal sanction should be given to them.

Prof. Ayrton agreed with M. Mascart, and mentioned that during the past five years many "Ayrton-Mather Field Testers" had been constructed to read off the strength of a magnetic field directly in C.G.S. units, but that no need for any special name for that unit had been felt in connection therewith. He added, however, that, while holding the opinion expressed by M. Mascart that it was not desirable to give the names of persons to the C.G.S. units, the units of field and flux had this peculiarity, that without any multipliers they were the practical units adopted.

To this M. Mascart replied that the word "practical" in this connection was ambiguous, since, although it was true that the C.G.S. units of magnetic field and flux were employed in practice, they did not belong to the so-called "practical system."

M. Hospitalier appealed to the Section to give names to the unit of field and the unit of flux. He did not ask for any legal decision in the matter, for the names were put forward as a simple recommendation to the Section.

After a discussion in which Messrs. Ayrton, Carpentier, Dorn, Hospitalier, Kohlrausch, Mailloux, Mascart, A. Siemens, Silvanus Thompson and others took part, Prof. Eric Gérard stated that in his opinion it was desirable to come first to a decision that names should be given to the C.G.S. units of magnetic field and to flux of magnetic induction.

M. Mascart, expressing his approbation of this idea, the president of the Section, M. Violle, put the following proposition formally to the meeting:—

"The Section recommends the adoption of specific names for the C.G.S. units of magnetic field and of magnetic flux." This proposition being adopted, with only two dissentients, the meeting was adjourned for a short time to enable the members to exchange their views regarding the exact names that should be employed. On the meeting reassembling, the president put the two following propositions successively:—

(1) *The Section recommends the adoption of the name of* GAUSS *for the C.G.S. unit of magnetic field.*

(2) *The Section recommends the adoption of the name of* MAXWELL *for the C.G.S. unit of magnetic flux,*

both of which were adopted with only two dissentients.

On the same afternoon these resolutions of Section I. were submitted to the Chamber of Government Delegates to the Congress and adopted, and finally, at the closing meeting of the Congress on Saturday, August 25, the action which had been taken in the matter was formally reported by M. Paul Janet, one of the two secretaries of the Congress.

THE AMERICAN INSTITUTE AND THE ENGLISH INSTITUTION OF ELECTRICAL ENGINEERS IN PARIS.

STARTING with a trip in electric launches up the Thames on Sunday, August 19, a lunch at Henley, visits to electric works in London and its neighbourhood on Monday, a dinner in the evening with many Anglo-American patriotic speeches, a trip to Chatham on Tuesday, inspection of the dockyard, a second lunch, more speeches, and a reception by General and Mrs. Fraser in the afternoon, the members of the two electrical societies prepared themselves to encounter a somewhat blowy passage in journeying together to Paris.

On Thursday, August 16, the formal joint meeting was held in the large hall of the American Pavilion at the Exhibition, with Mr. Carl Hering, the president of the American Institute, and Prof. Perry, the president of the English Institution, as joint chairmen. The American, unlike the British Royal Pavilion, is a large circular building stretching uninterruptedly from floor to dome with a series of galleries running round it, and it is fitted up as a kind of huge commercial club, whereas the British Pavilion has been designed to represent an old English manor house, and contains a loan collection of the finest examples of the British school of painting, chiefly of the eighteenth and early nineteenth centuries.

When one remembers the invasion of England with American machinery—especially electric machinery—one envies the commercial instincts that have produced the American Pavilion, with all its facilities for aiding commerce, its lifts, the doors of which magically glide open and shut again on touching a button, and in which you are rapidly and noiselessly wafted to any of the many galleries.

In our Pavilion, on the contrary, commerce has been relegated to a top room, reached by a back staircase, entered literally through a back door, and the lift connected with this commercial room has not advanced—and never will advance—beyond the construction of the well for it. But walk in at the front door, and you can feast your eyes on the work of Gainsborough, Reynolds, Romney, Constable, Turner, Lawrence, Hoppner, Opie, Hogarth and of others; and, after the roar of the Exhibition, the grinding of the moving platform running all round it, and the rumbling of the electric railways, you feel as if you had passed out of the whirl and money making of a factory into the peace and grandeur of Westminster Abbey. Why, however, has the British Royal Commission made so little use of this treasure on the Quai d'Orsay?

Mr. Hering welcomed the members of the two electrical societies present, and expressed the hope that this meeting might be the forerunner of many joint meetings, the next of which he hoped to see held in the United States, and an invitation to attend that meeting he daintily expressed in English, French and German.

Prof. Perry followed, and stated that, although no minutes could be read of any previous joint meeting, minutes of the present meeting were being taken, as he felt sure that there would be another joint meeting at which they would have to be read.

Prof. Mascart rose to express the thanks for the honour which the English Institution had done him in electing him one of their four vice-presidents some months ago. He hoped that not only might there be a joint meeting of the two societies in the United States—at Philadelphia, for example—but that it would be one at which all the Institutions of Electrical Engineering in the world would be represented. And although he feared that advancing age might prevent his being present, he would none the less co-operate in spirit.

The special subject dealt with at the present joint meeting was:—"The Relative Advantages of Alternate and Continuous Current for a General Supply of Electricity, especially with regard to Interference with other Interests," and the discussion was opened by Mr. Ferranti. He stated that this was not a continuation of the old contention between the relative advantages of direct and alternating current, for the rivalry which formerly existed between the two systems, and which led the advocates of the one to regard everything as absolutely wrong which was done by the advocates of the other, was luckily dying out. Engineers had begun to realise that the direct and the alternate current systems of electric distribution had each their separate functions, and the object of the present discussion was to elicit an expression of opinion as to whether the "interference with existing interests" did not furnish an important consideration in the choice of the system to be adopted in a particular case. It was not merely, he urged, the damage to water and gas pipes that was *now* being caused by the employment of the direct current that had to be taken into account, but they had to bear in mind the value of the underground property that might be injured ten years hence if the great development of the distribution of electric energy, which must necessarily take place in that period, were carried out on a wrong plan. He concluded by expressing the opinion that the difference in the magnitude of the disturbance caused by the two kinds of current was very great.

Mr. Arnold next spoke as a member of the American Institute—it being arranged that representatives of the two bodies should speak alternately. He drew attention to the difficulty of using the alternate current for general distribution arising from the inability to satisfactorily balance the load, and he considered, therefore, that the direct current system was the better. And, in view of the difficulties which attended the employment of the alternating current for driving electric tramcars, he considered that in this case also the direct current was the one to be adhered to.

Sir William Preece reminded the meeting that he has not given his adhesion publicly to either the direct or the alternating current system, and, therefore, that he was in a position to speak quite impartially. He considered that the interference of alternating current circuits with telephone lines could be entirely overcome by the employment of a metallic return for the telephone, but it had to be admitted that the surgings which occasionally took place in alternate current circuits disturbed the block signalling on railways. He referred to a case in France where the triphase alternate system of working had supplanted the direct current one, and suggested that this was an indication of the increasing appreciation of the former method, and that the capacity of long cables introduced a serious difficulty with alternate current transmission.

The variety of frequencies employed by the various companies—the London Electric Supply Company, for example, using a frequency of 67, while the City of London Company employed 97—he regarded as objectionable, and he hoped that this joint meeting would deal with the importance of arriving at a uniform standard of frequency. He also suggested that the relative advantages of underground and overhead conductors might well occupy the attention of the meeting.

Dr. Kennelly spoke of the relative fields for direct and alternating currents, and gave as an example that with an isolated plant of moderate size a direct current at a pressure of 100 volts might be employed, while if the area to be dealt with was larger, the current might still be direct, but a pressure of 200 or 220 volts would have to be resorted to, whereas when the area became large, transformation became necessary, and for that the alternating current was, of course, especially well adapted.

He referred to the growing use of high pressure alternating currents for transmitting power to tramways, and performing a double transformation for supplying the low pressure direct current for driving the electromotors on the cars; and he considered that this unnecessary complication arose from the tramway motor having been developed as a direct current motor, and from the difficulty that would now be experienced in replacing the many tens of thousands of direct current tramway motors with an alternating current type. In the case of new tramways and railways, at any rate, he looked forward to the time when the alternating current would alone be employed, but he admitted that the electric simplification would be accompanied with greater risk of shock and danger to life.

As to the interference that might be caused by electric tramways to magnetic observatories, he thought that, in view of the far greater commercial importance of the tramway, the magnetic observatory would have to give way, and remove its apparatus to a place where electric tramways were not required by the public.

Prof. Ayrton expressed the view that, since no doubt existed as to the considerable damage that electrical undertakings had caused to underground pipes, telephones, submarine cables and magnetic observatories, the question arose whether an endeavour was to be made to prevent the attack or to strengthen the defence. In the case of telephone circuits the Joint Committee of the two Houses of Parliament in England had decided that since—wholly apart from the advent of electric tramways—the Telephone Companies had realised that, in order to prevent interference between the telephone lines themselves, as well as to prevent the disturbance caused by neighbouring telegraph lines, it was necessary to abandon the earth-return and employ a metallic return, and since such a metallic return would shield the telephone circuit from disturbance that might otherwise be caused by electric tramways, there was no necessity to debar the tramway from employing the earth.

But as regards the electrolytic destruction of gas and water pipes the matter was quite different, and, therefore, the Board of Trade had imposed a regulation forbidding the difference of potential between any part of the rail and the terminal of the dynamo being allowed to exceed 7 volts. Prof. Ayrton pointed out, however, that this limit was too high even to prevent electrolysis, and certainly would not prevent the mutilation of messages received through a submarine cable which was landed in the neighbourhood of an electric tramway, as instanced at the Cape of Good Hope.

He questioned whether the security anticipated by Mr. Ferranti and others that would follow from a general substitution of alternating for direct current would be nearly as great as was imagined, and he referred to the experiments which he had published some years ago on the comparatively rapid production of separated hydrogen and oxygen that could be obtained in an ordinary sulphuric acid voltameter, through which an ordinary *alternating* current was passing. The specimen of a pipe corroded with an *alternating* current of one ampere passing for six weeks lying on the table, and which had been sent to the meeting by Mr. Trotter, of the Board of Trade, was an important illustration of the electrolytic action that could be produced with the commercial alternating current supplied by the London Electric Supply Company.

A magnetic observatory was in a more serious position still, since, as the undisturbed magnetism of the earth had to be measured, no system of defence could be utilised, and nothing short of the absence of attack could be satisfactory. He was glad, therefore, to say that the Electric Tramway Companies in London, thanks to the action of the Board of Trade in appointing a joint committee to represent the commercial and the tramway interests, and thanks to the experiments and the negotiations carried out by this committee during the past eight months, had not regarded the preservation of magnetic records from the drastic point of view advocated by Dr. Kennelly. In fact, the president of their Institution, Prof. Perry, in co-operation with Prof. Rücker, had succeeded in inducing the London Tramway Companies to propose a scheme in which, first, all the lines within a radius of two miles round the Kew Observatory should be divided up into absolutely *distinct one mile sections*; secondly, that the current should be led to the trolley wire and withdrawn from the rails at the *middle* of each of these sections; and, thirdly, the difference of potentials between the rails and the earth within this two miles radius should never be allowed to exceed one-fifth of a volt. And with these conditions, calculation showed that, although the protection afforded would not, of course, be as good as that obtained with a wholly insulated system, it would be probably sufficiently great to prevent any appreciable interference being caused with the magnetic observations regularly taken at the Kew Observatory.

M. Corda thought the adoption of the alternate or the direct current was mainly a matter of cost, and since the Fire Insurance Companies allowed the maximum pressure to be used with the alternating current to be only half as great as with the direct current, he considered that as long as that regulation lasted the direct current must gain the day.

Prof. Crocker said that the interference produced by an electric circuit on another undertaking might be divided into that produced by induction and that produced by leakage. The disturbance of the apparatus in a magnet observatory was due to both causes, but, as there were so few magnetic observatories in the world, that particular disturbance might be dismissed from consideration. With alternating currents the disturbance produced by induction was the more serious because this induction set up currents in other wires, and it was, therefore, very difficult to avoid. With direct currents the leakage disturbance was the more serious, but it was possible to prevent this. Some time ago he had had occasion to test the insulation of the whole of the New York electric lighting system, which was split up into sections for this purpose, and he found that the current which leaked to earth did not exceed one per cent. of the current that was supplied to the houses, whereas with the gas system in New York from 10 to 20 per cent. of the gas was lost by leakage. Consequently, since very high insulation could be obtained with the type of underground cables that were employed with high pressure work, it followed that the leakage on the low pressure electric light system employed in New York could be reduced to a still lower value than one per cent. Further, that if it were possible in London to reduce the potential difference between the rails and the earth to only half a volt, he should imagine that electrolysis might be avoided even with the ordinary trolley wire tramway. He was, therefore, in favour of employing the direct current for the purpose of avoiding interference with other interests.

But he considered that the considerations of economy and efficiency were more important than those regarding interference, and, while the three-phase and the direct current motors of the same power had the same efficiency from half up to full load, the direct current motor was the more efficient for small loads. Further, while for constant speed the regulation with both types of motor was about the same, the direct current motor had a distinct advantage in regulation when the speed was variable. On the whole, therefore, he was in favour of the use of a direct current system of electric supply.

Mr. Mordey, on account of lack of time, dealt shortly with the drop of pressure along the rails of an electric tramway, and stated that he had found that when the length was even 28 miles, the difference of potential between any parts of the rails and the generating station could be kept down to 7 volts; and he referred to the much greater attention that was given in England than in America to reducing the maximum drop of pressure along tramway rails. The employment of rotary transformers, as on the new Central London Railway, he deprecated as a makeshift, and suggested that, if the cost of all the transformers employed along the 6 miles of the route had been capitalised, it would have paid the company to have employed far thicker conductors. As regards the difficulty arising from the capacity of long underground cables traversed with alternate current, he pointed out that no difficulty in overcoming the effects of capacity had ever been met with in dealing with the 250 miles of underground cable in St. Petersburg. The Board of Trade had succeeded in using such instruments in their laboratory at Westminster that no interference could be caused by the construction of any electric tramway in the neighbourhood; therefore, he deplored the resistance that had been successfully offered a few years ago by a London college to the passing of a Bill for the construction of an underground electric railway near that college.

Mr. Mailloux pointed out that the small power-factor obtainable with alternate current motors, and the greater change in speed with a change in the E.M.F. that was experienced with alternate current than with direct current motors, was a serious objection to the employment of the former, and he instanced a case where the large current that was necessary for starting an alternate current motor had led him to adopt a direct current system in a sugar factory where 2000 horse-power was employed. The Fire Insurance Rules in the United States, which compelled the use of iron conduits, but which did not require that both the going and return conductors should be enclosed in the same iron tube—a condition, however, rendered necessary if alternate currents were employed—led to an important economy being obtained by using two separate conductors in separate iron tubes, which was, of course, quite possible with a direct current.

Prof. S. P. Thompson expressed his surprise that in wiring ships for electric lighting, where the possible disturbance of the compasses was a vital consideration, the direct current and two pole machines, the worst type to use, had been frequently employed even by the best firms, like that of Messrs. Siemens. He looked forward to seeing the use of multipolar machines on board ship, and of the alternating current; for not only would the compasses be then secure from disturbance, but there would be much greater freedom from electrolysis in damp places, and therefore of fire. He pointed out that the alternate current lent itself so readily to the use of efficient *low* voltage glow lamps combined with economic *high* voltage transmission; and finally that, since it was impossible to employ any device to screen a magnetic observatory from magnetic disturbance, since such a device would cut off the effects produced by variations of the earth's magnetism which the observatory existed to measure, there was a strong reason for running electric tramways with alternating current in any city where a magnetic observatory existed.

At the close of the preceding discussion, M. Hospitalier, Mr. Gavey, Mr. Hering and General Webber referred to points of special and novel interest in the several electrical sections of the Exhibition, in connection with which they had served as jurors; and in the afternoon these gentlemen acted as guides in taking parties of members of the two electrical societies to view the exhibits which had been specially mentioned.

THREE BOOKS OF POPULAR NATURAL HISTORY.[1]

MR. HUDSON has never written any book that is not extremely pleasant to read, though since he settled in England he has never had so much to tell us as was told in his "Naturalist in La Plata." That book, though it may not be his own favourite, will always, if we are not mistaken, be reckoned as his best; and the reason is simply that it treated of animal life among which *he* was entirely at home, and of which *we* knew little or nothing. His English books have not this quality, though they have many other excellences. The one before us, for example, is charmingly written, full of grace and feeling, touched with a tender and sympathetic imagination, made piquant by a certain quite inoffensive egoism; but, as we read in his pages of the South Downs, we are forced to recognise the fact that he is not of them. He is a stranger there—a most appreciative one, it is true—but still a stranger. It is perhaps given to few who have not been bred among the Downs to enter fully into their spirit, and we will not deny that Mr. Hudson, rambling alone through their sweet air and lying on their delicious turf, has caught it as none could do without rare gifts of sympathy and observation; yet there is something missing.

It is not pleasant to have to find fault with a book so readable; but a naturalist cannot but regret that Mr. Hudson should have given himself up so entirely to *impressions* throughout a volume of just three hundred pages, that no real contribution to natural history is to be found in them. He notices an interesting point, writes a charming paragraph about it, and leaves it, sometimes without making it clear what plant or creature he is talking about. To take an example: he has observed that the banded variety of *Helix nemoralis* is almost the only one to be found on the high downs, and that its bright coloration does not save it from the thrushes; but he does not pursue this fact, which has attracted the attention of conchologists and suggested at least one interesting explanation. Snail life on the downs is, indeed, so extraordinarily abundant, that a book which contains so much pleasant reading about the down turf is hardly complete without a chapter specially devoted to it. The same may be said of his remarks on insect life; he tells us of the common blue butterfly, and its habit of clinging to the bents, but of other blues he says nothing; a skipper is mentioned, but we are left in the dark as to the species. In writing of a certain fly, he declares that neither books nor entomologists have been able to tell him its name, and leaves it with a few words of good-natured contempt for the specialism of the present age. A little more exactness in a book by a naturalist, which naturalists may be expected to read, would have greatly added to its permanent value. Even men of letters may complain when they find an allusion to Arthur Young's famous "Tour through Great Britain in 1727." What book can this be?

The best chapters are those which deal with the birds and the human beings of the downs. Shepherds and shepherd boys are delightfully pictured; and Mr. Hudson has discovered for himself the pleasing habit of the ruddy-faced shepherd lads in adorning themselves with wild flowers. About the birds he has plenty to tell us—it is his own subject; and the chapter on "Shepherds and Wheat-ears" will be read by all ornithologists with mingled pleasure and pain. All that he writes of the singers of the downland is beautiful and true; perhaps the songs of the stonechat and whinchat have never

[1] "Nature in Downland." By W. H. Hudson. Pp. xii + 307. (London: Longmans, Green and Co., 1900.)
"The Birds of Cheshire." By T. A. Coward and Charles Oldham. Pp. 278. (Manchester: Sherratt and Hughes, 1900.)
"In Birdland, with Field-glass and Camera." By Oliver G. Pike. Pp. xvi + 280. (London: T. Fisher Unwin, 1900.)

been so well described. Of the linnet, too, he says most truly that it has one note, and only one, of almost unapproachable musical beauty. The singing of the skylarks, that invariable accompaniment of down life, is described with all Mr. Hudson's wonderful sympathy and delicacy of language; but what are we to say of his belief that the highest notes of this bird may be heard on the downs at a distance of three miles? It is a belief which it would hardly be possible to test.

"The Birds of Cheshire" is an excellent book of its kind. The first essential of such a compilation is that it should be unimpeachable as a record; and, so far as we can discover, the compilers have here used both pains and judgment in testing the records of others, while their own experiences are recorded simply and faithfully. Thus a real step is gained in the collection of valuable material for that comprehensive work on the distribution of birds in these islands which we may hope to see in due time. There is no superfluous matter in this volume, and no

FIG. 1.—Bearded Tit feeding young.

attempt at fine writing; and excellent paper, print and binding combine to make it a very pleasant book to handle. The half-dozen plates of Cheshire scenery are very effective, and nothing is wanting, unless it be a rather better map of the county.

The avifauna of Cheshire, as the authors remark, is surprisingly poor; the county does not lie upon any regular line of migration. It is too far north for the nightingale, which has seldom occurred, though we note that it has been recorded by that excellent observer, Rev. C. Wolley-Dod. The lesser whitethroat, as might be expected, is not common, nor is the grasshopper warbler. We should have expected the pied flycatcher to be more common than seems to be the case; the tree sparrow, a bird of peculiar distribution, has probably been often overlooked. The goldfinch and linnet are decreasing in numbers, but the opposite is the case with the turtle-dove. The list of waders, gulls, and birds of the coast, is not very large, and we regret to find that the ubiquitous golfer is contributing to its further diminution. The characteristic bird of the county is a noble one—the great crested grebe, which is widely distributed; and in dealing with it the authors have allowed themselves some half-a-dozen pages, which will be welcome to all ornithological readers.

Mr. Pike's little book bears the same relation to his photographs as a popular lecture does to its lantern illustrations: *i.e.* it is of secondary interest. Photography, applied to birds and their nests and eggs, seems to be a most attractive pursuit, leading its votary often to spend hours in the endeavour to catch a bird at some opportune and interesting moment, or to find the nest on which he has set his heart. It should certainly be useful in training the faculty of observation, and in assisting the memory; and it may become a most welcome substitute for the predatory habits of private egg-collectors, who are perhaps the most dangerous enemies of our rarer birds. The actual contribution to zoology, however, does not seem as yet to have been great, and it is quite possible that before long we may have too many books on the subject. Mr. Pike's is, however, so unpretending and so pleasantly written, that it will no doubt be welcome to many beginners in ornithology who wish to learn where and how to look for nests, and a few of his experiences and his photographs will be interesting even to the more experienced. Part iv., on Norfolk birds, is perhaps the most valuable section of the book, and of the three photographs which Mr. Pike succeeded in taking of the nest of the bearded tit we select one for reproduction, as a favourable specimen of his work.

THE INTERNATIONAL CONGRESS OF MATHEMATICIANS.

A CONGRESS of mathematicians was held at Chicago during the World's Fair; but this was an isolated one. The series of international congresses was inaugurated at Zürich in 1897, and the second congress of this series met in Paris from the sixth to the eleventh of the present month. About 225 mathematicians of various nationalities, with 25 members of their families, were present. It had been expected that the numbers would be very much greater, as many as one thousand provisional acceptances having been received before last December; the diminished attendance was doubtless due partly to the great heat of the preceding month, but probably in greater measure to the fear of exhibition crowds and exhibition extortions. It had been supposed that the Exhibition would attract people to the Congress; on the contrary, it seems to have kept them away. The composition of the Congress was certainly international; the numbers of members from the different countries were approximately as follows:—France, 90; Germany, 25; United States, 17; Italy, 15; Belgium, 12; Russia, 9; Austria and Hungary, 8; Switzerland, 8; England, 7; Sweden, 7; Denmark, 4; the remainder being from South America (4), Holland, Spain, Roumania, Servia, Portugal, Turkey, Armenia, Greece, Canada, Mexico, Japan.

The actual business was preceded by a *réunion* at the Café Voltaire, on the evening of August 5, when about half the members were present. The proceedings proper consisted of two general meetings on Monday and Saturday, with sectional meetings on the four intervening days. The opening general meeting had been announced for 2.30 p.m., August 6, in the Palais des Congrès in the Exhibition grounds; but unfortunately some action on the part of the Exhibition authorities necessitated changing the hour to the morning, and this change was decided upon too late to be communicated to all the members, many of whom had not even arrived in Paris at that hour. Thus a considerable number of the

members were unable to be present at the first general meeting, which was held on August 6 at 9.30 a.m. M. Hermite was acclaimed président d'honneur; M. Poincaré, president; the vice-presidents (some *in absentia*) were announced as MM. Czuber, Gordan, Greenhill, Lindelöf, Lindemann, Mittag-Leffler, Moore, Tikhomandritzky, Volterra, Zeuthen, Geiser. The secretaries were MM. Bendixson, Capelli, Minkowski, Ptaszycki, Whitehead; the general secretary, M. Duporcq.

M. Poincaré, on taking the chair, spoke a very few words of greeting, and then called upon the speakers of the day. M. Cantor, in his address, "Sur l'historiographie des mathématiques," sketched the development of this subject through Montucla (toujours un modèle que tout historiographe des sciences doit suivre), Kaestner, Cossali, Bossut, Chasles, Libri, Nesselmann, Gerhardt, Arneth, Hankel, Boncompagni, up to authors of the present day. He expressed the firm conviction that the history of mathematics, from the beginning of Lagrange's work, can only be written as a series of special histories, with a final volume (Histoire des Idées) co-ordinating the whole. M. Volterra, "Trois analystes italiens, Betti, Brioschi, Casorati, et trois manières d'envisager les questions d'analyse," compared and contrasted the work of these three mathematicians, and considered the influence their differing lines of thought and expression have had on the development of Italian analysis.

Six sections had been arranged, with meetings extending over four days. While in general two sections were sitting at the same hours, yet matters were so arranged as to avoid, as far as possible, the conflict of interests that had been felt at Zürich, where only one day was devoted to the sectional meetings. These six sections, with their presidents and secretaries, were as follows:—

(1) Arithmetic and Algebra: Hilbert, Cartan; (2) Analysis: Painlevé, Hadamard; (3) Geometry: Darboux, Niewenglowski; (4) Mechanics and Mathematical Physics: Larmor, Levi-Civita; (5) Bibliography and History: Prince Roland Bonaparte, d'Ocagne; (6) Teaching and Methods: Cantor, Laisant.

Owing, however, to the unavoidable absence on some days of the president of Section 5, and the small number of papers in that section, Sections 5 and 6 sat together, under the presidency, first of M. Cantor (Wednesday), and then of M. Geiser (Friday); and at the Wednesday morning sitting the two papers of most general interest in the Congress were read. These were Hilbert's address on the future problems of mathematics, valuable as assisting the mathematician to orientate himself, and Fujisawa's account of the mathematics of the old Japanese school, of special interest as giving information, not readily accessible otherwise, about a system of mathematics that is now entirely obsolete. It appears that the Japanese invented zero for themselves, and employed the circle as a symbol for zero; that they used imaginaries and complex numbers, and calculated the value of π correctly to forty-nine places of decimals. In connection with this, M. Cantor remarked that the use of zero is probably Babylonian, and dates from about 1700 B.C.

M. Hilbert considered the origin and nature of the problems of mathematics the study of which is most likely to prove profitable; the characteristics of a proper solution; and the methods of attacking any problem that offers special difficulties. If the problem is really insoluble, then for the advance of mathematics it is essential that the impossibility be rigorously demonstrated. He illustrated his argument by means of selected problems that invite attack—problems regarding the axioms of arithmetic and of physics, prime and transcendental numbers, questions in the theory of functions, and the determination of the arrangement of the circuits that an algebraic curve can possess; referring to a paper about to appear in the *Nachrichten* der Kgl. Gesellschaft der Wissenschaften zu Göttingen, 1900, for a more complete list of definite problems that demand investigation.

Much interest was displayed in the papers read by M. Mittag-Leffler at the Tuesday morning sitting of Section 2, "Sur fonction analytique et expression analytique," "Sur une extension de la série de Taylor." The domain of an ordinary power-series is a circle that reaches to the nearest singular point; at all points inside this there is convergence, at all points outside there is divergence; this the author generalised so as to obtain a certain expression convergent within a particular region (an étoile), and divergent without. He raised the question whether an analytic expression can be found which shall represent, throughout its domain of definition, an assigned analytic function. A discussion followed between MM. Borel, Hadamard and Painlevé, as to the nature of the connection between "analytic expression in a complex variable x" and "analytic function in x." At the Thursday sitting of Section 1, M. Padé read a paper, "Aperçu sur les développements récents de la théorie des fractions continues"; in this he showed the dependence of the expression of a function of x as a continued fraction on a certain diagram, in which each convergent is represented by a point whose co-ordinates are the degrees of the numerator and denominator of the convergent; and, referring to the discussion that followed Mittag-Leffler's paper, suggested that a continued fraction may be found to be a suitable analytic form for any assigned analytic function.

The Friday morning combined sitting of Sections 5 and 6 was to a great extent occupied by the discussion of a resolution offered by M. Leau, urging the Academy to consider favourably the adoption of a universal language, not with a view to displacing any of the existing languages, but as a scientific medium auxiliary to these. Some such resolution has been brought forward lately on several similar occasions by the advocates of the latest artificial language, Esperanto. The discussion showed, on the part of mathematicians, very little sympathy with the suggestion, and very little recognition of a need for any such medium. As one speaker remarked, mathematics already has a universal language, the language of formulæ; and the general sense of the sections was evidently that the existing diversity of languages need cause no real difficulty, so long as writers are willing to confine themselves to English, French, German and possibly Italian, this view of the case being formulated by a Russian, M. Vassilief. The only result of the discussion was the rejection of M. Leau's motion, and the recording of a wish that the Academy would discountenance any unnecessary diversity in the languages employed for scientific purposes. The four languages enumerated by M. Vassilief are those officially recognised in the meetings of the Congress, though it was noticeable that a great many of the speakers chose to speak in French, possibly out of compliment to their hosts.

Other communications of value, though of less general interest, were the following:—In Section 1, M. Stephanos, Sur la séparation des racines des équations algébriques; in Section 2, M. Tikhomandritzky, Sur l'évanouissement des fonctions Θ de plusieurs variables; M. Bendixson, Sur les courbes définies par les équations différentielles; M. Jahnke, Zur Theorie der Thetafunctionen von Zwei Argumenten; in Section 3, M. Lovett, On contact-transformations between the elements of space; M. d'Ocagne, Sur les divers modes d'application de la méthode graphique à l'art du calcul; M. Stringham, Orthogonal transformations in elliptic or in hyperbolic space; M. Jamet, Sur le théorème de Salmon concernant les cubiques planes; in Section 4, M. Hadamard, Relations entre les caractéristiques réels et les caractéristiques imaginaires pour les équations différ-

entielles à plusieurs variables indépendantes ; M. Volterra, Comment on passe de l'équation de Poisson à caractéristique imaginaire à une équation semblable à caractéristique réel ; in Sections 5 and 6, M. Padoa, Un nouveau système irréductible de postulats pour l'algèbre ; M. Capelli, Sur les opérations fondamentales de l'arithmétique. The attendance at these sectional meetings, all of which were held at the Sorbonne, varied from 50 to 120.

The concluding general meeting was held at the Sorbonne at 9 a.m. on Saturday. The proceedings opened with the sending of a message of greeting to M. Hermite, the président d'honneur of the Congress. It was then unanimously voted that the next Congress be held in Germany, in 1904, at the beginning or end of the summer vacation, the place mentioned as probable being Baden-Baden. M. Mittag-Leffler then delivered his address, "Une page de la vie de Weierstrass," and M. Poincaré spoke briefly on the "Rôle de l'intuition et de la logique en mathématiques," closing the proceedings immediately afterwards with the few words, "La séance est levée ; le congrès est clos."

On the conclusion of the Tuesday afternoon sectional meetings, members were received at the École Normale Supérieure, where a pleasant opportunity for social intercourse was enjoyed ; and at noon on the day after the closing of the Congress a banquet was held at the Salle de l'Athénée-Saint-Germain, when about 160 members sat down. In the absence of M. Poincaré, the proceedings were conducted by M. Darboux ; speeches were made also by MM. Geiser, J. Tannery, Stephanos and Vassilief. A considerable number of members of this and other scientific congresses accepted the invitation of Prince Roland Bonaparte to a scientific *soirée* on Saturday. A *fête* had been arranged by President Loubet for Thursday evening, but could not be held on account of the funeral of the King of Italy ; the invitations were consequently transferred to the *fête* in honour of the Shah on August 10.

It will be seen that very little business was transacted, apart from the reading of papers. At the joint sitting of Sections 5 and 6, it was asked what steps had been taken to put into effect the resolutions of the Zürich Congress as to the formation of a committee to consider certain questions of bibliography, &c., these having been adopted with the hope of ultimately consolidating mathematical enterprise, and directing it into profitable channels. No very satisfactory answer was forthcoming ; M. Laisant, on behalf of the French Mathematical Society, replying that they had done nothing in this line, having been entirely occupied with making material provision for the Congress. He drew the attention of members, however, to the announcement of the *Annuaire des Mathématiciens*, undertaken by Carré et Naud, 3, Rue Racine, which is designed to be a complete register of all mathematicians, with their addresses. It is much to be hoped that these questions, raised at Zürich, will be dealt with in a business-like manner at the Congress of 1904.

NOTES.

THE Scientia Club gave a banquet to Lord Kelvin during the International Physical Congress at Paris. M. Louis Olivier presided over a distinguished company, and speeches in appreciation of Lord Kelvin's scientific work were made by him and by Profs. Mascart and Cornu.

FROM the official report of the International Congress of Electricians at Paris, we see that two communications, by Mrs. Ayrton and M. Blondel, were received with great appreciation. Mrs. Ayrton's paper was on the luminous intensity of the electric arc with continuous current, and she showed that the best result, both from the point of view of luminosity and expenditure of energy, was obtained from an arc only a millimetre in length. Demonstrations in illustration of this conclusion, and showing the absorbing and cooling effects of carbon vapour produced in the arc, as well as the production and absorption of green and yellow radiations, were given by Mrs. Ayrton at a special meeting in the École supérieure d'Électricité. M. Blondel reviewed the progress of electric lighting during the past ten years, and made some very valuable remarks on arc lamps with alternating currents, and on the carbons commonly used in arc lights.

IN opening the business of Section A (Mathematical and Physical Science) of the British Association at the forthcoming Bradford meeting, we understand that Dr. Larmor will review the change of ideas which has recently become current regarding the scope and method of physical explanation. The brilliant experimental verification of Hertz has led to the acceptance on the Continent of the views originated in this country regarding the nature of electric actions and their dependence on the æther ; but there has been a strong tendency to eliminate from the exposition of the theory those dynamical explanations which formed a main feature of its development in the hands of Clerk Maxwell. It is of fundamental importance to consider how far purely descriptive methods can thus avail towards an effective formulation of general physical theory, without appealing to a dynamical foundation of some kind. In all branches of the subject the discrete atomic constitution of matter is reached when we probe deep enough ; thus the method of representation of the physical activities of the material atoms, so far as they can be known to us, is of the essence of a dynamical treatment. This leads on to the cognate question, whether denial of direct action at a distance necessarily implies the passing on of all electric effects from element to element of the medium entirely by simple stress ; if that be too narrow a scheme, the efforts that have been made towards formulation on this basis were foredoomed to failure. The scope and limitations of the method of statistical enumeration of the activities of the atoms, which is the only one now available in ultimate thermodynamic discussions, depend on considerations of a different order. The modern extension of the range of the principle of Carnot also requires us to face the question how far the processes of chemical interaction between atoms, as distinct from the properties of the molecules when formed, are amenable to dynamical representation.—The general scheme for the business of the section is to take physical papers of a mathematical nature on Friday, September 7. On Monday, September 10, the section will divide into two, dealing with mathematics and meteorology respectively. On Tuesday a discussion on ions will be opened by Prof. Fitzgerald. It is also hoped to arrange discussions on the partition of molecular energy, and on the relation of radiation to temperature, under the thermodynamic aspect.

A PASTEUR Institute has just been opened at Kasauli, a hill station in the Punjab district, about thirty miles from Simla. It is thus no longer necessary for a person bitten by a rabid animal in India to journey to Paris for treatment by inoculation. The treatment at the Kasauli Institute is to be given free of charge.

PROF. J. C. BOSE, who has been attending the recent International Congress of Physics at Paris as the delegate of the Government of Bengal, will also attend the British Association meeting at Bradford in the same capacity, and will there describe some electrical investigations with which he has lately been engaged.

THE following international congresses upon scientific subjects will be held in connection with the Exposition at Paris during September : 3-8, History of Religion ; 3-5, Basque Studies ; 3-4, Pharmacy Specialities ; 10-16, Meteorology ; 10-12, Agri-

culture; 10–12, Folklore; 13–14, Fish Culture and Arboriculture; 14–19, Agriculture and Fisheries; 15–20, Aeronautics; 22–28, Acetylene.

PROF. GIARD, director of the biological station at Wimereux, has been made Chevalier of the Order of Leopold by the Belgian Government, as a recognition of the hospitality which he has extended to Belgian students and naturalists at his laboratory for many years.

DR. J. W. B. GUNNING, the director of the State Museum at Pretoria, speaks in high terms of the way in which he has been treated by the new British authorities. He has not only been confirmed in his post at the museum, but also materially assisted in his efforts to add to it a zoological garden, which he had planned before the outbreak of hostilities. It was to this (incipient) garden that the celebrated lioness (now in the Regent's Park Garden) was presented by Mr. Rhodes, but subsequently returned to the donor by Mr. Kruger's order.

AN international association for the promotion of psychical research has been established under the title: Société internationale de l'Institut Psychique. A *Bulletin* has been issued containing a report of the inaugural meeting held at Paris on June 30, and explaining the objects of the organisation. The Comité de Patronage includes the names of Prof. Mark Baldwin, Prof. W. F. Barrett, Sir William Crookes, Prof. O. J. Lodge, and Mr. W. H. Myers. The general secretary is M. Yourievitch, Russian Embassy, Paris.

A MONUMENT to Bertrand Pelletier and J. B. Caventou, renowned as pharmaceutical chemists, was unveiled at Paris, by M. Moissan, during the recent International Congress of Pharmacy. Caventou was born in 1795, and studied at the Paris School of Pharmacy. While pharmacist at the St. Antoine Hospital he met Pelletier, and their fruitful collaboration began. Two years after discovering brucine and strychnine they were able to announce the discovery of quinine, and with rare disinterestedness they made their work public by presenting an account of their methods and results to the Paris Academy of Sciences on September 11, 1820. In their memoir they stated that they had succeeded in isolating cinchonine and quinine from both yellow and red cinchona bark, and described the therapeutic properties of these substances. In 1827 the Montyon prize of the Academy of Sciences was awarded to them in recognition of their valuable discovery, and now the monument, representing the two investigators together, stands to remind observers of their joint services to science and humanity.

THE International Meteorological Congress will be opened at Paris on Monday, September 10, under the presidency of M. E. Mascart, and will continue during the week. The International Meteorological Committee, which met last year at St. Petersburg, decided that it would convene, at the same time as the Congress, the various committees appointed by the Paris Conference in 1896. These committees are the following:—(1) Terrestrial Magnetism and Atmospheric Electricity. (2) Aeronautics. (3) Clouds. (4) Radiation and Insolation. The first of these committees held an important meeting at Bristol in 1898, the proceedings and resolutions of which have been published in the reports of the British Association. A great number of ascents, both with free as well as captive balloons, have been made in different countries, for the systematic investigation of the upper regions of the atmosphere. Finally, the publication and discussion of the international observations of clouds, made in 1896-97, will probably be completed in 1900 in the majority of the countries taking part in the same. From this it will be seen that communications of very high interest will be brought before the Congress. The questions which will be dealt with are not restricted exclusively to meteorology properly so-called: they will include, generally, everything which affects the physics of the globe. The meetings of the Congress and of the committees will be held at the House of the Société d'Encouragement, 44, Rue de Rennes, where the International Conference met in 1896. Communications relating to the organisation or to the programme of the Congress should be addressed to Mons. Angot, general secretary, 12, Avenue de l'Alma, Paris.

A REUTER telegram, dated Madrid, August 24, states that twelve fragments of a meteorite have fallen on the boundary of the provinces of Jaen, Cordova and Granada. The fall was preceded by a series of loud detonations. One fragment, weighing about a pound, which was picked up at Val, in the province of Jaen, is said to be of hexagonal shape, grey on the surface, and of a greenish colour inside.

AS attempts are being made to found a domestic science, and to introduce exactitude into the operations of the kitchen, a note in the *Monthly Weather Review* recording the actual experience of a housekeeper at Albuquerque, New Mexico, is of interest. It appears that cooking recipes and practices which are trustworthy not far from sea-level are worthless at Albuquerque, the altitude of which is 4933 feet. Water boils there at 202° F., instead of 212° F.; hence articles of food, the cooking of which depends upon heat applied through the medium of water, require a longer time for cooking than is given in the cookery books. On account of the extreme dryness of the atmosphere, farinaceous foods, such as beans, corn, &c., lose so much of their moisture that they have to be left for a long time in water before cooking, in order to be softened. But the worst difficulty is with cake-making. Ordinary recipes as to number of eggs and amount of baking powder break down altogether, and housekeepers have to modify them if they wish their operations to be successful. As the barometric pressure determines to what extent the disengaged carbon dioxide shall expand and aerate the dough, this may explain the different action of baking soda and egg batter. In any case, the observation is interesting, and chemists may find it worthy of their attention.

La Nature of August 18 contains an article, by M. E. Roger, director of the meteorological station at Châteaudun, near Paris, entitled "The Greatest Heat of the Century." A temperature of 103°·6 in the screen was observed there on July 27 of this year. The nearest temperature to this hitherto recorded in the vicinity of Paris during the last hundred years was 101°·5 at Montsouris Observatory on the 20th of the same month. At Poitiers in July 1870, a temperature of 106°·2 was recorded. Among the highest temperatures recorded in or near London are 95°·2 at the late Mr. Symons' station, Camden Town, on July 16 last, and 97°·1 at Greenwich in July 1881; in that month a reading of 101° was obtained at Alton, Hants.

THE Pilot Chart of the North Atlantic Ocean for August, issued by the U.S. Hydrographic Office, contains a diagram showing the path of the noteworthy cyclonic tropical storms of the years 1898 and 1899, together with the time of their duration, which varies from 2 to 39 days; two of the storms were traced entirely across the Atlantic. Taken collectively, the several tracks exhibited show the doubtful accuracy of generalised statements concerning certain characteristics of these storms, such as their velocity, the latitude of their recurvature, &c. Thus the statement is often made that in the higher latitudes, after recurvature, the velocity along the track will average 25 or 30 miles an hour. However true this may be as the statement of an average, its untrustworthiness with regard to a particular storm is well shown by one of the tracks laid down,

in which the velocity of the centre after recurvature off the coast of Florida fell to about three miles an hour through three degrees of latitude.

WE have received a copy of the meteorological observations made at Sir Cuthbert Peek's observatory at Rousdon, Devon, for the year 1899, the sixteenth year of the series. This observatory is a second order station of the Royal Meteorological Society, and possesses a very complete equipment of instruments, both astronomical and meteorological, including various patterns of standard anemometers, the observation and comparison of which form a special and valuable feature of the regular work of the station. The mean temperature of the year exceeded the average by more than 2°; but the year was free from extremes in either direction, although at Greenwich on August 12 a temperature of 90° was recorded. The rainfall was about two and a half inches below the average, and amounted to only 29·31 inches; falls of an inch or more occurred on five days. A daily comparison is made between the actual weather and the forecasts of the Meteorological Office; as regards wind, the percentage of success has increased from 69 in 1884 to 93 in 1899, and in the case of weather, from 73 to 92 in the same period.

THE following notes from a report by Mr. H. A. Byatt, assistant collector, Fort Alston, are published with others in the *British Central Africa Gazette*:—"After passing over the ridge of hills which culminates about two miles to the east of Ndonda, some forty miles from the lake shore, the appearance of the country and the nature of its soil changes very considerably. In place of the low-lying marshy expanses along the coast, one finds a monotonous series of undulating grassy plains, covered almost exclusively with a growth of tall rank grass. The soil generally, though occasional small deposits of clay are found, consists of a layer of coarse porous sand, apparently of no great depth, lying upon a substratum of hard rock, and may well have been washed down by centuries of rain from the low hills above mentioned. The country is remarkably waterless. Judging by the appearance of the vegetation which it supports, the soil is of poor quality, and offers but little hope of successful cultivation. Large timber is conspicuous by its absence, and it is only at rare intervals that the raphia-palm and other trees requiring a copious supply of moisture are found; but possibly such woods as the Mlanje cedar might be introduced with success. Owing to the rank growth of grass, it is an ideal cattle country; but the true reason of the excellent condition of cattle in this country is to be found, I believe, in the presence of a certain salt in the earth—possibly a nitrate or phosphate of soda. In many places itis so abundant that upon the evaporation of the water it is left as a thick white deposit on the surface of the soil, whence it is gathered up by the natives and used as a condiment. Of other minerals, beyond the existence of graphite, I have so far found no trace."

THE progress of work on the new wheel-pit of the Niagara Falls Power Company, at Niagara Falls, N.Y., which is intended to supplement the present hydraulic installation of the same company, is described and illustrated in the New York *Electrical Review* (August 15). It is only a few years since the company began operations with a plant capable of being extended to 50,000 horse-power. Both the rapid growth of electrochemical industries at Niagara, and of electric power applications in Buffalo, twenty-six miles away, have rapidly carried the plant up to the limit of its former hydraulic equipment. Now the new one, which is slightly larger than the old, is under construction, and it is expected that within a year 105,000 horse-power will be generated and distributed from this one plant. The growth of such industries in the United States has been extraordinary. In New York State there is another plant under construction which will be finished within a year, and will develop the enormous total of 150,000 horse-power. Practically all of the latter installation will be used in electrochemical work in the manufacture of carbides and caustic and bleaching powder.

THE manufacture of artificial dye-stuffs in Germany was referred to in a recent report from H.M. late Consul-General at Frankfort-on-Main. The endeavours of manufacturers and industrial chemists are directed, generally speaking, to producing the organic natural products, such as those of colour plants, dye woods, insects, molluscs, &c., by artificial and even cheaper and purer means, and in a more serviceable form for dyeing; also to producing new colours, which not only approach in brilliancy and effectiveness the natural kinds, but even surpass them. Since the discovery that the important dye-stuff madder —alizarine—could be produced in an easy and cheaper manner from the carburetted hydrogen of coal-tar, the use of dye-stuffs obtained by coal-tar distilling has gradually grown to such an extent that in Germany about five times as many artificial colours are made as in all other countries combined. According to the census in 1895, there existed twenty-five factories for the manufacture of aniline and aniline colours, and forty-eight factories (with seven branches) for the production of other coal-tar products (*i.e.* not only for colours, but also for other commodities, such as picric acid, &c.). The aniline works employ 7266 hands, the latter factories 4194; in all, 11,460 men.

IN connection with the foregoing note, the *Board of Trade Journal* gives some particulars as to the manufacture of artificial indigo in Germany, from a report to the Foreign Office. The importance of indigo is evidenced by the fact that the production of natural vegetable indigo equals in value the entire world's production of artificial dye-stuffs. The present artificial indigo of commerce represents almost pure indigotin. It is sold in the form of a 97 per cent. powder, whereas the indigotin contained in vegetable indigo fluctuates between 70 and 80 per cent. It contains no indigo-red, no indigo-brown and no indigo-blue. The lack of indigo-red and indigo-blue, which both seem to be of some importance in the relation of the dye-stuff to the fibre, are its special disadvantages. The indigo-red seems to be of importance in the production of darker shades of colour. There is no doubt that at some time not too far off it will be possible to produce this ingredient also. Artificial indigo is used by dyers in the same way as vegetable indigo. If it is possible to render the process of manufacture materially cheaper, and thereby to considerably reduce the price of artificial indigo, the danger to natural indigo will be greatly increased; it is, indeed, to be feared that with the increase of chemical knowledge the same fate awaits this dyeing plant, which is extensively cultivated in British territories, as overtook the Krapp plant, the cultivation of which nowadays no longer pays. Artificial indigo affords a new example of the manner in which applied science revolutionises the most varied spheres and destroys as well as creates great wealth.

THE *Atlantic Monthly* for August contains an account, by Mr. Sylvester Baxter, of a method devised by Mr. Arthur J. Mundy, whereby a ship may be guided into port in stormy weather which prevents ordinary signals from being of service. The method is called "Acoustical Triangulation." It is based on the property that sound travels under water with a velocity that is unaffected by the disturbances such as winds, which have so large an influence on the propagation of sound-waves in air; and the putting of this principle into practice depends on the invention of a successful apparatus for ringing a bell under water by electrical connections. Three bells placed at the corners of a triangle, preferably equilateral, are sounded at known intervals of time. By noting the intervals of time between the instants when the first and second bells are heard, the locus of the ship's

position is known to be one of the branches of a certain hyperbola the foci of which are the two bells. By noting the apparent interval between the second and third bell, the ship is similarly located on another hyperbola, and the intersection of the two curves gives the required position of the ship. The only objection to the method appears to us to be that a pair of hyperbolic branches may intersect in *two* points, so that for given intervals between the bell sounds the position of the ship may be ambiguous. This could be avoided by having four bells instead of three.

AT the annual meeting of the Physical and Natural History Society of Geneva, Prof. A. Pictet surveyed the work which had been brought before the society during 1899. Eighteen meetings were held, and no less than seventy-three communications or reports were read. M. F. L. Perrot and Prof. Guye have made a series of measures of surface tension of various liquids by the method of falling drops. The conclusion arrived at as a result of their observations was that these tensions are not proportional to the weight of the drops. A new recording telephone was described by M. F. Dussaud. M. T. Tommasina has studied the variations of conductivity of coherers, and M. E. Steinmann has contributed a note on the thermo-electricity of various alloys. To the section of chemistry and mineralogy, M. Louginine has contributed an important memoir on the latent heat of evaporisation of some organic liquids; MM. Dutoit and Friderich have determined the molecular weights of some organic liquids by the method of capillary ascensions; Prof. A. Pictet and M. Athanasescu have presented a note on the constitutional relation between two alkaloids of opium-papaverine and laudanine; M. Duparc has described his researches on the Liparite rocks of Algeria; and M. H. Auriol has made a detailed study of the agricultural soils of the Canton of Geneva. In the section of botany, M. de Candolle stated that grains of wheat which he had kept for four years under mercury had germinated and produced normal plants; and Prof. Chodat has described several micro-organisms of plants. Among the subjects of papers contributed to the section of zoology and anthropology are the development of the wings of Lepidoptera, by M. A. Pictet; and a comparative study of a series of skulls from old burying-places in the Valais district, by M. Pitard. In the section of physiology and medicine, Prof. J. L. Prevost and Dr. Battelli have described their detailed researches on the action of electric currents upon animals; and M. Babel has given an account of his work on the comparative toxicology of aromatic amines.

THE present trend of legislation in the interests of fish preservation in the United States is, Dr. Whitten remarks (*State Library Bulletin*, No. 12, New York), to place more reliance on methods of fish propagation than on a multiplicity of vexatious restrictions, and to obtain through scientific research the knowledge essential to enlightened regulation. In 1871 the United States commission of fish and fisheries was created to undertake scientific investigations, collect information, and to further the introduction and multiplication of food fishes, particularly in waters under national jurisdiction. In 1898 the commission maintained 34 fish-cultural stations and distributed 857,509,546 eggs, fry and adult fish. Fish commissions have been created in every State except Kentucky. Many of the commissions exist primarily for protective purposes, but others carry on valuable scientific work and maintain hatcheries and stock local waters with the most valuable food fishes. Illinois has a zoological station, and Oregon has created the office of State biologist for the investigation of the animal resources of the State and the development of such as have economic value.

THE relation of the cell to the enzymes, or soluble ferments which originate from cells, was touched upon by Sir J. Burdon-Sanderson, Bart., in the address he delivered before the recent International Medical Congress at Paris. Formerly, he pointed out, each kind of cell was regarded as having a single special function proper to itself, but the progress of investigation has shown that each species of cell possesses a great variety of chemical functions and that it may act on the medium which it inhabits, and be acted upon by it, in a variety of ways. Thus, for example, the colourless corpuscles of the blood (or, as they are now called, leucocytes) are considered not merely as agents in the process of suppuration or as typical examples of contractile protoplasm, but rather as living structures possessing chemical functions indispensable to the life of the organism. Similarly, the blood disc, which formerly was thought of merely as a carrier of hæmoglobin, is now regarded as a living cell possessed of chemical susceptibilities which render it the most delicate reagent which can be employed for the detection of abnormal conditions in the blood. The tendency of recent research is to show that the reactions referred to as chemical functions of the cell (action of the cell on its environment—action of the environment on the cell) are the work of ferments—intrinsic or extrinsic—which are products of the evolution of the living cell, and therefore to which the term enzymes may be applied.

RECENT researches have plainly indicated that in the case of the disease-producing micro-organisms, the specific functions which for years were regarded as proper to, and inseparable from, the cell belong essentially to the enzymes which they contain. It has been further shown that similar statements can be made as regards ferment-processes which differ widely from each other and no less widely from those induced by bacteria. So that in the domain of microbiology the enzyme may in a certain sense be said to have "dethroned the cell." For if, as M. Duclaux has said, it is possible to extract from the cell a substance which breathes for it, another which digests for it, another which elaborates the simple from the complex, and finally another which reconstitutes the complex from the simple, the cell can no longer be considered as *one*, but rather as a complicated machine, the working of which is for the most part dependent on enzymes, which, however numerous and varied may be the processes in which they are engaged, all follow and obey the universal law of adaptation, and all contribute to the welfare and protection of the organism.

IN our last week's issue reference was made to Dr. Haller's views as to the relationships of the different groups of the Vertebrata, based on his study of the hag-fishes and lampreys. And in the July number of the *Journal of Anatomy and Physiology* the subject of the origin of Vertebrates, as deduced from the study of the larval lamprey (Ammocœtes), is resumed by Dr. Gaskell. In this important communication the author arrives at the conclusion that Ammocœtes is a representative of the Devonian Cephalaspids, and also that a larval form of the latter group must have existed which was of the nature of the Eurypterid Crustaceans. Again, judging from the development of Limulus, it would appear that the larval Eurypterid resembled a Trilobite, and there is evidence that Trilobites are Phyllopods, which are almost certainly derived from Chætopod Crustaceans. Admitting the derivation of the lampreys from Cephalaspids, we find that the latter, in their adult condition, approximate to larval Amphibians; and we hence pass from the latter to the lower Mammals, and so on to Man. Thus, according to Dr. Gaskell, the study of Ammocœtes, owing to the importance of larval forms, enables us to bridge the gulf between the Annelid and Man.

THE greater portion of the July number of the *Quart. Journ. Microscopical Science* is occupied by a communication from Messrs. F. W. Gamble and J. H. Ashworth on the anatomy and classification of the Sandworms (Arenicolidæ). This is followed by a most interesting series of diagrams illustrating the life-history of the parasites of malaria, by Messrs. Ross and

Fielding-Ould, accompanied by a short explanatory text. The diagrams were originally intended to illustrate a lecture delivered at the Royal Institution, to which reference is made in NATURE of March 29. The authors adopt the name Hæmamœbidæ for the intracorpuscular amœba-like bodies which occur in the blood of certain animals. Of these, three species occur in human beings (producing the various types of malarial fever), one in monkeys, three in bats, and two in birds. Only the human and avian forms are illustrated. The development of four of these has been followed in gnats; the three human forms living in Anopheles, while the bird-infesting species dwells in the common *Culex pipiens*. To this paper Prof. E. Ray Lankester appends a separate communication describing the generative process in the aforesaid "Hæmamœbids" and in the allied Coccidiidæ, which are parasitic in cuttle-fish. Sexual conjunction, or "zygosis," has recently been demonstrated to occur in the former group, and shortly before certain peculiar bodies known as microgametes and macrogametes were found to occur in the latter. These Prof. Lankester now shows respectively correspond to the spermatozoa and ova of higher organisms, specimens of the Coccidiidæ being figured in which the process of fertilisation by the microgametes is actually taking place.

To vol. xiii. Part 1 of the *Annals* of the New York Academy of Sciences, Prof. H. F. Osborn contributes an important paper on the correlation between the Tertiary mammalian horizons of Europe and America. The author is of opinion that the Puerco Eocene of the United States has no parallel in the European series, and that the Egerkingen beds of Switzerland are newer than the Wasatch. The three main divisions of the European Miocene are correlated with the Loup Fork and a portion of the John Day groups of America. But the most generally interesting portion of the paper is that in which Prof. Osborn enunciates his views with regard to former land connections. The theory of an extensive Antarctic continent synchronously connecting South America and Australia, and also communicating at some epoch with Africa, is deemed to be demonstrated. And it is considered that South America has experienced four distinct streams of faunal migration. In the first it received its peculiar Ungulates and Edentates; in the second it yielded the ancestors of Aard-varks, Pangolins, and perhaps Hyraces, to Africa; during a third land connection Marsupials immigrated from Australasia; and in the fourth the modern North American types effected an entrance. In contradistinction to the general view that Africa received its fauna from the north, the author is of opinion that the Dark Continent was itself the great dispersing centre and theatre of evolution; but whether South America received its original fauna from Africa or from North America is left an open question.

AMERICAN zoologists continue to devote their attention to the mammals of the Old World; and in the *Proceedings* of the Washington Academy of Sciences for July, Mr. G. S. Miller publishes two papers on the squirrels of Siam and Malacca, as well as a third on the European red-backed field-mice. Mr. Bonhote has just been writing on the former subject in the *Annals of Natural History*, and it seems a pity that naturalists cannot agree to divide their work so as to avoid overlapping and consequent unnecessary multiplication of names.

THE *Zoologist* for August contains an interesting account of a visit to Lundy Island during the nesting season, by Mr. F. L. Blathwayt. In the course of the paper allusion is made to the tradition that the Great Auk, or some equally large unknown bird, formerly inhabited the island. Only one or two pairs of this bird were known to the islanders, but an egg (subsequently broken) was secured in 1839. This subject seems worthy of further investigation.

WE are glad to see that in its September issue the *Girl's Realm* is endeavouring to awake an interest in the animal life of the sea-shore among its numerous juvenile readers, by publishing an illustrated article, entitled "An Hour in a Drang," by Mr. E. Step. "Drang," we learn, is Cornish for a deep cleft; and in his admirable description of such a cleft among the rocks at low tide, the author introduces his young friends to its living inhabitants in such a delightful manner that he can scarcely fail to gain many converts to the study of natural history. The photographs of crabs and lobsters with which the article is illustrated are admirably presented.

A *Bulletin* (Technical Series, No. 8) just issued by the U.S. Department of Agriculture (Division of Entomology) contains contributions towards a monograph of the American Aleurodidæ, by Mr. A. L. Quaintance, and a paper on the Red Spiders of the United States (Tetranychus and Stigmæus), by Mr. Nathan Banks. We have only one or two species of the interesting homopterous family Aleurodidæ in England. They are garden insects, which have a superficial resemblance to small white moths. In the present monograph forty-two American species of Aleurodes (Latreille) are described, most of them for the first time, and ten others belonging to the genus Aleurodicus (Douglas). To these the plates refer. The second paper, which is illustrated by wood-cuts, relates to the mites improperly called Red Spiders, which are equally troublesome in gardens and greenhouses in Europe and America. Of the two genera here discussed, ten species of Tetranychus (Dufour) and one of Stigmæus (Koch) are described; several as new. It is rather a pity that the term entomology is used in England so narrowly as practically to exclude mites, spiders, centipedes, &c., from entomological publications, and thus to hinder the popularisation of knowledge respecting them. In America, entomology is given the wider extension which it possessed at the beginning of the century, as may be seen by the inclusion of mites in the present publication.

THE members of the Manchester Microscopical Society deserve a word of encouragement for the efforts they make to extend a knowledge of natural history. One section of the society is entirely concerned with this work, and the members of it propagate the gospel of natural history by lecturing and demonstrating wherever their services are required. A programme containing a list of nearly fifty subjects has been issued, and the honorary secretary, Mr. George Wilks, 56, Brookland Street, Eccles New Road, Manchester, will arrange for lectures or demonstrations upon any of them if a communication is made to him.

THE two last numbers of the *Bulletin* of the Free Museum of Science and Art of Philadelphia show that this institution is growing rapidly under the care of Mr. Cu'in. The more important recent additions are figured. In vol. ii. No. 3 is an account of the historical Dickeson collection from the Mississippi mounds, and in the following number is a descriptive catalogue of the Berendt collection of books and manuscripts on the languages of Central America in the Museum Library, carefully compiled by the late Dr. Brinton.

THOSE interested in the decorative art of primitive folk should consult two fully illustrated papers in the *American Anthropologist* (N.S. vol. ii. No. 2, 1890). One, by Mr. R. B. Dixon, deals with basketry designs of the Maidu Indians of California, in which animal and plant forms, feathers, arrow heads, mountains and clouds are plaited in a very conventional manner. The author makes the significant remark, "The knowledge of the designs is almost exclusively confined to the older women, the younger generation knowing only very few." The second paper is one by Mr. B. Laufer, on the Amoor tribes, and is a preliminary account of the work done by this observer on the Jesup North Pacific

Expedition. Mr. Laufer gives a careful analysis of zoomorphic patterns, mainly of the Gold tribe; their decorative art shows distinct traces of Chinese influence, but the designs have been evolved in an original and interesting manner.

THE catalogue of bacteriological and pathological apparatus, just published by Messrs. J. J. Griffin and Sons, contains several new instruments and accessories, and will well repay inspection. Among the apparatus we notice several spirit Bunsen burners, which can be used instead of ordinary Bunsen burners where gas is not available. These are, of course, suitable for any laboratory, and not merely for bacteriological work. Of special interest are a number of new centrifuges for use in the examination of blood, sputum, milk. In water, urine and milk analysis a comparatively low rate of revolution is required, and a hand centrifuge giving up to 2000–3000 revolutions a minute is sufficient. When examining blood or sputum it may be necessary to make upwards of 10,000 revolutions a minute, which rate can be obtained by a water-power centrifuge manufactured by Messrs. Griffin. Another noteworthy addition is a special test-tube possessing characteristics always required for bacteriological work, but rarely found.

THE additions to the Zoological Society's Gardens during the past week include a Javan Mynah (*Gracula javanensis*) from Malacca, presented by Mr. George Smith; an Indian Crow (*Corvus splendens*) from India, presented by Mr. E. A. Williams; a Rose-coloured Pastor (*Pastor roseus*) from India, an Indigo Finch (*Cyanospiza cyanea*), a Nonpareil Finch (*Cyanospiza ciris*) from North America, presented by Mr. L. Ingram Baker; a Raven (*Corvus corax*), European, presented by Mr. G. St. Leger Hopkinson; three Blackish Sternotheres (*Sternothoerus nigricans*) from Madagascar, two Prasine Snakes (*Coluber prasina*) from Upper Burmah, eleven American Box Tortoises (*Cistudo carolina*) from North America, deposited; an Occipital Blue Pie (*Urocissa occipitalis*) from the Western Himalayas, ten Common Chameleons (*Chamaeleon vulgaris*) from North Africa, purchased; a Brush-tailed Kangaroo (*Petrogale penicillata*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

ASTRONOMICAL OCCURRENCES IN SEPTEMBER.

Sept. 1. 8h. Jupiter in conjunction with the moon. Jupiter, 0° 51′ North.
3. 7h. 16m. to 8h. 11m. Moon occults the planet Saturn.
4. 7h. 35m. to 8h. 50m. Moon occults the star ξ^1 Sagittari (mag. 5·0).
5. 7h. 24m. Transit (ingress) of Jupiter's Sat. III.
12. 12h. 35m. to 13h. 43m. Moon occults π Arietis (mag. 5·6).
12. 16h. 27m. to 17h. 40m. Moon occults ρ^3 Arietis (mag. 5·5).
13. 9h. 43m. to 10h. 34m. Moon occults 13 Tauri (mag. 5·4).
14. 8h. 39m. to 9h. 18m. Moon occults D.M. + 20°, 785 (mag. 5·8).
15. Venus. Illuminated portion of disc = 0·493.
15. Mars. ,, ,, ,, = 0·915.
16. 12h. 8m. Minimum of Algol (β Persei).
17. 6h. Venus at greatest elongation. 46° 1′ West.
18. 14h. 48m. to 15h. 40m. Moon occults 29 Cancri (mag. 5·9).
19. 8h. 57m. Minimum of Algol (β Persei).
23. 0h. Sun enters Libra, autumn commences.
27. Saturn. Outer minor axis of outer ring = 17″·25.
28. 21h. Jupiter in conjunction with the moon. Jupiter, 0° 13′ North.

RING NEBULA IN LYRA.—It is interesting to find in the *Bulletin* de la Société Astronomique de France, August 1900, an account of the first published work done with the great 50-inch refractor of the Paris Exposition while that exhibition is still in progress. M. Eugène Antoniadi, of the Juvisy Observatory, has been for some time making systematic observations of nebulæ with the instrument, and a drawing showing a considerable amount of detail accompanies his paper on the Ring Nebula, the first of the series he has undertaken to study. He mentions that the lens used is the photographic one, the other, specially corrected for the visual rays, not yet being in position. The focal length of this glass is about 186 feet (57 metres).

OCCULTATION OF SATURN.—On Monday evening next, September 3, there will be an occultation of Saturn by the moon, for which the following particulars for Greenwich may be useful:—

	Sidereal Time.	Mean Time.	Angle from North point.	Angle from Vertex.
	h. m.	h. m.	°	°
Disappearance ...	18 6	7 16	128	126
Reappearance	19 1	8 11	217	206

Providing the weather be favourable, this should be an excellent opportunity for observing the occultation of the planet, as the altitude will be almost at its maximum, meridian passage at Greenwich occurring at 7h. 7m. G.M.T. Moreover, from its being such a bright object, observations may be made with instruments of the lowest optical power.

In the *Bulletin* de la Société Astronomique de France for August 1900, M. M. Honorat gives an illustrated description of his observation of the last occultation of Saturn on June 13. He mentions the conspicuous contrast between the slightly yellowish colour of the moon and the greenish tint of the planet. During the occultation the planet appeared separated from the lunar limb by a narrow shadow about 5″ of arc in width, probably a contrast effect.

At the reappearance of Saturn at the terminator, he could not perceive any trace of penumbral shadow cast on the planet's disc.

OPPOSITION OF EROS.—Two additional circulars have been issued by the special committee appointed by the Astrographic Conference to direct the observations of Eros during the coming opposition. Special attention is drawn to the work which may be commenced at once, such as micrometric observations with all equatorials of large aperture, for furnishing definite positions for the theory of the planet's movement, and that these should be published as soon as possible, to perfect the ephemerides for the actual parallax work later. An ephemeris is included from the computations of M. Millosevich, and tables showing the limiting times between which the planet will have an altitude greater than 20° at various latitudes, and also a table indicating the proper regions to be included on the photographs on dates extending from September 19 to January 7.

In the *Astronomische Nachrichten* (Bd. 153, No. 3656), Prof. S. J. Brown, of the U.S. Observatory at Washington, calls attention to the many opportunities for simultaneous micrometer observations at widely separated stations, and as many observatories are not equipped with the photographic instruments necessary for the more general programme contemplated, gives data for assisting micrometer observers to co-operate for this type of work alone. The high declination of the planet makes it possible to secure simultaneous observations at all the Eastern stations west of Pulkowa, and at all the American observatories east of Denver. He also gives a table showing the Greenwich Mean Time at which the planet will be simultaneously visible at the observatories of Pulkowa, Königsberg, Vienna, Evanston, Madison, Yerkes and Denver for intervals of ten days from 1900 October 1–1901 January 19. Careful sketches of the comparison stars in the field should be made to facilitate subsequent identification. Owing to the rapid orbital motion of Eros rendering observations for position angle and distance very troublesome, measures should be made in rectangular co-ordinates referred to the true equatorial position of the fixed micrometer wire.

THE INTERNATIONAL PHYSICAL CONGRESS.

THE first International Congress of Physics, which has just finished its sittings, has been a brilliant success. The number of participators exceeded a thousand, and, in spite of the attractions which Paris always offers, in spite of the simultaneous rivalry of the Universal Exhibition itself, sectional and general meetings were closely followed up to the last day by a great number of visitors.

The cause of this unexpected success must no doubt be sought in the idea underlying the plan of the Congress, worked out as it was with the greatest care by a committee of the Société Française de Physique. That committee deliberately rejected the method of simply presenting personal memoirs, or notes on limited subjects, and concentrated all its efforts upon the preparation of a well-arranged summary of the actual state of physical science, in the branches in which, within the last few years, the greatest progress has been made, and the actual stage of progress of which at the end of the nineteenth century it was considered most important to investigate. Once the list of subjects was completed, the work was divided among the physicists who seemed best qualified to give a complete representation of their special subject. This plan gave rise to a series of reports,[1] many of which are works of a very high value, and which, in their entirety, constitute the most complete representation of any science at a given epoch yet made. These reports number about 80. To summarise them here would be, so to speak, repeating the work of the Congress on a small scale, and that could not be thought of. I shall, therefore, confine myself to referring to them by groups which are obviously related and mutually supplement each other.

For this considerable task, a preface was necessary. M. H. Poincaré provided such a preface, and brought it before the Congress amid great applause, showing how mathematical generalisation could render experimental work infinitely more fertile. Experimental physics is a library. Mathematical physics arranges it and prepares the catalogue. It does not enrich it, but if it is well prepared it enables one to draw a greater profit from the former. The celebrated mathematician then showed how hypotheses have succeeded each other, in the form of physical images or simply mathematical images, where the symbol often remains true even when the mechanism is no longer accepted. Mathematical analysis also alone gives the true sense of the simplicity hidden under complexity, as in the case of Newton's law—which is always rediscovered in the most complicated movements of the heavenly bodies—or the kinetic theory of gases, where the law of large numbers hides the isolated individuals, only permitting the appearance of an aggregate for which the laws of Mariotte-Boyle and Gay-Lussac, long considered simple, are only the destruction of the action of individual molecules. Starting from these now well-known facts, M. Poincaré showed how the same methods and ideas apply to theories now being evolved concerning the interaction of matter and ether. His speech will no doubt be read and studied for a long time to come, and will remain one of the most perfect expressions of the state of mind of the masters of modern science.

To the organisers of the Congress, Lord Kelvin's promise of a personal contribution of work had been a powerful and valued encouragement. But what they hardly dared hope for was to see him, after the fatigues of a voyage, take a very active part in the Congress, and to see him hold spell-bound by the charm of his discourse a respectfully attentive audience bent upon seizing every thought of the great physicist. M. Poincaré's speech gave him an occasion for a brilliant improvisation on the constitution of the ether; and he also dealt with the subject in a paper on the waves produced in an elastic solid by the motion of a body acting upon it by attraction and repulsion. But it was not only in that speech that the illustrious honorary president of the Congress showed the interest he felt in the assembly. Presiding every day at sectional meetings, he clothed both reports and debates with a very special authority.

To facilitate work, the Congress had been divided beforehand into seven sections, the work of which I propose briefly to review.

In the measurement section, presided over by M. Benoit, the chief work was that of determining the actual state of metrology properly so called. After a very complete recapitulation, by the president, of the history of standards and methods employed in the measurement of length and the progress so far made, detailed attention was devoted to the complete metrological definition of standards and their legal definition; the legal status of the electrical units; and some improvements which might conveniently be made in a number of insufficient definitions, or definitions referring to conceptions recently introduced into science, such as the different abscissæ of the spectrum, &c. Some resolutions were passed, such as that recommending the adoption of the mechanical C.G.S. units (erg and joule) for the expression of calorimetric quantities, comprising, naturally, the solar constant, to be reduced by the meteorologists to the calorie per minute per sq. cm. Also that in the expression of elastic constants, the C.G.S. unit of pressure, the *barie*, be adopted, of which the multiple by 10^6, the *megabarie*, is sufficiently represented by the pressure exercised by a column of mercury 75 cm. long at 0° and under normal gravity. The Congress further supported the sectional resolution that national laboratories be created in countries which do not as yet possess any.

The interferential methods of measurement brought out an excellent paper by M. Macé de Lépinay; there were also four contributions relating to thermometry of precision (Chappuis), pyrometry (Barus), the mechanical equivalent of heat (Ames), and a special study of the variation of the specific heat of water (Griffiths). All these showed that great progress has been made in these various departments. Thus at present the divergencies among the various gas thermometers are known over a long interval, and it is also known that though the hydrogen and nitrogen thermometers, for instance, may still differ between 0° and 100°, their divergence at the higher temperatures is insignificant if care is taken to slightly correct the mean coefficient of expansion between 0° and 100°. The difficulty of employing hydrogen at high temperatures lends a great importance to this provision. Pyrometry also is rapidly advancing, and as regards the mechanical equivalent, the great divergences which existed a few years ago have disappeared owing to a more complete correction of thermometric values and a better knowledge of electric standards.

Some very fine work has also been done in connection with gravitation. The measurement of the Newtonian constant, admirably expounded by Mr. Boys, whose special work in this department is now classical, and the announcement of anomalies of gravitation by Messrs. Bourgeois and Eötvös, gave rise to very interesting discussions. A few years ago these anomalies were placed beyond a doubt, and it is already possible to study the details with the aid of apparatus which, like that of M. Eötvös or that of Messrs. Threlfall and Pollock, indicates the most minute details, whereas the pendulum formerly employed only gave the more considerable anomalies. The Congress expressed a hope that the study of these anomalies will be pursued by the new methods, not only for the sake of knowing the gravitational acceleration in every place, but also for the better knowledge of the constitution of the globe.

Finally, M. Leduc presented to the section a report on the electro-chemical equivalent of silver, and M. Gouy another on the standard of E.M.F. It appears from the latter that the cadmium standard is preferable to every other.

The measurement of the velocity of sound, dealt with by M. Violle, forms in a manner the transition between the section of measurement and that of mechanical and molecular physics. In the latter, presided over by M. Violle, after a very complete treatise by M. Amagat on the whole of his work, and an admirable paper by M. van der Waals on the statics of mixed fluids, M. Mathias showed, in a paper well provided with references, how the critical point may be determined by various methods. Specialising further, Prince Galitzine dealt with the refractive index, and, finally, M. Battelli exhibited the relations between the statics of fluids and their calorimetry. Except as regards mixtures, the ideas on these various subjects are well fixed nowadays, and new light can only come from the experimental side. Mixtures are less known, and the paper in which the celebrated Amsterdam physicist condensed our actual knowledge of this question will no doubt powerfully contribute to make them known. Having created the idea of continuity between the liquid and the gaseous states, he has had the satisfaction of seeing it become classical. But it is in another direction that this evolution advances nowadays. Does this continuity also exist between the liquid and the solid state? The diffusion of solids, their flow under pressure, the constitution of alloys, so well studied, notably by M. Spring and Sir W. Roberts-Austen, might lead to that belief, especially since M. Schwedoff has proved the rigidity of liquids. M. Tammann raises some doubts concerning this idea, and recommends a careful distinction between the amorphous and the crystalline states. In any case, the presence at the Congress of the eminent physicists mentioned, with the exception of M. Tammann, who was represented by M. Weinberg, contributed greatly to the interest of the subject and to its future progress.

The study of the permanent or temporary deformations of

[1] These reports presented to the Congress have been translated into French. They were printed for purposes of discussion, and will be shortly published in three volumes.

solids naturally furnishes interesting data. A work by M. Mesnager, and another by the author of the present article, were devoted to these two questions. It is interesting to note that the last experimental researches are all in favour of the chemical theory of temporary deformations.

M. Voigt has devoted a great amount of indefatigable activity to the study of the elasticity of crystals. His summary of this question was a great boon to the second section. It was a considerable piece of work, in which, naturally, the mathematical formula was predominant. This work will serve as a base for all those interested in the elasticity and the piezo-electricity of crystals, as well as in questions of symmetry.

M. van't Hoff was not present at the Congress, but he showed his interest by sending a work on the formation of crystals in a mother-liquor containing a mixture of salts. In this case questions of equilibrium play an important part, the form of the crystals depending, not only upon the solubility of each salt in the mixture, but also upon the quantity of each.

It was very interesting to learn the ideas arrived at by M. van der Mensbrugghe, after a long career devoted to the study of capillarity. The report presented by Joseph Plateau's son-in-law constitutes a precious document on capillarity, a subject which has been somewhat eclipsed by other subjects, but which has formed the object of investigation of the greatest spirits, and continues to do so.

We must be short, and can only mention the report by M. Brillouin on gaseous diffusion, by M. Perrin on osmosis, and by M. Bjerknes on hydrodynamical actions at a distance. The latter derives its interest more especially from the fact that a hydrodynamical model may be constructed which possesses all the characteristics of a world subjected to actions at a distance.

The third section, presided over by M. Lippmann, dealt with optics. The recent researches on the laws of radiation naturally formed part of its programme, opened by those inseparable reports, on the theoretical laws of radiation, by M. W. Wien; on the radiation of solids, by M. Lummer; and on gaseous radiation, by M. Pringsheim. The practical realisation of the black body, the verification of Stefan's law for a large range of temperature, and certain simple relations between the temperature and the position of the maximum in the spectrum, are the salient facts which the experimental work of recent years has brought out. For gases, a doubtful point is the validity of Kirchhoff's law, but according to M. Pringsheim that does not seem to be in any danger if only the purely thermal radiation is considered.

Recently, the spectrum has been greatly extended in the infra-red. M. Rubens, to whom the greatest progress in this direction is due, had undertaken to give a summary of this question, showing how the dispersion formulæ agreed with experiment, and demonstrating experimentally the connection between long light waves and electrical waves. This work again called forth a discussion on the formulæ and theories of dispersion opened by M. Carvallo.

The kinematics of the spectrum has also made great progress since Balmer showed for the first time that the hydrogen rays are represented by a very simple formula. The researches of Kayser and Runge and other physicists, Rydberg among them, have shown that the distribution of the spectrum lines is governed by laws, some of which are clearly established, while others are as yet unknown. Of all this work, M. Rydberg gave an excellent summary.

The velocity of light has, as we know, given rise to metrological work of the first rank, and of extreme difficulty. It fell to the distinguished president of the Congress, M. Cornu, to give a review of this subject, and during the remarkable speech which he delivered at the École Polytechnique, the physicists from all parts had the privilege of seeing the original apparatus of Fizeau and of Foucault, who were the first to give an approximate value of that velocity by measurements confined to the earth.

It is this characteristic velocity which for Maxwell was the touchstone of the theory involving the identity of luminous and electrical oscillations. As the instruments become more perfect, and the sources of error disappear, this identity is more and more emphasised. It was very interesting to co-ordinate the numbers furnished by light proper with those furnished by the comparison of units and the direct measurement of the velocity of electric waves. M. Abraham undertook the first part of this work, and MM. Blondlot and Gutton the second. This brings us to the electrical section, presided over by M. Potier, and in his absence by M. Bouty. The line of demarcation, however, is becoming more and more difficult to draw. The extremely interesting work of M. Lebedef on the pressure produced by radiations, has its origin in the great work of Maxwell; but it might also arise from pure thermodynamics, as shown by Bartoli and Boltzmann. As regards Hertzian waves, treated in a masterly manner by M. Righi, they approach so closely to the work of M. Rubens, that the small interval which still separates them is probably the only reason—and a very artificial one—for keeping them separate at all. In a supplementary note, M. Branly gave an account of some of his own researches on coherers. The reports just mentioned furnished the experimental side of an idea, the theoretical aspect of which was treated of in a paper by Prof. Poynting on the propagation of electrical energy.

We encounter another group of questions in the gaseous dielectrics, studied by M. Bouty, as well as electrolysis and ionisation, which have made such vast progress during the last decade, and which were dealt with by M. Arrhenius, one of the promoters of the new ideas, in a paper which will remain a model of clearness. Finally, we have M. Christiansen's theories of contact electricity, M. L. Poincaré's theories of the electric cell, and the exposition of Nernst's ideas, which had not been contemplated in the programme of the Congress, but which enabled their founder to give to the meeting a review admirably completing this group of questions.

The presentation of present ideas on magnetism had been excellently prepared by two fundamental reports, one, by M. du Bois, on the general magnetic properties of bodies, and another, by M. Warburg, on hysteresis, which he was the first to observe, and which, in the hands of Ewing, Hopkinson and others, attained such great importance. Two particular aspects of magnetism, viz. magneto-striction and the E.M.F. of magnetisation, which could not form part of the general reports, were treated separately by M. Nagaoka and M. Hurmuzescu.

Although the applications of electricity are almost entirely beyond the subject-matter of the Congress, there are some which are connected so closely with general physics that it seemed very desirable to have them dealt with. This was done by M. von Lang, whose work on the electric arc is well known, while M. Potier gave an exhaustive paper on the theory of polyphase currents, and M. Blondel the description of apparatus for tracing the curves of rapidly varying currents.

In a few years' time the work of the fifth section—ionisation and magneto-optics, presided over by M. Becquerel—will no doubt fall naturally into one of the preceding sections. But at the present moment they are still so undefined, they open up such new horizons, that it appeared well to collect them in a special section. The idea proved very fruitful, for the section was largely attended, and the discussions at it proved very fascinating.

M. Lorentz had prepared an admirable report on magneto-optics, with special reference to the Zeeman phenomenon. He expounded both his own ideas and those of M. Voigt. The presence of the latter gave the section the privilege of an exposition at first hand of his latest ideas.

The absence of Prof. J. J. Thomson could not but be severely felt. But the work which he had sent in, concerning the ratio of the electric charges to the masses carrying them, was read amid great interest after the general exposition made by M. Villard of the state of our knowledge of kathode rays.

The phenomena of actino-electricity, somewhat forgotten now, though much studied ten years ago, gave rise to a report by MM. Bichat and Swyngedauw. Perhaps increased attention will be devoted to them now that the researches of M. Becquerel and those of M. and Mme. Curie have proved so fertile in the examination of new bodies.

The speeches in which first M. Becquerel and then M. Curie expounded the disconcerting properties of uranium, polonium and radium rays, were for many a revelation. These extraordinary bodies, discovered by their radio-active properties, which were first announced by M. Becquerel, and then followed up with such startling success by M. and Mme. Curie, were known to the majority of those present, but only a few had seen those few decigrammes of material extracted from several tons of the mineral richest in it, pitchblende, and certainly the effects produced surprised by their intensity those who saw them for the first time.

Several hundred persons at a time could see this light, which appears everlasting, radiated perpetually by radium, the clear

patch which it produces even across a sheet of metal on a screen of barium platino-cyanide, the instantaneous discharge of an electrified body brought near to the substance, and the sparks passing when radium is brought within a few centimetres of the spark gap. The magnetic deflection of the rays could, of course, not be made evident to such a large audience. But the original negatives could be projected, and they showed the curvilinear propagation of the rays in a magnetic field.

The new bodies constantly project matter endowed with a great velocity. Neighbouring bodies are impregnated with it, and become radio-active in turn. These particles attach themselves, not only to objects, but to persons as well, so that M. Curie will be condemned for some time to abandon every kind of electrostatic research. No electrometer remains charged in his neighbourhood, and it is certain that if radium had only been as plentiful as gold, static electricity would never have been discovered.

In the same domain, important generalisations have been made, such as the theory of dispersion in metals, founded by M. Drude upon the electron theory, of which the author gave an account to the section.

The sixth section, under the presidency of M. Mascart, occupied itself with cosmical physics. Terrestrial magnetism should undoubtedly have formed part of the work of this section, but the Meteorological Congress which will shortly meet intends to make that the principal object of its studies, and it was evidently necessary to leave it aside.

Yet the work of this section was very fruitful. Here, naturally, observation still holds a predominant place, as in the work of the Swiss physicists, with M. Hagenbach at their head, on glaciers; and the detailed study of oscillations of lakes by MM. Sarasin and Forel, who brought their results before the Congress.

In the department of atmospheric electricity, a very good account was given by M. F. Exner, and Mr. Paulsen gave an account of the Danish expedition to Iceland for the study of the aurora. The evaluation of the solar constant by M. Crova, according to recent researches, and a very ingenious theory of suns-pots established by M. Birkeland after troublesome calculations, were heard with much interest. Finally, M. C. Dufour showed how, without the help of any laboratory apparatus, the approximate brightness of the stars could be determined.

It had seemed useful to collect in a seventh section some works relating to biology. In the absence of M. d'Arsonval, this section, presided over by M. Charpentier, did a great deal of good work, and justified the idea of the organisers of the Congress. The application of physical and mathematical methods to the transmission of energy in organisms, to which M. Broca has devoted attention for a considerable time, and the curious retina phenomena studied by M. Charpentier, gave this section a vast field of discussion. Finally, the new theory of accommodation established by M. Tscherning received the sanction of a very largely attended meeting, while M. Hénocque spoke of the spectroscopic methods used in biology.

The proceedings of the Congress were not confined to sectional work and general meetings. A visit to the laboratories of the Sorbonne and the École Polytechnique showed many experiments in progress, installed by the professors of these establishments or their provincial and foreign colleagues. These could only be properly appreciated by observing them closely and in small groups.

Shall I speak of the reception in the Jardin de l'Elysée, whither the President of the Republic invited several Congresses to witness a theatrical performance? Or of the charming *soirée* for which Prince Roland Bonaparte had placed at the disposal of the organisers his vast and magnificent library for a number of interesting experiments? This *soirée*, which will leave in the minds of all who were present the most agreeable memories, would itself deserve a lengthy description. But I cannot conclude this already lengthy article without saying how much the French physicists have been touched by the sympathetic action of the foreign secretaries of the Congress, who deposited a magnificent crown on the modest tomb of the great Fresnel, of which the Société Française de Physique has constituted itself the guardian. A moving speech by M. Warburg, and a warm expression of thanks by M. Cornu, president both of the Congress and of the Society, referring in a few words to the life of that great physicist, ended this first Congress, where so many new thoughts have been born, and so many friendships made or consolidated.

CH. ED. GUILLAUME.

ORIENTATION OF THE FIELD OF VIEW OF THE SIDEROSTAT AND COELOSTAT.

OBSERVERS who have practical acquaintance with the siderostat and heliostat are familiar with the fact that while the reflected image of a star may be kept stationary, the images of surrounding stars have a rotation around it; while if the sun is the object viewed in the mirror, the image will rotate about the axial ray. It is on account of this rotation of the field that neither the siderostat nor the heliostat can be used with a fixed telescope for celestial photography, except for objects which can be photographed with short exposures.

Certain unexpected peculiarities of this motion have recently led Prof. Cornu to investigate the general laws governing the rotation of the field in both instruments (*Comptes rendus*, vol. cxxx. No. 9, 1900; *Bulletin Astronomique*, February 1900). Some of the results at which he has arrived are of great interest, and we believe attention has not been previously drawn to them, although they could have doubtless been derived from Orbinsky's formula for the orientation of the field ("Die totale Sonnenfinsternisse am 9 Aug. 1896"), or from other formulæ which have been employed by observers as occasion required.

Prof. Cornu first discusses the general question of the orientation of the field, irrespective of the mechanical means of retaining the reflected image in a fixed position. In Fig. 1, NESW represents the horizon, Z the zenith, P the pole, PD the hour circle of the star D, and D′ the point of the horizon towards which the rays are reflected. PN is equal to the latitude of the

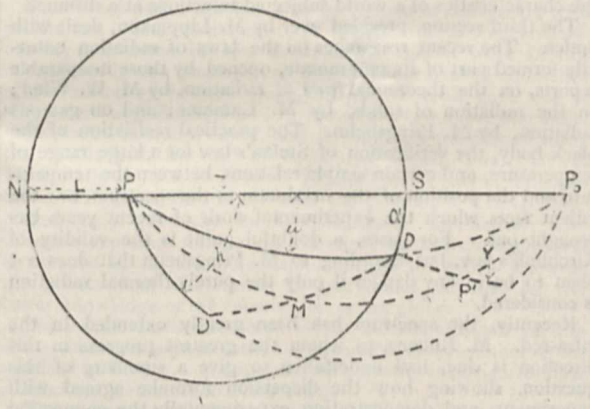


FIG. 1.—Orientation of field of siderostat.

place, = L; PD is the polar distance of the star, = δ; SPD is the hour angle of the star, = *h*. For the purposes of calculation the point D′ is defined by its polar distance PD′ = ρ, and by the angle SPD′ = ω which the plane PD′ makes with the meridian; ρ and ω can be determined in terms of the azimuth of D′ (= SD′ = α, reckoned positive towards the west) and the latitude, by solving the right-angled triangle PSD′, in which PS = 180° − L; thus

$$\cos\rho = \cos\alpha\cos L\,;\quad \tan\omega = \frac{\tan\alpha}{\sin L}.$$

The normal to the mirror must always bisect the arc DD′ of a great circle, at M, so that the position of the reflected ray from any part of the sphere can be easily determined. Thus the image of P is at P′ in the continuation of the hour circle PM, MP′ being equal to PM. To determine the orientation of the field, it is most convenient to ascertain the direction, after reflection, of the point P, since it is a fixed point on the sphere. Taking the plane of PD′P₀ as the reference plane, and its trace on the sphere as a fixed direction, the orientation of the reflected pole is conveniently defined by the angle P₀D′P′ = Y, which can be readily calculated, as also D′P′, the distance of the reflected pole from the centre of the field.

Applying this in the first place to the siderostat, where the reflected rays are south or nearly so, and the angle α consequently small, Prof. Cornu obtains the following results:—

(1) The reflected image of the pole describes a circle round the centre of the field, with a radius equal to the polar distance of the star observed.

(2) Since the angle Y is equal to the supplement of the angles at the base of the triangle PDD′, P being the apex, the orientation of the reflected pole (that is, the direction of the north point of the field) is given by the equation

$$\tan \tfrac{1}{2} Y = \frac{\cos \tfrac{1}{2}(\rho+\delta)}{\cos \tfrac{1}{2}(\rho-\delta)} \tan \tfrac{1}{2}(h-\omega)\,[1]$$

The law of rotation readily follows. The interval from the passage of the star over the hour circle PD′ being expressed by t, with a day as the unit of time, $h - \omega = 2\pi t$, and the equation becomes

$$\tan \tfrac{1}{2} Y = K \tan \tfrac{1}{2} 2\pi t.$$

$$\text{where } K = \frac{\cos \tfrac{1}{2}(\rho+\delta)}{\cos \tfrac{1}{2}(\rho-\delta)}$$

Hence :—(*a*) The rotation of the field has the same period as the diurnal motion.

(*b*) The motion is continuous and in the same direction, direct or inverse according to the sign of K.

(*c*) The plane of reference is a plane of symmetry, since the angle Y has equal values of contrary sign at equidistant intervals of time from passage across the reference plane.

Prof. Cornu illustrates the rotation by a diagram similar to those in Fig. 2.

(3) The angular velocity of rotation at the epoch t is given by

$$\frac{dY}{dt} = 2\pi \frac{K}{\cos^2 \pi t + K^2 \sin^2 \pi t}.$$

(6) When the reflected ray is in a horizontal and southerly direction, as is usually the case, $\omega = 0$, and $\rho = \pi - L$, so that the formula for orientation becomes

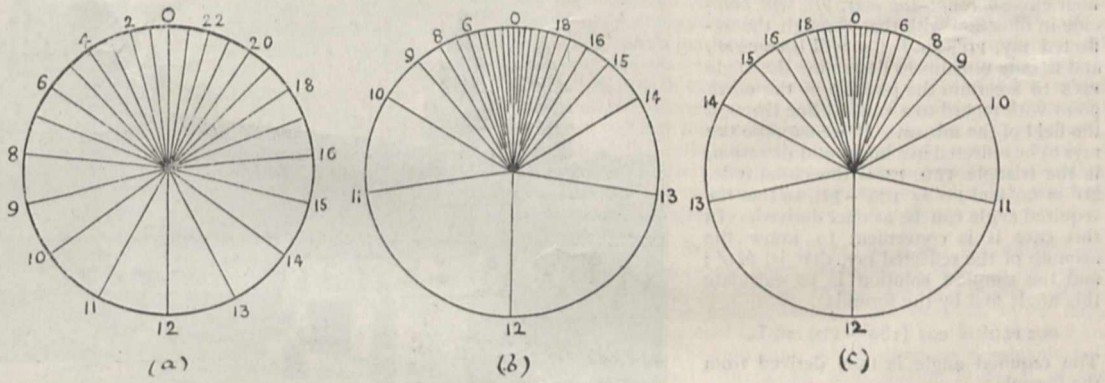
$$\tan \tfrac{1}{2} Y = K \tan \tfrac{1}{2} h$$

where

$$K = \frac{\sin \tfrac{1}{2}(L-\delta)}{\sin \tfrac{1}{2}(L+\delta)}.$$

It readily follows that there is no rotation of the field in this case when the polar distance of the star observed is equal to the latitude of the place of observation ; the rotation is clockwise if the polar distance be less than the latitude, and contrary if greater. Fig. 2 illustrates the varying conditions of rotation in the latitude of London (*a*) for the position of the sun at the winter solstice, (*b*) for the position of the sun at the summer solstice, and (*c*) for a star which passes through the zenith. In each case the numbers are placed to represent the position angles of the north point of the field at corresponding hour angles.

In the case of the heliostat, where the rays are reflected in a northerly direction, a similar method of computation is adopted by Prof. Cornu ; but as the instrument is so little used in work of precision, it is unnecessary to give the details. The important result is that the field of view under ordinary conditions has an angular velocity of rotation greater than that of the diurnal motion.



Sun at winter solstice, London. Sun at summer solstice, London. Star through zenith, London.

FIG. 2.—Illustrating rotation of field of siderostat.

The denominator is always positive, so that the velocity has always the same sign as K ; its value varies from $2\pi K$ (when $t = 0$) to $\frac{2\pi}{K}$ (when $t = \frac{1}{2}$), and is equal to the diurnal motion when the conditions make the denominator equal to K. The velocity varies so slowly for small values of t, that it may be sufficient to regard it as constant and equal to $2\pi K$. Since the northern meridian passage cannot be observed with the siderostat, the value $\frac{2\pi}{K}$ is not observable.

(4) The apparent motion of the field, as seen in the mirror, will evidently be in the same direction as the apparent motion of D′P′ seen from outside the sphere, and it will not be reversed by an astronomical telescope. When the polar distance of the star observed is less than the supplement of the polar distance of the reflected ray, the apparent direction of rotation of the field of a siderostat is clockwise ; it is in the contrary direction if the polar distance of the star is greater than this supplement.

(5) When $\cos \frac{1}{2}(\rho+\delta) = 0$, we have $K = 0$, and $Y = 0$ for all values of t. Hence there is no rotation of the field when the polar distance of the star observed is equal to the supplement of the polar distance of the direction of the reflected ray.

In this case, $\rho + \delta = 180°$, and PM $= 90°$, so that the mirror is parallel to the earth's axis, and the instrument thus behaves like a cœlostat.

[1] This gives the angle reckoned from the direction D′P. To obtain the inclination to a vertical line passing through the mirror, it would be necessary to calculate the angle PD′Z.

A knowledge of the orientation of the field as reflected by a mirror is so frequently required that it may be useful to refer briefly to other ways of treating the problem.

Orbinsky proceeds much in the same manner as Prof. Cornu, but considers the more general case in which the reflected rays are neither in the meridian nor horizontal. The position of the normal is midway between the direction of the star and that of the reflected ray, on a great circle, so that the direction of the reflected ray from any other point of the celestial sphere can at once be determined.

In this way the position of the zenith point of the field (vertex) is derived with respect to the vertical circle in the plane of the reflected ray. A calculation of the angle between the vertex and the north point is then all that is required to give the direction of the north point of the field with respect to a vertical line through it.

Another method of representing the orientation was adopted by Mr. Shackleton in connection with the eclipse of 1896. This can be applied to a reflection in any direction, but it will suffice to indicate its application to a siderostat with the reflected ray in the meridian. Using Prof. Cornu's notation so far as possible, in Fig. 3 NESW is the horizon, NPS the meridian, P the pole, D the star, M the mirror, MS the direction of the reflected ray from D, and SDN the trace of the plane of reflection. Representing the direct field by *anb*, *n* is the north point. The field of the mirror appears behind the mirror as $a'n'b'$, $a'b'$ remaining in the plane of reflection, and $b'Nn'$ being equal to bDn. Since Nv is a vertical line through the field of the mirror, and $vNa' = DSP$, it is evident that $vNn' = 180° - (PSD + PDS)$.

vNn' thus corresponds with the angle Y in Prof. Cornu's formula, and its value is derived by precisely the same formula.

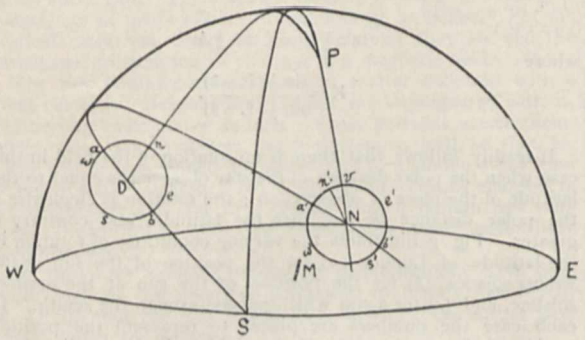


FIG. 3.—Orientation of field of siderostat.

The orientation of the field of a cœlostat is very readily derived. In this instrument the mirror turns on a polar axis in its own plane, so that the normal is always on the equator, and the polar distance of the reflected ray is always equal to the supplement of the polar distance of the star. Thus, in Fig. 4, PD′ is the supplement of PD. The reflection of the hour circle through the star, PD, will coincide in direction with that through the reflected ray, PD′, so that n will become n', and it only remains to determine the angle PD′Z to ascertain the position of the north point with regard to a vertical line through the field of the mirror. If we suppose the rays to be reflected in a horizontal direction, in the triangle PZD, PZ = the co-latitude, ZD′ = 90° and PD′ = 180° − PD, so that the required angle can be at once derived. In this case it is convenient to know the azimuth of the reflected ray, that is, PZD′; and the simplest solution is to calculate this angle first by the formula

$$\cos PZD' = \cos (180° - PD) \sec L.$$

The required angle is then derived from the formula

$$\sin PD'Z = \sin PZD' \cos L \operatorname{cosec} (180° - PD).$$

The position of the north point having been determined, the remaining points can at once be placed, noting that the east and west points are reversed as compared with the direct view in the sky.

It is important to note that although there is no rotation of the field so long as the telescope remains in one position, the whole field is turned when the telescope is set in a different direction. Thus, if the telescope is directed west for observations of the morning sun, the orientation of the field will be different when the telescope is pointed in an easterly direction for observations of the sun in the afternoon; in the former case the north point lies to the right of the vertical, and in the latter case to the left.

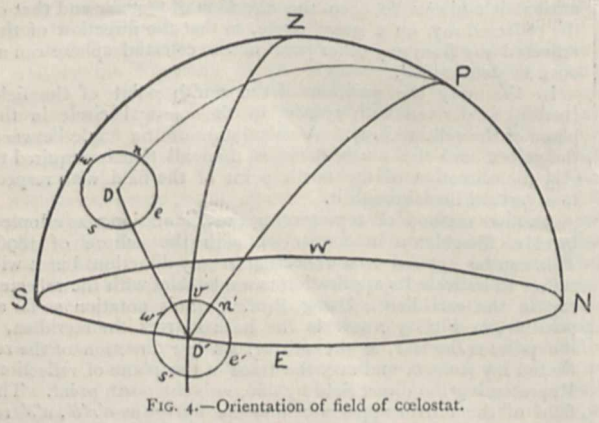


FIG. 4.—Orientation of field of cœlostat.

Other investigations relating to the cœlostat, including the determination of the best position for the telescope under given conditions, have been made by Prof. H. H. Turner (*Monthly Notices R.A.S.*, vol. lvi. p. 408).

As the cœlostat has not yet come into very general use, it may be of interest to add a few remarks as to the arrangements which have been made by Sir Norman Lockyer at the Solar Physics Observatory for utilising this instrument in a permanent observatory (Fig. 5). On account of the varying declinations of the heavenly bodies, the position of the observing telescope must admit of corresponding changes, either in inclination or azimuth, or both. When special instruments, such as the spectro-heliograph, are to be used with the cœlostat, as at the Solar Physics Observatory, motion in azimuth is the only motion permissible, and this is provided for by fixing the receiving instrument on a platform which runs on circular rails, with the cœlostat at the centre. The platform carrying the telescope or spectroscope is covered with a travelling hut, the roof of which is inclined so as not to obstruct the mirror. The cœlostat itself is provided with a hut, which is removed to the north when the instrument is in use; this is shown to the left in the illustration.

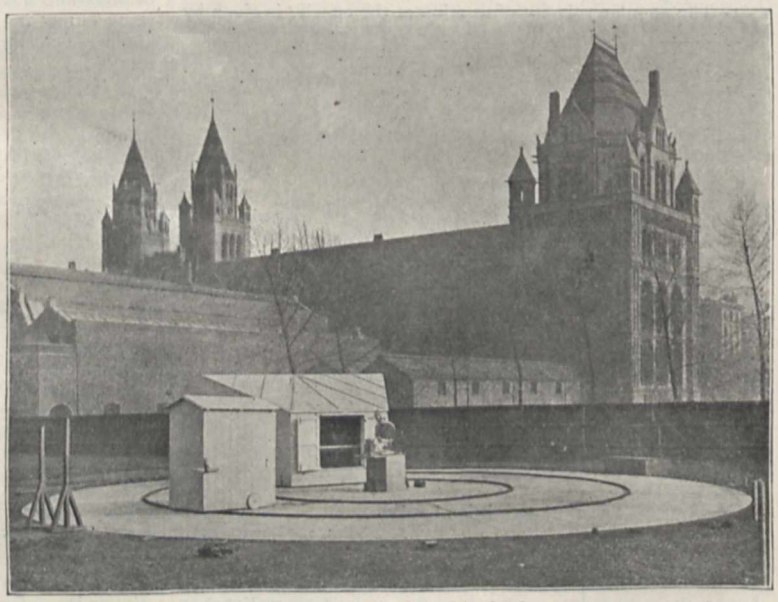


FIG. 5.—The cœlostat of the Solar Physics Observatory.

A. FOWLER.

THE ANNIVERSARY MEETING OF THE REALE ACCADEMIA DEI LINCEI.

A MELANCHOLY interest attaches to the anniversary meeting of that ancient scientific society, the Reale Accademia dei Lincei, held in June, from the fact that the society was then mourning the loss of its distinguished president, Prof. Beltrami, and has since been plunged into deeper mourning by the untimely and unexpected loss of its patron, King Humbert, who with Queen Margherita had for many years taken part in these yearly meetings. It is, moreover, largely due to the munificence of the late King of Italy that the society is enabled to further the advancement of science by the award of prizes for theses dealing with some subject of scientific research.

From the presidential report of Prof. Mesadaglia, we learn that the society's losses have included, besides Beltrami, the names of Capasso, De Simoni, Ferrara, Nestore and Tommasi-Crudeli among the ordinary members, and, of foreign members, Bertrand, Bunsen, Janet and Liais. The *Atti*, or "Proceedings" contain for the year 147 papers, in addition to which several

longer papers are being printed in the *Memorie* or "Transactions," and the corresponding societies with which an exchange of publications is made now number not less than 500. Under the title of *Notizie degli Scavi*, the society brings out accounts of archæological discoveries in Italy, the material for which is furnished monthly by the Minister of Public Instruction. Of recent publications, we note the issue of three volumes of the "Codex Atlanticus" of Leonardo da Vinci, a magnificent work, in the cost of publishing which the late King gave material assistance; also the "Forma Urbis Romæ" of Signor Lanciani, consisting of a large scale archæological map of Rome.

For the Royal prize of 1000 francs for normal and pathological physiology six candidates entered, and a large number of essays of considerable merit were submitted by them. The prize has been adjudged to Prof. Giulio Fano, of Florence, for sixteen papers, dealing, amongst other subjects, with the physiology of the embryonic heart, the doctrine of experimental psychology, the organ of hearing, the graphic registration of respiratory chimism and reflex movements, the latter being a continuation of previous researches on the organs of *Emys Europea*. Of the six candidates for the Royal prize for geology and mineralogy, two were considered worthy of the award, which was therefore divided equally between them. One of the successful candidates, Prof. De Lorenzo, chose geological subjects, and sent in about twenty essays, the most important of which dealt with the trias of the environs of Lagonegro, the mesozoic mountains of Lagonegro, geological observations on the Apennines of the southern Basilicate, and geological studies of the southern Apennines. Prof. Giorgio Spezia's work, on the other hand, was entirely mineralogical, dealing with the influences of temperature and pressure, respectively, on the chemical metamorphism of rocks and minerals. From a long and laborious series of experiments, many of them occupying five or six months, the author concluded that pressure has little or no effect, while the influence of temperature is considerable. The results have a special bearing on the theory of quartz formation. The Royal prize for advances in archæological science was adjudged to Dr. Paolo Orsi, of Roveredo, for his investigations of the antiquities of Eastern Sicily. Dr. Orsi has thrown quite a new light on the prehistoric development of the people known as the Siculi, from the neolithic epoch down to the period of expansion of the Greek colonies. A special prize for philosophy and moral science had been offered for an essay dealing with either the theory of consciousness or the foundations of practical philosophy. This prize has been divided equally between Prof. Bernardino Varisco and Prof. Francesco de Sarlo. The Minister of Public Instruction offered a sum of 3400 lire for two prizes in physical and chemical sciences, and a like sum for two prizes in philological sciences, the prizes being confined to teachers in secondary schools. The committee for the prizes in physical and chemical sciences have awarded two equal prizes—one to Prof. O. Marco Corbino, more especially for his work on light traversing metallic vapours in a magnetic field, and the other to be divided between Profs. Carlo Bonacini and Riccardo Malagoli, more especially for their joint papers on Röntgen rays. In philology, the prizes have been divided up into a number of minor awards, distributed between Signori Giuseppe Vandelli (whose work stood first), Antonio Belloni, Astorre Pellegrini, Giuseppe Rua, Giuseppe Lisio, Augusto Balsano, Giovanni Negri and Guglielmo Volpi.

At the conclusion of the awards a biographical commemoration of the late Prof. Beltrami was delivered by Prof. Luigi Cremona. In the number of the *Atti*, this is followed by a chronological list of Beltrami's scientific works, in compiling which use has been made of the previously published lists by Prof. Dini, and by Signori Pinti and Brambilla in the *Annali di Matematica* and the *Rendiconto* of the Naples Academy respectively.

The proceedings terminated with an address by Signor Giuseppe Colombo on the progress of electrotechnics in Italy. Signor Colombo briefly traced the gradual development of the theory of the electrical transmission of energy, from the discovery of Volta, through the various stages indicated by Pacinotti's invention of the first dynamo, Galileo Ferraris' principle of the rotating magnetic field, and a number of intermediate inventions, down to the principle of wireless telegraphy, to the development of which two Italians, Righi and Marconi, have so largely contributed. The absence of coal has long been a serious bar to the progress of Italy in commercial competition, but Signor Colombo proves by statistics that Nature has provided a source of energy more than sufficient to fill the deficiency, in the water-power with which the country has been well endowed, and it only needs the development of plant for the electrical transmission of power, aided, moreover, by the best means for minimising waste of energy, to raise Italy to a condition of commercial prosperity.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE *Pall Mall Gazette* states that Miss Cruickshank has given to Aberdeen University, in memory of her brother, Dr. Alexander Cruickshank, the botanic garden at Chanoury, Old Aberdeen, extending to six acres, and capable of accommodating nearly six thousand specimens. Miss Cruickshank has devoted to its endowment the sum of 15,000*l*.

MR. GILBERT R. REDGRAVE, Senior Chief Inspector in the South Kensington branch of the Board of Education, has been appointed an Assistant Secretary for Technology. Announcement is made that in the ensuing autumn the Duke of Devonshire will appoint a departmental committee, on which the county councils and the City and Guilds of London Institute will be represented, to consider, *inter alia*, the co-ordination of the technological administration of the Board of Education with the technological work at present carried on by educational bodies other than that Board.

A GOOD idea of the scope and value of the work of the examinations department of the City and Guilds of London Institute can be obtained from the "Programme of Technological Examinations (1900-1901)," published by Messrs. Whittaker and Co. Examinations are held in seventy technological subjects, and also in manual training (wood-work and metal-work). For each examination a syllabus is given, and a useful list of works of references; and the questions and practical exercises set at the recent examinations are all reprinted. Several of the syllabuses have been revised, notably those of photography, pottery and porcelain, silk throwing and spinning, and silk weaving, electric lighting, watch and clock making, typography, lithography, carpentry and joinery.

THE Redruth School of Mines, of which the syllabus for 1900-1901 is before us, offers exceptional facilities for studying the principles of mining in the Cornish mining district. One wing of the school building is occupied by a large mineral gallery, erected to the memory of the late Dr. Robert Hunt, F.R.S. The museum, which contains a valuable collection of mineral specimens, and is the property of the Mining Association and Institute of Cornwall, is at all times accessible to students of the school. The mining course consists of practical underground work, including the timbering of shafts and levels, and of lectures on geology, the principles of mining, the raising and mechanical preparation of ores, and of practical work in gold panning and vanning. Students, in addition, are taught the methods of prospecting for minerals in all possible positions, and are trained to detect favourable indications on the surface. There is thus a reasonable combination of science with practice in subjects essential to the training of mining engineers.

WHAT school gardens are to children, allotments are to adults in agricultural districts, and both provide valuable means of experiment. The Report of the Technical Instruction Committee of the Oxfordshire County Council shows that this is well recognised is several parts of the county. For instance, at the Chipping Norton Agricultural Class there were fifty-four students of an average age of thirty-eight. They were factory hands, labourers, mechanics and small tradesmen, who all cultivated allotments, and were thus able to put principles to a practical test, and determine the causes thus affecting growth. At Reading College, which is connected with the Oxfordshire Committee, various insects and plants were received from different parts of the county for identification, and advice was given in many localities. Field experiments were made on sainfoin and lucerne, rotation, "finger and toe," mangel, and different manures for barley. Charlock spraying was investigated at three farms, and other experimental work had been done under the auspices of the College and the Technical Education Committee.

SCIENTIFIC SERIAL.

American Journal of Science, August.—Rowland's new method for measuring electric absorption and losses of energy due to hysteresis and Foucault currents, and on the detection of short curcuits in coils, by L. M. Potts. Rowland's method, in which the condenser is placed in one arm of a Wheatstone bridge, together with the fixed coils of an electrodynamometer, while the movable coil is mounted in the cross connection, is practically useful. The electric absorption always acts as a resistance in series with a capacity. The resistance is independent of the current, but the temperature has a decided effect on both.—Some new Jurassic vertebrates, by W. C. Knight. The author describes two new species, called *Plesiosaurus shirleyensis* and *Cimoliosaurus laramiensis* respectively. They are in the collection of the University of Wyoming.—Carnotite and associated vanadiferous minerals in Western Colorado, by W. F. Hillebrand and F. Leslie Ransome. Carnotite is probably a mixture of minerals of which analysis fails to reveal the exact nature. Instead of being the pure uranyl-potassium vanadate, it is to a large extent made up of calcium and barium compounds. Near Placerville, Colorado, certain sandstones show a green colouring and cementing material which contains nearly 13 per cent. of V_2O_3. It is intended to work this sandstone for vanadium.—Restoration of Stylonurus Lacoanus, a giant arthropod from the Upper Devonian of the United States, by C. E. Beecher. The arthropod described takes equal rank with the Giant Spider Crab of Japan and the great "Seraphim" (*Pterygotus anglicus*). The animal has a length of nearly 5 feet, and with the legs extended it would measure about 8 feet.—Iodometric estimation of arsenic acid, by F. A. Gooch and Julia C. Morris.—Further notes on pre-glacial drainage in Michigan, by E. H. Mudge. The author discusses the present and former levels in the vicinity of the village of Saranac.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 20.—M. Maurice Lévy in the chair.—New observations on the high valley of Dordogne, by M. A. Michel-Lévy. Owing to the cuttings recently made for the railway between Queuille and Mont-Dore, some new facts on the geology of this valley have been discovered. On the left flank of the valley the deposit of labradorite can be traced up to the Capucin. More to the south an outcrop of trachyte, rich in black mica and amphibole, can be followed up to near the ravines of Riveaugrand. The right flank of the Mont-Dore valley shows clearly the prolongation of the lower andesite of the Grand Cascade. A trachytic dyke has also been recently discovered by M. Paul Gautier in the first ravine west of Compissade, which is rich in granitic inclusions.—On the existence of *Ceratitis capitata*, var. *hispanica*, in the neighbourhood of Paris, by M. Alfred Giard. During the present spring a large proportion of the apricots at Courbevoie, near Paris, fell off the trees in a green state, and the remainder, although apparently exceptionally fine when ripe, where found to be honeycombed with larvæ. This larvæ were found, on development, to give rise to *Ceratitis capitata*, a species that has already been found to be very destructive to many kinds of fruit in the Azores, at Madeira, the Cape of Good Hope, Algeria and Malta. This is its first appearance near Paris, possibly owing to an exceptionally favourable spring. Means for combating this scourge are suggested, as it is of the first importance that it should not become acclimatised in Paris.—Observations on shooting stars made from August 11 to August 14 at the Observatory of Paris, by Mlle. D. Klumpke. About thirty meteors were observed during four nights, of which some came from Perseus and others from the polar region. The former were white, short and very rapid, the latter luminous and coloured.—Observations of the sun made at the Observatory of Lyons with the Brunner equatorial during the first quarter of 1900, by M. J. Guillaume. The results are given in three tables showing the number of spots, their distribution in latitude, and the distribution of faculæ in latitude.—On the composition of the air in a vertical section, and on the composition of the upper layers of the terrestrial atmosphere, by M. G. Hinrichs. By applying a formula of Laplace, the composition of the air is deduced at different levels. From these calculations, carbon dioxide would disappear at 30,000 metres, argon at 60,000 metres. At 100,000 metres the air would consist of oxygen 0·3, nitrogen 4·6 and hydrogen 95·1 per cent.—On the dielectric cohesion of gases, by M. Bouty. When a gas contained in an insulating vessel is placed in a constant electric field, there is a certain critical pressure above which the gas acts as a dielectric, and below which the discharge passes. The relation between this critical pressure (p) and the field (y volts per centimetre) has been studied for three gases—hydrogen, air and carbon dioxide. For low pressures the relation found is $y = a + \frac{c^2}{p^2}$. For higher pressures the curve is practically coincident with the asymptote, $y = a + b(p + \pi)$.—On the extraction of oxygen from the air by solution at a low temperature, by M. Georges Claude. Various solvents for air have been tried at low temperatures in the hope of discovering a liquid in which the difference of solubility of the two gases would be very marked. The experiments, however, were unsuccessful, as it was found that at low temperatures the solubility of the nitrogen increased, so that starting with a mixture containing 65 per cent. of oxygen, after solution and boiling out, the amount of oxygen was practically unchanged, amounting in no case to more than 70 per cent.—On the pyrogallol-sulphonic acids, by M. Marcel Delage.—On the dextrins of saccharification, by M. P. Petit. The results obtained by the action of diastase upon starch were very divergent, depending upon the age of the diastase and the conditions under which it had been preserved.—On the use of sodium peroxide for making wholesome wells containing carbonic acid, by M. E. Derennes. The use of milk of lime for the absorption of dangerous amounts of carbonic acid contained at the bottom of a well has the disadvantage that the residual gas may consist almost entirely of nitrogen. The substitution of sodium peroxide for lime would ensure as much oxygen being given off as carbon dioxide absorbed.

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