THURSDAY, OCTOBER 12, 1911.

BIOLOGICAL PHILOSOPHY.

Creative Evolution. By Prof. H. Bergson. Authorised translation by Dr. A. Mitchell. Pp. xv+425. (London: Macmillan and Co., Ltd., 1911.) Price 10*s*. net.

NOT a few of the great philosophers of the past were expert students of science, especially of mathematics and physics. We think at once of men like Descartes, Leibnitz, and Kant, to mention three whose periods are in almost continuous chronological sequence. The widening of the field of knowledge and submission to a correlated division of labour have made it less possible in these later days for a man to be a mathematician in the morning and a metaphysician at night, but the tradition of an alliance between the two disciplines has not been lost. For to a greater extent than is generally recognised there have been of recent years, in the ranks of the philosophers, men having not merely—though that is much—an intelligent sympathy with scientific work, but familiarity therewith and ability to offer competent criticism. We think, for instance, of men like the late Prof. William James, Prof. Royce, Prof. James Ward, and Prof. A. E. Taylor. Within the same period, too, we have seen one department of science after another making its definite contribution to philosophy. Now a mathematician, and again an embryologist, has been as a Saul among the prophets. We think, for instance, of Mr. Bertrand Russell, Dr. Hans Driesch, and Prof. Lloyd Morgan. It seems then that the time is ripening for a closer cooperation of philosophy and science, and the man of the time is Henri Bergson.

Metaphysician as he is, M. Bergson seems to be equally at home with mathematical and biological concepts, and he appreciates the aim of science with a rare sympathy. He recognises that metaphysics, in its endeavour to discover the general conditions of a complete and consistent formulation of experience, may be of great service to science, but he is equally clear that, in forming its coherent conception of the whole scheme of things, metaphysics must utilise the materials which the sciences furnish. It is indeed one of the outstanding features of his "Creative Evolution" that its author insists on finding in a more complete appreciation of the manifoldness of nature a basis for his new philosophy of life.

One of the main motives of the essay before us is the conviction that *theory of knowledge* and *theory of life* are inseparable inquiries. They must join each other and "push each other on unceasingly." In their common enterprise, "they would dig to the very root of nature and of mind."

"For the false evolutionism of Spencer—which consists in cutting up present reality, already evolved, into little bits no less evolved, and then recomposing it with these fragments, thus positing in advance everything that is to be explained—they would substitute a true evolutionism, in which reality would be followed in its generation and its growth."

The book is divided into four chapters, the sequence of which the author explains. In the first chapter "we try on the evolutionary progress the two ready-made garments that our understanding puts at our disposal," mechanism and finalism; neither will fit, but finalism "might be recut and resewn, and in this new form fit less badly than the other." In the second chapter, to get beyond the concepts which the understanding puts at our disposal, the author reconstructs the main lines of evolution along which life has travelled—to vegetative torpor, to instinct, to intelligence. Besides the line of evolution which ends in man, there are others which "also express something that is immanent and essential in the evolutionary movement." Perhaps certain powers within us that are complementary to conceptual and logical thought, "will become clear and distinct when they perceive themselves at work, so to speak, in the evolution of nature." The third chapter is an effort to bring back the intellect to its generating cause, "which we then have to grasp in itself and follow in its movement." "A fourth and last part is meant to show how our understanding itself, by submitting to a certain discipline, might prepare a philosophy which transcends it."

Prof. Bergson's book, the translation of which reflects the highest credit on Dr. Arthur Mitchell, has been called both brilliant and profound, and it is too big for us to praise. We wish to say, however, that we have read it three times with increasing enjoyment and gratitude. When we have read it other three times we may perhaps understand it more perfectly, for it is useless to pretend that it is easy. The style is so brilliant and picturesque, the play of the sword is so fascinating, there is such abundance of interesting illustration that the pages slip easily past, yet for the student of organic evolution, seeking for fresh light, the thought often seems very abstract and subtle. For example, specialists may find no particular difficulty in the conception of "durée," which is so essential to the argument, but that has not been our experience. For the pages of NATURE it may be most suitable that we should leave the more purely philosophical part of the book alone, and confine ourselves to a few of the salient biological ideas, *e.g.* of the organism as a historic being, and of evolution as a succession of creations—expressions of sustained "effort."

One of the pivots of the essay is its conception of the organism, from which, as it seems to us, modern biology has something to learn, something to translate into its own universe of discourse. Bergson dwells on the likeness between the life of the organism and our own personal experience. We change without ceasing and the organism continually exhibits its characteristic metabolism. But both have the mysterious quality of "durée"—a word so difficult to translate, for Bergson means more than duration in the merely physical and chronological sense; he means "the continuous progress of the past which gnaws into the future and which swells as it advances." "Our personality shoots, grows, and ripens without ceasing. Each of its moments is something new added to what was

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before. We are creating ourselves continually." So of an organism it may be said that "its past, in its entirety, is prolonged into its present, and abides there, actual and acting."

"Continuity of change, preservation of the past in the present, real duration—the living being seems, then, to share these attributes with consciousness. Can we go further and say that life, like conscious activity, is unceasing activity?"

Bergson answers this question by an emphatic affirmative. The spontaneity of life is manifested by a continual creation of new forms.

Many biologists and others have previously expounded the idea of the organism as a historic being, but Bergson has given it a new vividness. "Wherever anything lives, there is, open somewhere, a register in which time is being inscribed." For it is of the essence of Bergson's thinking that time has an effective action and a reality of its own.

"We perceive duration as a stream against which we cannot go. It is the foundation of our being, and, as we feel, the very substance of the world in which we live."

"The evolution of the living being, like that of the embryo, implies a continual recording of duration, a persistence of the past in the present, and so an appearance, at least, of organic memory."

It is this conception, in part, which leads Bergson to reject radical mechanism with some emphasis, and, for that matter, radical finalism as well, though he ends with leaving us with a theory that partakes of finalism to a certain extent.

Prof. Bergson thinks of life as

"the continuation of one and the same impetus, divided into divergent lines of evolution. Something has grown, something has developed by a series of additions which have been so many creations." "Evolution has taken place through millions of individuals, on divergent lines, each ending at a crossing from which new paths radiate, and so on indefinitely."

He believes that the essential causes working along these diverse roads are "of psychological nature." It is to be expected therefore that "they should keep something in common in spite of the divergence of their effects."

"Something of the whole, therefore, must abide in the parts; and this common element will be evident to us in some way, perhaps by the presence of identical organs in very different organisms."

It is this idea which leads Prof. Bergson to devote particular attention to the phenomenon of convergence in evolution, to the occurrence, for instance, of closely similar eyes in molluscs and in vertebrates—eyes which differ greatly in development, and must have had a quite independent evolution.

"What likelihood is there that, by two entirely different series of accidents being added together, two entirely different evolutions will arrive at similar results?"

Of course, the conventional Darwinian and Lamarckian interpretations are carefully considered.

"But such similarity of the two products would be natural, on the contrary, on a hypothesis like ours: even in the latest channel there would be something of the impulsion received at the source. *Pure mechanism, then, would be refutable, and finality, in the special sense in which we understand it, would be demonstrable in a certain aspect, if it could be proved that life may manufacture the like apparatus, by unlike means, on divergent lines of evolution; and the strength of the proof would be proportional both to the divergency between the lines of evolution thus chosen and to the complexity of the similar structures found in them.*"

This is one of the ingenious arguments of this brilliant essay, but we doubt if it would convince anyone against his will.

Prof. Bergson considers various theories of evolution, which he regards as each true in its way. The neo-Darwinians are probably right in teaching that the essential causes of variation are the differences in the germs borne by the individual, but probably wrong in regarding (or if they regard) these differences as purely accidental and individual. Eimer was probably right to some extent in his idea of variation continuing from generation to generation in definite directions, but probably wrong in his claim that combinations of physical and chemical causes are enough to secure the result. The neo-Lamarckians are probably right in insisting on causes of a psychological nature, but they are probably wrong in thinking merely of the conscious effort of the individual and in assuming the regular transmission of acquired characters. The author's own position may be gathered from the following sentences:—

"A hereditary change in a definite direction which continues to accumulate and add to itself so as to build up a more and more complex machine, must certainly be related to some sort of effort, but to an effort of far greater depth than the individual effort, far more independent of circumstances, an effort common to most representatives of the same species, inherent in the germs they bear rather than in their substance alone, an effort thereby assured of being passed on to their descendants."

So we come to the idea of—

"an *original impetus* of life, passing from one generation of germs to the following generation of germs through the developed organisms which bridge the interval between the generations. This impetus, sustained right along the lines of evolution, among which it gets divided, is the fundamental cause of variations, at least of those that are regularly passed on, that accumulate and create new species. In general, when species have begun to diverge from a common stock, they accentuate their divergence as they progress in their evolution. Yet, in certain definite points, they may evolve identically; in fact, they must do so if the hypothesis of a common impetus be accepted."

This remains too shadowy for the working naturalist, but it is a fresh attempt to express what must some day become clearer, the essential thought of Lamarck, of Goethe, of Robert Chambers, of Samuel Butler, and of later vitalists—the idea of variations as intrinsic self-expressions of the organism.

Another cardinal idea of Prof. Bergson's book is that the evolution of life has taken a number of divergent directions, leading to quite different goals. It is neither a series of adaptations to accidental circumstances, as the mechanistic view sees it, nor the realisation of a plan, as the finalist view would have it. A plan is given in advance, but evolution is a creation unceasingly renewed, a development of an original impetus in various directions. Two of these directions are represented by the world of plants with their fixity and insensibility, and the world of animals with their mobility and awakened consciousness.

"But the waking could be effected in two different ways. Life, that is to say, consciousness launched into matter, fixed its attention either on its own movement or on the matter it was passing through; and it has thus been turned either in the direction of intuition or in that of intellect."

Intuition could not go very far, and shrank into instinct. Intelligence became more and more free, and "it can turn inwards on itself, and awaken the potentialities of intuition which still slumber within it." While Bergson shows very finely how the plant may sometimes rouse itself from its torpor and the animal sink into vegetativeness, how instinct may be mingled with intelligence, and intelligence penetrated by instinct, yet his definite conclusion is that the differences between vegetative torpor, instinct, and intelligence are differences of kind.

"*The cardinal error which, from Aristotle onwards, has vitiated most of the philosophies of nature, is to see in vegetative, instinctive and rational life, three successive degrees of the development of one and the same tendency, whereas they are three divergent directions of an activity that has split up as it grew.*"

And it is from this that the author passes to his even more important conclusion that while intelligence guides us into matter and delivers to us the secret of physical operations, it is instinct—which is sympathy—that will give us the key to vital operations.

"Intelligence goes all round life, taking from outside the greatest possible number of views of it, drawing it into itself instead of entering into it. But it is to the very inwardness of life that *intuition* leads us—by intuition I mean instinct that has become disinterested, self-conscious, capable of reflecting upon its object and of enlarging it indefinitely."

Thus while nature-poetry is in no sense biology, it may be a very important complement.

J. A. T.

TIDES AND ORBITS.

Scientific Papers. By Sir George Howard Darwin, K.C.B., F.R.S. Vol. iv., Periodic Orbits and Miscellaneous Papers. Pp. xviii+592. (Cambridge: University Press, 1911.) Price 15*s.* net.

IN this fourth volume Sir George Darwin has for the present completed the task of editing his papers, a task which he commenced four years ago on the invitation of the syndics of the Cambridge University Press. If we may judge from the fact that nine papers in the present volume have appeared since the publication of the work was started there is reason to hope that a supplementary volume will be needed before many years are past. That volume when it comes will have to contain, if it is to be consistent with former volumes, pioneer investigations of a high order in some difficult branch of applied mathematics. To one who desires to speculate along what line Sir George Darwin's future work is likely to take him the present volume is of especial interest. For in the papers classed under the head "Miscellaneous Papers in Chronological Order" will be found several early papers containing the germ of much of the later more important work. Several of these papers (notably 11, 12, 13) would appear to be by-products of larger investigations which were already (we judge from the chronological list of papers) well in hand when these investigations were published. But the paper "On the perturbation of a comet in the neighbourhood of a planet," which was followed after an interval of four years by the historic investigations on periodic orbits, does look like the first attempt along a new and fruitful line of investigation. In fact, though differing in scope and nature from the larger work, the small paper to which we have just referred might quite fairly, from a historic point of view, have been placed in the section containing the periodic orbits papers, as a preliminary piece of research. This section is the most important part of the volume under review, and we must discuss it in some detail.

In the introduction to the well-known memoir in the *Acta Mathematica,* the author speaks of the prodigious amount of numerical work involved in his attack on the problem of periodic orbits. He adds:—

"It is not for me to say whether the enormous labour I have undertaken was justifiable in the first instance; but I may remark that I have been led on, by the interest of my results, step by step, to investigate more, and again more cases. Now that so much has been attained I cannot but think that the conclusions will prove of interest both to astronomers and mathematicians."

Recent successful applications to problems of celestial astronomy of what are to a large extent Sir George Darwin's methods would alone justify his heavy work. But quite apart from these applications the paper has great intrinsic value. The important stability discussion and the useful account of the method of mechanical quadratures practically developed by the author both serve a very useful purpose to the student. The presence of a paper by Mr. S. S. Hough, his Majesty's astronomer at the Cape, is a valuable addition to the section. It not only serves to bridge over the gap between Darwin's first and third papers and to supply an important addition to the theory of the subject, but it also supplies an account of the orbit work from a different point of view from that of the author. It may not unfairly be compared to Schwarzschild's account of Poincaré's work on revolving bodies, and its presence alongside Darwin's papers is of great value. It should be added that the illustrations have been well reproduced, and that from an interesting appendix some idea may be gleaned of the heavy computing work involved in these researches. Here it seems not unreasonable to refer to Sir George Darwin's generous and thoughtful appreciation of his great co-worker's investigations in his own field. His address on presenting the gold medal of the Royal Astronomical Society to M. Poincaré is full of interest. This, with his two British Association addresses, will form the chief item of interest in this volume to the non-mathematical reader. We can only glance at two points of interest here.

The idea that some physical truth underlies Bode's empirical law seems to persist in these addresses, and we could hope that there lies the germ of Darwin's next attack on the problems of cosmogony. We naturally cannot agree with all the statements made in what are essentially popular addresses, and we signal as one instance of doubtful reasoning the reference to a condensing ring on p. 537. The effect of a mobile central nucleus inside the ring seems to be left out of account.

Among the miscellaneous papers we select first for mention those dealing with mechanical designs, where the collaboration of the author's brother, Horace Darwin, is again suggestive of later developments; the sandthrust and ripple experiments also give evidence of a side of Darwin's nature not suspected from a casual knowledge of his work. It was with something of a start that the writer found in "A Geometrical Puzzle" a note (dated 1877) referring to an old puzzle which has only recently had a return of popularity. The papers on "Marriages between First Cousins and their Effects" form an appendix which is still of considerable interest to the biological statistician. But if we may judge from the preface the paper to which Darwin would ascribe the greatest value himself is the one on "The Mechanical Conditions of a Swarm of Meteorites." The author notes that the paper has received but little notice, and the reason for this does not seem far to seek. The seat of the controversy has moved away from the point to which the investigation was directed, as is indeed clear from Darwin's own addresses referred to above. The assumptions of a spherical distribution do not apply to a spiral nebula—which has become of recent years the chief source of speculative interest. Lastly, we must mention the paper on the Antarctic tides. It is curious to compare Darwin's forecast of a great unsuspected bay in the Antarctic with Harris's forecast of a large piece of undiscovered land in the Arctic Ocean. Both suggestions have been based on tidal observations, supported to some extent by rival theories. Both are open to proof or disproof through subsequent voyages of exploration.

We have left until last the English text of the important article, "Bewegung der Hydrosphäre," in the "Encyklopädie der Mathematischen Wissenschaften." Here again Mr. Hough has collaborated and added a lucid discussion of the dynamical theory of the tides. The practical application of the theory by the harmonic and synthetic methods are fully discussed, though the treatment is somewhat too condensed for the average reader. A useful bibliography and schedule of the symbols in common use is added, and an account of many miscellaneous investigations, such as the Bidston tidal-load experiments. It is perhaps disappointing to gather that we cannot yet with any confidence make any wide generalisations as to the nature of the tide-wave in the open ocean. But in each unsolved problem lies the charm of the unknown, the fascination which lures the born researcher on to investigation after investigation. That George Darwin by right of descent and by natural aptitude is one who must pursue the search in the unknown is amply testified in his collected works. That he has pursued his investigations in the right spirit his own words testify.

"Man is but a microscopic being relative to astronomical space, and he lives on a puny planet circling round a star of inferior rank. Does it not then seem as futile that he can discover the origin and tendency of the universe as to expect a house-fly to instruct us as to the theory of the motions of the planets? And yet, so long as he shall last, he will pursue his search, and will no doubt discover many wonderful things which are still hidden. We may indeed be amazed at all that man has been able to find out, but the immeasurable magnitude of the undiscovered will throughout all time remain to humble his pride. Our children's children will still be gazing and marvelling at the starry heavens, but the riddle will never be read."

THE SCIENCE OF MODERN ARTILLERY.

Modern Artillery in the Field: a Description of the Artillery of the Field Army, and the Principles and Methods of its Employment. By Colonel H. A. Bethell. Pp. ix+393. (London: Macmillan and Co., Ltd., 1911.) Price 7*s.* 6*d.* net.

THIS book is a welcome sign that the country is beginning to wake up to the importance of the study of artillery science, in which we see such superior interest everywhere abroad.

The territorial is very keen to make himself acquainted with the science of his arm; and in the absence of official financial support this treatise of Colonel Bethell will prove useful to make him without practice into the theoretical gunner, contrasted with the regular gunner, practical man without practice.

In opposition with what can be seen on the Continent, here in this country we have no practice ranges for artillery—*Champs de Tir,* so plentiful in France. We shall have to trust to territorial enthusiasm in antagonism to official neglect for providing at private expense the best amateur substitutes possible, which the regular gunner will be glad to utilise on an emergency when once a system is started; he too is starved in practice to an equal extent.

The retired general officer is not forgotten—landowner and on a pension, who at the end of the last century was so decided in his refusal to give any facility to volunteer rifle shooting; but soon was sorry he had been so outspoken, when the bad news came streaming home from South Africa shortly after.

Modern artillery has been revolutionised by the introduction of the quick-fire (Q.-F.) gun, described with useful diagrams by Colonel Bethell; but the name should be changed to Q.-A. (quick-aim).

By allowing the gun a long recoil of three or four feet over the carriage, the reaction can be reduced until the wheels do not jump off the ground; the carriage remains still, so that a slight adjustment only is required for the next shot.

Without this Q.-A. arrangement the Q.-F. principle cannot be utilised; and one of these guns is a match for six of the type we used in South Africa.

The gunner who fires the gun is still called by official misnomer the "layer"; but he does not "lay"; he merely keeps the telescopic sight on the mark and fires as fast as the gun can be loaded—twenty times a minute. He is the *pointeur*; other gunners attend to laying of the gun, in giving the elevation to correspond with the range finder, and in setting the fuse, for which a special instrument has at last been introduced; others traverse the gun when required and hand over the ammunition, and all can work in security behind a steel shield. But the man who fires the gun gives his individual attention to "pointing."

Official optimism at the end of the last century had declared our artillery to be perfect—a sure prelude to disaster. We know now that it was fit only for the scrap heap, and would have been knocked out in the first encounter with a European Power; and the German mercenary gunner in Africa was more than a match for our regular artillery.

We must look to France for the most modern development of artillery science, as our military authority is quite content on a back seat.

Parts iii. and iv. have the appearance of being lifted from a French source. The territorial gunner will profit at his leisure by a study of these parts and the useful hand sketches; also in walking over the ground in his neighbourhood with eyes open; his opportunity of actual insight at manœuvres will be small.

The word mobility is always in vogue, with little grasp of its meaning.

After a war the cry is always for a more powerful gun; and our eighteen-pounder weighs 24 cwt. on a pair of wheels. This is too much for the road and the team, and is putting the cart before the horse according to the proverb modified. A field gun must be able to leave the road and cross a ploughed field, so that the old definition of the Act of Parliament of Henry VII. still holds good, of a ton as a cartload, in fixing the standard weight to be carried on a pair of wheels.

But in a long peace, when smart evolutions are considered of more importance than gunnery, and mobility comes to mean a gallop with no reality between the team, the weight decreases to an opposite extreme.

The horse scarcity is becoming acute with the advance of the motor-car. Territorial gunners will have to learn their drill indoors with blocks of wood and toy soldiers, like naval officers playing a war game on the gun-room table; and this book will provide plenty of ideas for abstract tactical problems.

The artillery tactics of the flying machine come in for discussion. These tactics have been worked out long ago by the French, and the dirigible balloon was directed to take up a place of safety hovering vertically overhead, as then the enemy would not dare to fire with the prospect of the shot descending on his own head or his friends'.

We prefer to think of the flying machine as a dragon-fly, in the German name, harmless and lovely for our delectation. But no public funds would be available if it could not be shown that the flying man could be utilised for human destruction, employed as "the light militia of the lower sky."

G. GREENHILL.

INSULATING MATERIALS AND ARMATURE WINDINGS.

(1) *Les Substances Isolantes et les Méthodes d'Isolement utilisées dans l'Industrie Électrique.* By Jean Escard. Pp. xix+313. (Paris: Gauthier-Villars, 1911.) Price 10 francs.

(2) *Les Enroulements Industriels des Machines à Courant continu et à Courants alternatifs: Théorie et Pratique.* By E. Maree. With a preface by Paul Janet. Pp. vii+240. (Paris: Gauthier-Villars, 1911.) Price 9 francs.

(1) A TREATISE on insulating materials conceived in a scientific spirit would certainly be welcome to many electrical engineers, and on reading the author's preface to his attempt to write such a treatise one concludes he has approached his subject from this point of view. He tells us that his work is not intended to be a mere enumeration of the various insulating materials available, but a critical investigation, such as will help the practical engineer to make in each case the best selection possible. Good as the author's intentions were, his performance falls short of them.

There is, to begin with, a good deal of matter in his book which has nothing whatever to do with insulating materials. The first forty pages are devoted to a discussion of metallic and liquid conductors, and here we find merely a repetition of statements and figures which will be found in any text-book on physics. This is padding; so is the picture of a drilling machine, that of a shop in which tissue paper is pasted on to transformer plates, and so are the illustrations of various wooden and ferro-concrete telegraph poles. To drag in the coherer used in wireless telegraphy is also padding, pure and simple. That the insulating properties of concrete are discussed is quite right, but it is misleading to draw any conclusions from it in respect of the insulation of dynamos. Yet on p. 128 we are told that small machines are generally placed on timber, and are thus sufficiently insulated from earth. Large machines must be put on a concrete foundation, and although this is not an absolute insulator, it is a sufficiently poor conductor to prevent any considerable escape of electricity to earth. But precautions are necessary; the foundation must be kept dry, and to this end one must avoid the neighbourhood of steam and water pipes, and one must dry the air in the engine-house by ventilating fans. How a steam dynamo is to be driven without steam and water pipes coming near it the author does not explain.

As regards special insulating compositions, there is little more than enumeration accompanied by some general remarks, such as one might find in a trade list. In some cases the composition is given in detail, but no definite electrical data. We find such trade names as "Radoonite," "Terracite," "Refragor," "Megotalc," "Micacementite." The last-mentioned material is said to withstand vibration, and we are told that certain traction motors which were not insulated with it broke down after a run of 20,000 km., whereas after this material was used they were able to run 40,000 km. Information of this kind is simply valueless.

A good deal of space is devoted to air as an insulating material, and reference is made to the investigations of Ryan, Steinmetz, Scott, and Mershon (the latter's name being persistently spelled Merthon). There is, however, nothing said about Watson's research on the increase of the dielectric strength of air under high pressure, and the practical application he made of it, and brought before the Institution of Electrical Engineers a few years ago. The best chapter in the book is that on porcelain as an insulator. Here we get some definite data, both as to the various types used and the methods of testing.

(2) Formulæ for armature windings are a fascinating subject to the mathematician. It is, of course, possible to represent any winding, no matter how complicated, by some mathematical expression, or even to devise a general winding formula of formidable aspect which, by a suitable choice of coefficients and constants, may be reduced to represent any winding, even the simplest. To an accomplished mathematician there must be a great temptation to treat the subject in this comprehensive way; and we may feel grateful to the author for having withstood the temptation and given us a treatise which restricts the subject to those windings that are of importance to the manufacturer. But these he treats thoroughly, not only as mathematical problems, but also from the manufacturer's point of view, that is, including detailed descriptions of the various special tools required. The use of winding tables instead of drawings of connections is, of course, well known, but the author's way of arranging the winding table is extremely useful. It contains not only the sequence of the conductors (or in a coil winding of the coil sides) proper, but also the sequence of slots and commutator sections, so that the division of current between the armature circuits and the potential difference between any two conductors or any two commutator segments can be seen at a glance.

The use of open slots and binding hoops is recommended for peripheral speeds under 6000 feet a minute; beyond that wooden wedges should be used, or, better still, slots with an overlapping lip. As regards equipotential connections the author seems to think them of equal importance for wave and lap winding, and he fails to point out that with four-pole machines, even if lap wound, they are not nearly so necessary as in a six-pole machine. This is, however, a minor matter, and, moreover, does not affect the system of winding, which is, strictly speaking, a geometrical and not a dynamical problem.

In the second part of the book we come to windings for alternating-current machinery. These are generally more simple than direct-current windings, but the author treats them with equal thoroughness. Even such questions as the shape of the e.m.f. curve as influenced by the number of slots per phase per pole, the comparative merits of six-phase and three-phase windings for converters, those of two-phase *versus* three-phase generators, and other more theoretical matters receive due attention. The special tools required are fully discussed and illustrated, and questions of insulation, such as the thickness of cotton covering, thickness of micanite tubes, covering and protection of coil ends, are not overlooked. The work is profusely illustrated both with line drawings and with perspective views of windings in different stages. These are very clear, and, as examples, well chosen. Polyphase winding diagrams are shown in different colours, so that it is easy to follow out the circuits for each phase separately. GISBERT KAPP.

AGRICULTURAL BACTERIOLOGY.

(1) *Handbuch der landwirtschaftlichen Bakteriologie.* By Dr. F. Löhnis. Pp. xii+907. (Berlin: Gebrüder Borntraeger, 1910.) Price 36 marks.

(2) *Landwirtschaftlich-bakteriologisches Praktikum.* Anleitung zur Ausführung von landwirtschaftlich-bakteriologischen Untersuchungen und Demonstrations-Experimenten. By Dr. F. Löhnis. Pp. vii+156. (Berlin: Gebrüder Borntraeger, 1911.) Price 3.40 marks.

AS the fertility of virgin soils becomes exhausted and the world's population increases, man will become more and more dependent on artificial methods for increasing the fertility of the soil and on intensive cultivation. Research during the last twenty years has shown how important lowly forms of life are in these connections. The microbiologist has already indicated that, for instance, by increasing the nitrogen-fixing micro-organisms in the soil by inoculation, or by partial sterilisation whereby forms inimical to them may be destroyed, much may be done to increase the yield of crops without the actual addition of plant-food elements by means of manures.

(1) There has of late been an enormous output of work from various laboratories and experimental stations, and the first work under review gives an admirable summary of the more important researches on agricultural microbiology. It is a large volume of 900 pages, and has been compiled with true German industry from the original papers, the references to which are given. The latter occupy from a quarter to one-half, and in many cases three-quarters, of every page, often with a line or two of comment or explanation appended, so that the book forms a very complete bibliography of the subject, and it is pleasing to note that British, Colonial, and American work appears to have received full recognition, which is not always the case in German literature. The volume is divided into five main sections, which respectively deal with the occurrence and activity of micro-organisms in (1) fodder and agricultural foodstuffs, (2) the "retting" of flax and of hemp, and tobacco fermentation, (3) milk and milk products, (4) manure, and (5) the soil, and the treatment of each is very complete. Thus, in the first named, after a general discussion of the number and nature of micro-organisms in fodder and foodstuffs (hay, straw, grain and seeds, meal and roots), the subjects of the influence of micro-organisms in the preparation, heating, and firing of hay, in ensilage, in the decomposition of the starchy, saccharine, protein, and fatty constituents of fodder, &c., on digestion in the animal which consumes them,

and on its intestinal flora, are all treated. Finally, to every section or subdivision of a section a description of the physical, chemical, and biological methods of investigation is appended.

That we have much yet to learn concerning many of the natural processes involved is apparent from a perusal of such a section as that on the heating and firing of hay. This appears to take place in three stages, a first in which the temperature rises to 45–50° C., a second in which the temperature rises from 50° C. to 70° C., and a third which proceeds above 70° C. The first two stages are caused by the activities of micro-organisms involving processes of decomposition and oxidation ("thermophilic" bacteria being active between 50° and 70° C.), but the cause in the third stage of the production of heat above 70° C. and ultimately culminating in ignition is not so obvious. It is probably a physico-chemical process due to the production of carbonaceous and other matters which adsorb, condense, and oxidise the hydrogen, marsh and other inflammable gases, which have resulted from decomposition in the earlier stages, and cause their ignition, much in the same way as spongy platinum causes the ignition of hydrogen.

Nor is the subject-matter strictly confined to "bacteriological" details, but if others are of importance in relation to the general treatment of a subject, they are included. Thus, as regards milk, not only is the importance of streptococci discussed, but the nature and significance of the cellular elements which are constantly present in less or greater number are reviewed. These cellular elements when in small numbers have generally been considered to be leucocytes, when in large numbers as pus cells and to be abnormal, but investigation has shown that under normal conditions and with perfectly healthy cows these cells are occasionally present in enormous numbers; all this is summarised.

Considerable space is also devoted to the chemistry of the changes and decompositions which occur in the various processes, and while the vegetable micro-organisms claim most attention, some reference is made to the protozoa and higher animal organisms, *e.g.* earth-worms and their importance. Had the work been compiled later, doubtless more space would have been devoted to the protozoa, the treatment of which as it stands is too brief.

The book, which is not illustrated, is clearly printed on good paper with numbered lines for facility of reference, and concludes with very full and complete indexes of authors and subjects.

(2) This little book, by the same author as the preceding, gives in the briefest outline a general account of bacteriological methods followed by a series of simple practical lessons on the bacteriology and biochemistry of milk, manure, and soil. The student who works through these lessons will certainly gain a considerable amount of knowledge of the subjects treated, and will be ready to undertake more advanced work. Many illustrations are given, most of which are good and appropriate, though the methods of inoculating tubes given in Figs. 19 and 24 seem clumsy and archaic.

R. T. H.

OUR BOOK SHELF.

British Rainfall, 1910. On the Distribution of Rain in Space and Time over the British Isles during the Year 1910, as recorded by nearly 5000 Observers in Great Britain and Ireland, and discussed with Articles upon Various Branches of Rainfall Work. By Dr. H. R. Mill. The fiftieth annual volume. Pp. 112+328. (London: Edward Stanford, 1911.) Price 10*s*.

THE author remarks in his report to the trustees that the chief object of the rainfall organisation is to present the results of the labours of the observers in the best and most useful way. An inspection of the volume under review leaves no doubt that this desirable aim has been fully attained. As in former years, the work is divided into three principal sections, including, *inter alia*, (1) organisation and special articles, (2) monthly and seasonal rainfall and its relation to the average and heavy falls of rain (see NATURE, February 2), and (3) general table of annual rainfall and number of rain-days at 4874 stations. The cartographic treatment has been carried further than in previous volumes; the maps referring to heavy falls on rainfall days are of exceptional interest, and include a series of remarkable thunderstorms which occurred chiefly in the south of England from June 5 to 10, with a coloured map (as frontispiece) showing the distribution of torrential rains in the Thames valley on June 9.

The most laborious of the changes this year is the more satisfactory arrangement of the stations of the general table for England and Wales in river basins, although for convenience of reference the counties are retained as the units. This forms the subject of a special article, illustrated by maps of each division showing the county boundaries and watershed lines. The treatment of the stations in Scotland and Ireland has been postponed. Another laborious piece of work has been the introduction of a new rainfall average based on the thirty-five years 1875–1909. For the British Isles generally and for Ireland this makes practically no change, so far as the annual totals are concerned, from the thirty years' average. For England the new average is 5 per cent. less, in Wales 3 per cent. less, and in Scotland 4 per cent. more. In a special article on the greatest rainfall which may occur on the wettest day of the year it is shown that during the last forty-seven years falls of 4 inches have occurred in a great number of counties, even exceeding 6 inches in a few. Another useful article on the rain-gauge in theory and practice will remove several of the difficulties usually experienced by beginners of rainfall observations. We cannot conclude this notice without expressing regret that this very valuable organisation is not self-supporting, and that a considerable financial burden has to be borne by the director.

Partridges and Partridge Manors. By Captain A. Maxwell. Pp. xii+327. (London: A. and C. Black, 1911.) Price 7*s*. 6*d*. net.

WHAT the author accomplished with the assistance of Mr. George Malcolm in 1910 for the grouse he has succeeded in doing single-handed for the partridge in 1911, and the praise we felt bound to accord to his former effort we have pleasure in re-echoing in the case of the present beautifully illustrated volume. It contains, in fact, practically all that the sportsman ought to know with regard to the plump brown game-bird of our stubbles, and much that ought to interest the ornithologist. For Captain Maxwell appears to be a good field observer himself, and has likewise availed himself largely of the stores of information possessed by the better class of gamekeepers. Among such information, it may be mentioned, is a heavy and apparently conclusive indictment against the hedgehog as a game-poacher of the blackest dye.

Partridge-preserving the author considers to be decidedly beneficial to the farmer, as it not only brings money into country districts, which otherwise would be spent elsewhere, but it provides him with "a small machine [in the shape of the partridge] which turns noxious weeds and useless insects into a valuable food." After discussing the economical question in chapter i., the author takes the natural history of the partridge as the subject of chapter ii. Here we are told at the outset that "no fewer than 152 species of partridges and their affinities" are recognised by ornithologists—a statement difficult to understand owing to the ambiguity of the term "affinities." A few other minor criticisms might be made on this chapter, but in the succeeding chapters, dealing with rearing, driving, and shooting partridges, the author appears to be thoroughly in his element and a master of his subject. Every sportsman should buy a copy of the book. R. L.

Practical Drawing. A Preliminary Course of Work for Technical Students. By T. S. Usherwood. Pp. viii+163. (London: Macmillan and Co., Ltd., 1910.) Price 2*s*.

THIS useful little manual provides an excellent course of instruction in instrumental drawing, very suitable for the junior classes of technical institutes. The beginner is first shown the use of the rule and callipers in the making of dimensioned hand sketches of simple objects. Then full explanations are given of the manipulation and handling of drawing instruments, including tee and set squares, in the production of accurate work to scale. Facility in the use of instruments is acquired along with a working knowledge of geometrical principles, by the plotting of lines, angles, figures, vectors, and the drawing of simple mechanical and architectural details.

The subsequent work in plane geometry includes the construction of scales, circles, triangles, polygons, geometrical patterns, and similar figures; also graphing on squared paper, the calculation of areas, and the plotting of the paths of points moving under geometrical or mechanical constraint. The author wisely devotes a chapter to the method of representing solid objects by plans and elevations, and by metric projections to scale. The book is provided with an index, and the student with answers to the numerical exercises. The author is evidently an experienced teacher. He supplies good examples in great variety. The scheme of instruction is a sound and desirable one, and affords a thorough groundwork for subsequent study.

Die praktische Bodenuntersuchung. By Prof. E. Heine. Pp. xii+162+plate. (Berlin: Gebrüder Borntraeger, 1911.) Price 3.50 marks.

WHILST there are many works in German dealing with the properties of soil from the purely scientific point of view, there is none, according to the author, that gives the practical farmer the kind of knowledge he wants in order to understand the nature of the soil and the processes going on therein. While it is not denied that a farmer can get on sufficiently well without this knowledge, nevertheless he will find not only a source of interest, but also of profit, in learning something about the fundamental properties and laws on which the cultural operations and the fertility relationships of the soil are based. The author therefore deals in successive chapters with the soil as a medium for plant growth, the physical properties, chemical composition, and biological relationships of soils, methods of classification and improvement. In the second part of the book the soils of North Germany are described, and instructions are given for the use of soil maps.

The information is clearly set out, and in its general style will appeal to the farm student and to the young farmer who has sufficient energy and interest to read after his day's work is done. Indeed, the information is better than the method: a book written for the same class of readers in England would be expected to give many more actual illustrations of the application of general principles than are here attempted. The reviewer's experience is that general principles as such have little meaning to the farm student, and copious illustrations are necessary to give point to them. The present book is deficient in this respect.

More stress might well have been laid on the part played by calcium carbonate in soil fertility. No soil deficient in calcium carbonate can be regarded as very satisfactory; vegetation relationships are markedly different according as calcium carbonate is present or not. Thus in the description of humus the differences between the various types is attributed to differences in air supply, the part played by calcium carbonate not being considered important. It is evident, also, that the German method of mechanical analysis is less satisfactory than our own, which would have formed the basis of several of the chapters in such a book.

But apart from these points the little book is very good, and conveys in simple language an accurate presentation of our present ideas on the soil.

E. J. R.

Conic Template. J. T. Dufton's design. For Junior Students of Conics. (London: Macmillan and Co., Ltd.) Price, nickel-plated metal, 4*d*. net; transparent celluloid, 8*d*. net.

STUDENTS of geometrical conics should not fail to provide themselves with this accurately made and handy little "Conic Template." By merely passing a pencil round its curved edges, a true ellipse, parabola, and hyperbola can be drawn, the three curves having closely related elements, which are specified in the instructions accompanying each instrument. The regular employment of accurate figures, instead of rough diagrams sketched freehand, will add interest to the work, and will materially assist in fixing on the mind of the student the forms and properties of these important curves.

How to become a Pharmacist in Great Britain. With Appendixes on Pharmaceutical Qualification in Ireland, Pharmaceutical Registration in the British Empire, Degrees in Pharmacy, and the Schedule of Poisons. Edited by John Humphrey. Pp. 52. (London: The Pharmaceutical Press, 1911.) Price 1*s*. net.

CLEAR and precise information is given here about each stage in the preparation for the work of a pharmaceutical chemist, from apprenticeship to the passing of the major examination of the Pharmaceutical Society. The appendixes give details as to the particular conditions under which qualification to practise pharmacy may be secured in Ireland and in other parts of the British Empire. The advice offered is sound and helpful; and the view throughout is to regard the work of the pharmacist as a branch of applied science needing the practice of scientific methods for its successful performance.

LETTERS TO THE EDITOR.

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

The Simultaneity of Certain Abruptly-beginning Magnetic Disturbances.

IN the first volume of my work "The Norwegian Aurora Polaris Expedition, 1902–3," I stated (p. 63), after studying the magnetograms from seventeen stations in all quarters of the earth, that the characteristic sudden similar magnetic changes occurring often during positive equatorial perturbations "appear *simultaneously*, or rather, the differences in time are less than the amount that can be detected by these registerings." "The above question on simultaneity, which is of great importance, cannot be definitely decided until we are in possession of rapid registerings."

In the spring of 1911 I made an investigation of the zodiacal light in the Sudan and Egypt, during which I had mounted two complete sets of registering apparatus, the one for slow, the other for rapid, registrations, which were working every night near Aswan for one month under the supervision of Mr. Krogness.

The instruments were set up in the depth of an ancient Egyptian tomb, in which the temperature was fairly constant. Thanks mainly to Mr. Keeling, the superintendent of the Khedivial Observatory in Helwan, we enjoyed all the facilities for our work that we could desire.

In order to obtain "quick-run" magnetograms from other stations taken at the same time, I published in NATURE for March 16 (No. 2159, p. 79) a letter requesting other observatories to take such registrations at the same hours as we. I have, unfortunately, not received any intimation of any such "quick-run" registrations having been taken except in Samoa, where Dr. Augenheister commenced the registrations on April 10, while the only sudden equatorial storm registered in the prescribed period of one month occurred on April 9.

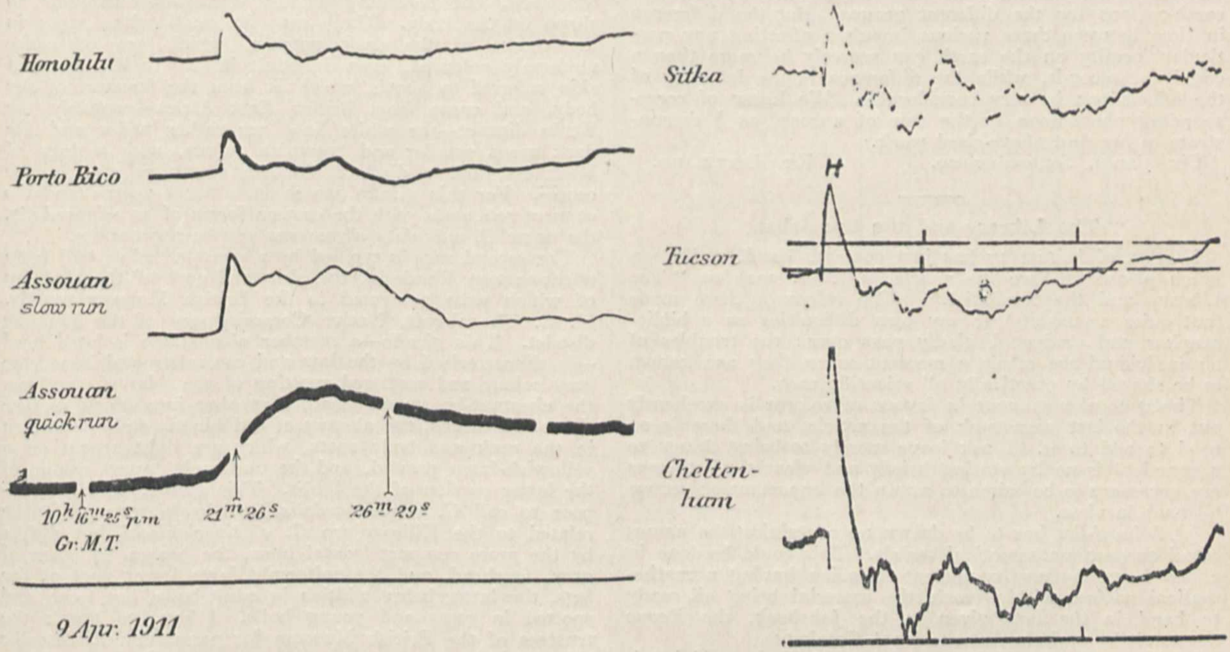
Mr. Tittmann, superintendent of the U.S. Coast and Geodetic Survey, has been good enough to send me some copies of slow-run registerings for April 9 from Cheltenham, Porto Rico, Tucson, Sitka, and Honolulu. Of these, the curves from Honolulu (158° W.) and Porto Rico (65° W.) are of special interest, because these stations, together with Aswan (33° E.), form a particularly happy distribution of stations about the earth.

The figure shows that on this day an equatorial perturbation occurred the character of which on these three stations is very similar. The times of commencement in H are as follows:—

Honolulu	Porto Rico	Aswan
10h. 20m. 7s. p.m. G.M.T. ...	20m. 8s. ...	20m. 44s.

The changes in D at the same time were very small, as might be expected would be the case with this kind of perturbation.

The first notices of time are given in a letter from the Coast and Geodetic Survey; the last value is found by the quick-run magnetogram from Aswan, as shown by the diagram. The time-marks here, which refer to the central point for the obliterated parts, are certainly correct to one second, but a greater uncertainty arises when it is a question of determining when the perturbation shall be said to have commenced. I consider we may be safe when we estimate the possible error at ± 4 seconds. But the values of the slow-run magnetograms lie within this margin in Honolulu and Porto Rico, where, however, the readings are naturally not so trustworthy as those of the quick-run magnetograms from Aswan.



The curves from Sitka, Tucson, and Cheltenham show that the perturbations in those places have had a somewhat different character from those at the three first-named stations, for it appears as though a magnetic polar storm interferes. The curves for D and Z show the same thing.

The times we have been given from the Coast and Geodetic Survey for these stations are:—for Sitka, 10h. 21m.; Tucson, 10h. 20m.; and Cheltenham, 10h. 21m. 9s.; and these refer to the "larger displacement" in H. This occurs shortly after the first abrupt beginning, and the times are, as may be seen, with the exception of Tucson, slightly greater than the others.

As regards Tucson, we notice that the first time-mark is considerably smaller than the later ones; for this reason I think this value perhaps ought to be taken with some reservation.

From Trondhjem I have only one slow-run magnetogram, as the corresponding quick-run, unfortunately, is wanting for the only hour in question. At this station the polar character of the storm is distinctly apparent, as might be expected from so high a latitude. On the occasion of the magnetic storm we are here studying, the similar sudden changes occurred thus around the terrestrial equator *simultaneously* within the limits of error in the observations.

When several observations of such magnetic storms around the equator, obtained by quick-run registerings, are available, as I hope may be the case soon, this important question on simultaneity will be finally determined.

It may be of interest in connection with this to call to mind that, in 1900, quick-run registerings were taken simultaneously in Potsdam and at my observatory at Haldde, near Bossekop. In my work "Expédition Norvégienne de 1899–1900 pour l'étude des aurores boréales," Christiania, 1901, photographs of these registerings are given which show that corresponding small sudden alterations in D were simultaneous within three seconds in Potsdam and Bossekop.

According to my theories of magnetic storms, it might be expected that sudden similar magnetic changes which occur in different parts of the earth arise rather simultaneously. When the sun suddenly sends forth a strong pencil of kathode rays towards the earth, this pencil will, owing to earth-magnetism, be broken up in such a way as to form different partial systems of magnetic impulses—polar and equatorial. The various groups of rays have to travel different way-lengths in space before reaching nearest to the earth, and may arrive at very different earth-regions for the different groups. But the difference in time between these various impulses affecting any particular locality on the earth can scarcely be more than a couple of seconds, while the difference in the intensity of the effects can be very considerable. We know of corresponding phenomena in the case of aurora, as I demonstrate in my first above-cited work.

Christiania, September 29. KR. BIRKELAND.

The Library and the Specialist.

NATURE of August 17 has just come to hand, and I am much pleased to see the article in it (p. 222) on "The Library and the Specialist." The reference there made (not quite accurately) to my own difficulties as a bibliographer and student I gladly pass over: the troubles of an individual are of little moment when they are known to be shared by practically all scientific men.

The general argument in favour of reform is excellently put in the last paragraph of the article, and there is no need to add to it. I ask leave merely to bring things to a practical issue by stating briefly and clearly what steps are necessary to be taken to attain the important object we all have in view.

(1) A hand-list has to be drawn up containing the names of all current mathematical serials. This could be done in a few hours by any competent librarian having a mathematical adviser within reach, the material being all ready to hand in the lists given in the *Jahrbuch*, the *Revue Semestrielle*, and the International Catalogue.

(2) Six copies would have to be made of the said hand-list when finally revised, and one each sent to the librarians of the Mathematical Society, the Royal Society, the British Museum, University College, South Kensington, and the Patent Office, in order that each librarian might indicate which of the serials his library possesses. From all I know of these libraries, I am sure that there is not one of them but would wish to help.

(3) A new list would then have to be made containing the combined details provided by the six, and a copy of this to be furnished to each library.

Any serious obstacle in the way of accomplishing this scheme it is impossible for an outsider to conceive. One of your influential correspondents in 1906 seemed to imply that the librarians would "stand upon the order of their going." Personally, I esteem them too highly to believe this. Any one of three of them might fairly expect the others to follow, the Mathematical Society having a claim to lead because of the special science concerned, the Royal Society because of its outstanding position among scientific bodies, and the British Museum because of its unique position among libraries. Will none of the three risk a rebuff for the work's sake?

I fail even to see that there is a money difficulty in the way. The libraries concerned are constantly being put to greater expense by private individuals. But if money really be wanted, the least we can ask for is to be told the amount. THOS. MUIR.

Cape Town, South Africa, September 5.

I AM glad to be able to assure Dr. Muir and others interested in the matter that steps are about to be taken to carry out the plan he suggests, and to supply each of the six London libraries with the list in its final form. It may even be possible to draw up a more comprehensive scheme, and to publish the list in a periodical readily accessible to mathematicians. If the librarians will give their aid, the minimum for which Dr. Muir appeals will be accomplished before the meeting of the International Congress in 1912.

THE WRITER OF THE ARTICLE.

Two Undescribed Giraffes.

A PIECE of tanned giraffe-skin in my possession, which I intend to present to the British Museum, indicates, apparently, an undescribed race of the netted giraffe (*Giraffa reticulata*) of Somaliland and British East Africa. That species is characterised by the markings taking the form of a coarse network of narrow white lines on a liver-red ground, the dark meshes being large and quadrangular on the neck, but becoming smaller and more irregular in shape on the body. There may be small white spots in the centre of the dark patches, which are otherwise uniformly coloured, even in adult bulls. In the piece of skin referred to above, which is from the forepart of the body, and came from British East Africa—probably the Kenia district—the white lines are rather wider and the dark areas smaller and brownish rufous, with a tinge of blackness, and a distinct blackish streak or star in the centre. For this giraffe, which in a slight degree tends to connect *reticulata* with the eastern forms of *camelopardalis*, the name *G. reticulata nigrescens* will be appropriate.

The second race is typified by a mounted adult bull from north-eastern Rhodesia, the skin and part of the skeleton of which were presented to the British Museum by Mr. H. S. Thornicroft, Native Commissioner of the Petauke district. This giraffe—a member of a single isolated herd—is characterised by the low and conical frontal horn, the grey colour and scattered spotting of the sides of the face, the chestnut-brown forehead, deepening into black on the tips of the horns, the absence of a distinctly stellate pattern in the neck and body spots, which are light brown on a yellowish-fawn ground, and the uniformly tawny colour of the lower portion of the limbs. This giraffe, which I propose to call *G. camelopardalis thornicrofti*, appears to be related to the Kilimanjaro *G. c. tippelskirchi*, but differs by the more compact frontal horn, the brown, in place of grey, forehead, and the uniformly fawn lower part of the legs, the latter being whitish in adult bulls, but fawn and spotted in cows and young bulls. I have to thank the trustees of the British Museum for permission to describe this specimen. R. LYDEKKER.

The Distastefulness of *Anosia plexippus*.

IN "Essays on Evolution," p. 274, 1908, Prof. Poulton directed attention to the instance of mimicry amongst Lepidoptera supplied by the American Danaine, *Anosia plexippus*, otherwise known as *Danaida archippus*, and its mimetic species. It occurred to me, therefore, that it would be interesting to test the distastefulness of this butterfly. This I was enabled to do through the kindness of Mr. F. W. Frowhawk, who at my request sent me a newly emerged female on September 22 of this year.

The following are the results of my experiments. Two Indian shamas (*Cittocincla macrura*) in succession tasted it, but left it alone after one or two pecks. It was then taken by an Indian sibia (*Sibia capistrata*), which quickly dropped it. A red-vented bulbul (*Pycnonotus haemorrhous*) then pounced upon it, with the same result. A ground thrush (*Geocichla cyanonotus*) tried it, but soon left it. A mynah (*Gracula intermedia*) took it, but quickly let it fall. Two South African bustards (*Otis ludwigi*) persevered for a long time, but finally rejected it. A kagu (*Rhinochaetus jubatus*), a kind of rail or crane from New Caledonia, behaved in the same way, shaking his head after each peck. An Australian water-hen (*Tribonyx ventralis*) and a crow-shrike (*Barita destructor*) pecked it only once, the latter vigorously shaking his head and wiping his beak after the taste. A Cuban mocking-bird (*Mimus orpheus*) and a Brazilian hangnest (*Ostinops viridis*) attempted it, but after a few pecks gave it up. Finally, the mangled remains were eaten with much hesitation by a rufous tinamou (*Rhynchotus rufescens*). Whether the latter would have eaten it, if given the first refusal, it is, of course, impossible to say; but there is no doubt that the other birds found the butterfly highly distasteful. I was particularly impressed by its rejection by the two bustards, which on previous occasions have eaten some of the most unpalatable of British insects (see Proc. Zool. Soc., 1911, pp. 809–68).

The birds used for these experiments belong to tropical American, Asiatic, Australian, and African species, and were purposely selected from a variety of families. *Anosia plexippus* has, I understand, comparatively recently invaded the Old World from the New; and the result of the above-recorded experiments suggests that no serious barrier to its dispersal will be offered by insectivorous birds. If it succeeds in widely distributing itself it may, as a useful model, bring about marked mimetic changes in the Lepidoptera of the districts in which it settles.

The Zoological Society. R. I. POCOCK.

The Arithmetic of Hyperbolic Functions.

THROUGHOUT the books treating of hyperbolic functions, although elaborate series for their determination are given, the possibility of calculating them directly from their definitions, by means of common logarithms, is never suggested, and it would appear, therefore, that the merits of the direct method are insufficiently recognised.

If the hyperbolic functions of a quantity U are required, it is convenient, for purposes of writing and printing, to get rid of the exponential and to write $A=e^{U}$. Then $\log_{10} A = 0{\cdot}43429448\,U$, and A is thus found at once from a book of common logarithms. The functions can then be calculated by a slide-rule, or by logarithms, in the simple form

$$\cosh U = \tfrac{1}{2}(A + 1/A)$$
$$\sinh U = \tfrac{1}{2}(A - 1/A);$$

and similarly for tanh U, coth U, sech U, cosech U, and versh U—all in terms of A.

For example, calculate cosh 2 and sinh 2. Here

$$\log_{10} A = 0{\cdot}43429448 \times 2 = 0{\cdot}86858896;$$

A is therefore 7·389060, and 1/A is 0·135335. Hence cosh 2 = 3·76220 and sinh 2 = 3·62686

In the more general case the functions of a complex quantity $(U+i\theta)$ are required, and they have consequently to be expanded in terms of cosh U, sinh U, cos θ, and sin θ. So far as cosh U and sinh U are concerned, the direct method by common logarithms is still available, and the result is best dealt with in the form, for example,

$$\sinh (U+i\theta) = \tfrac{1}{2}\{(A-1/A)\cos\theta + i(A+1/A)\sin\theta\}.$$

The only real difficulty then left for the student is in ensuring that cos θ and sin θ are given their proper signs. That is to say, he must be clear regarding how many quadrants are contained in θ, how many degrees there are in θ beyond that number of quadrants, and the proper sign of cos θ and sin θ, respectively, in each quadrant.

In general, as is well known, if the functions are not required to a greater degree of accuracy than 1 in 10,000, it is permissible for all real values of U greater than 5 to write

$$\cosh U = \sinh U = \tfrac{1}{2}A;$$

and the direct method has obvious advantages. For values of U less than 8, Ligowski's excellent tables give sinh U and cosh U, proceeding by increments of 0·01 of U; but for practical purposes these 0·01 steps are too great, and "difference" columns have to be used. Consequently, to find the functions for values of U less than 5, where U is given to three or more places of decimals, it will usually be as quick and as accurate to adopt the direct method as to worry through the irksome arithmetic involved in estimating "differences."

In cable problems it is, as a rule, desirable to retain at least four significant figures for U.

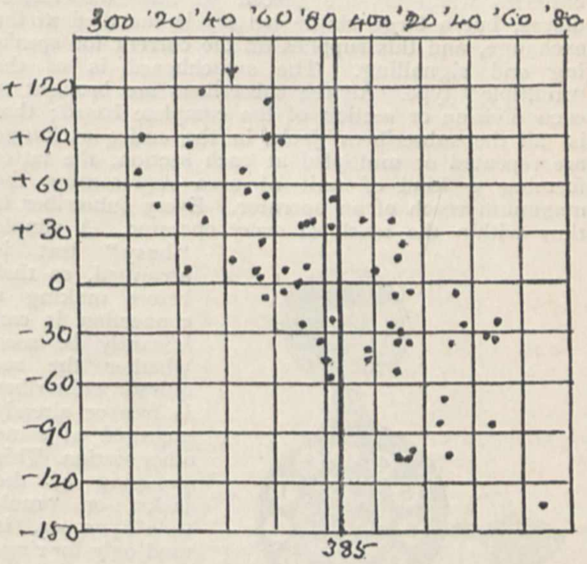
October 3. ROLLO APPLEYARD.

Hot Days in 1911.

BY a "hot day" will here be meant one with 70° or more. There are about seventy-seven of these at Greenwich, on an average, in the year. I propose to show how a method of forecasting recently described would apply to those days in 1911.

The series of annual numbers (1841–1910) is first smoothed with sums of five; then we compare, in a dot-diagram, each sum with the difference between it and the fifth after.

The last comparison before this summer was that between 324 (for 1903) and its difference with 335 (for



Comparison of hot day numbers, Greenwich.

1908), *i.e.* +11. Next we come to 343 (for 1904) and the position of the new dot (for 1909, representing the sum of 1907–11).

Placing an arrow-head at 343 in the horizontal scale, we might fairly expect the new dot to be above the zero line. Suppose, however, to be on the safe side, we say not below −10. Then 343−10=333. Now the four years 1907–10 yield 243, and 333−243=90. So that we might say the year 1911 was likely to have at least 90 hot days.

The actual number is 101.

The method may be commended, perhaps, for application to various weather items. ALEX. B. MACDOWALL.

Frequency of Lightning Flashes.

A LETTER on rainless thunderstorms in NATURE of August 31 leads me to ask if any accurate counts have ever been taken of the frequency of lightning flashes.

Watching a severe storm from my bungalow about a year ago, I made an attempt to separate and count the flashes—to the unassisted eye the lightning was as continuous as a flickering arc-lamp.

The only thing I could find to help me was a gramophone; I took its top works off, and on the horizontal disc I put one radial white chalk line. The speed of the disc was adjusted, by trial, exactly to 100 revolutions per minute, and the instrument was placed where the storm-light fell directly on it.

The appearance of the revolving disc was as if irregularly spaced phosphorescent spokes were being shown instantaneously in sections of various sizes in continually changing positions. It was difficult to estimate the number of separate streaks in one revolution, but I finally settled on eight as a fair average during the whole storm—sufficiently exact to show the order of figures being dealt with.

This works out at 800 flashes per minute, or, say, 50,000 an hour. H. O. WELLER.

Jamalpore (Dist. Mymensingh), E. Bengal,
September 19.

THE AUTOMATIC TELEPHONE EXCHANGE.

AT an ordinary or manual telephone exchange, as is generally known, the subscribers' lines terminate on "jacks," and are put through to each other by means of "plugs" and flexible conductors. The jacks, mounted on a suitable surface, form a "switchboard," and it is the business of the exchange operator to make the necessary connections and to sever them at the proper time, to answer calling subscribers and to ring up wanted ones. Large modern exchanges are worked on the common-battery plan; that is, no batteries whatever are placed at the subscribers' offices, but a large single battery is installed at the exchange, and this supplies all the current for speaking and signalling. The switchboard is of the "multiple" type. All the subscribers are brought to each division or section of the complete board; that is, all the subscribers' jacks in the entire exchange are repeated or multipled at each section, the latter forming a kind of unit of area representing the maximum reach of an operator. Every subscriber is thus within the reach of every operator. A simple "busy" test is arranged, so that before making a connection it can instantly be seen whether the required subscriber is free or already engaged at some other section. This grouping of the jacks, or "multiple" proper, is used only for ringing up and connecting to wanted subscribers. In addition, each operator has a certain number of subscribers brought to other—"answering"—jacks, placed in her immediate vicinity, and it is on these that calls from subscribers are received. At the subscriber's end everything is arranged with a view to simplicity. The signalling is automatic; that is, the subscriber has simply to lift his receiver and the exchange is called automatically, and when the conversation is finished the replacing of the receiver upon its hook advises the operator that the connection is to be severed.

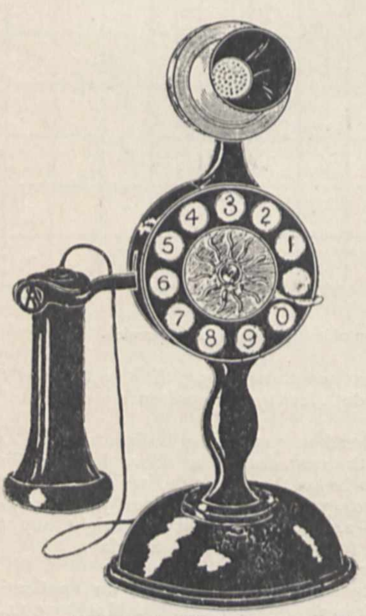


FIG. 1.—Subscriber's Telephone, with calling arrangement.

For automatic exchange working we have to substitute mechanism for the exchange operator, and the place of the large common switchboard is taken by a number of small individual switches, one of which is allotted to each subscriber and is entirely under his control. The plan which we are about to outline is the Strowger system, as applied to a small exchange of less than a hundred subscribers and operated on the common-battery plan. Other excellent systems are in use, but it is thought that some degree of detail of one system will be more useful than the statement of the main principles of several.

Considering the subscriber's end first. In addition to the usual speaking apparatus, transmitter, receiver, &c., we have the selecting and calling mechanism, as the subscriber has to "get through" to his correspondent by his own unaided efforts. Fig. 1 illustrates a "table set." In the central portion the figures 1 to 0 are arranged in a circle, and over them is a movable disc, perforated near the edge so that the figures, which are fixed, are visible through the holes. Suppose subscriber No. 58 is required. The receiver is first removed from its hook. A finger is then inserted in the hole through which the figure 5 shows, and the disc turned in a clockwise direction until a stop bars the way. This turning of the disc winds up an inner spring. The finger is then withdrawn and the spring carries the disc back again. In its return journey it causes one of the lines of the loop to be earthed (momentarily) five times, and at the

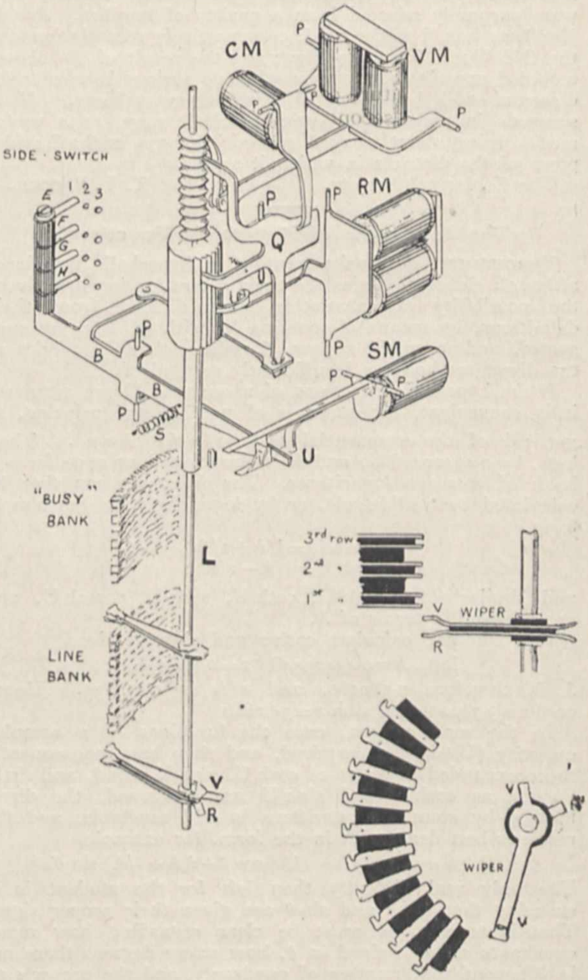


FIG 2.—Details of Subscriber's Switch at Exchange.

end of this series the other line is earthed once. The finger is then inserted in the hole over the 8 and the disc brought round again—again winding up the spring. Its release and return to normal earths the first line eight times and then the second line once, as before. As the exchange battery is permanently on the lines, this earthing causes impulses of current to be sent over them by way of certain apparatus, and the calling subscriber is now through to No. 58 line. When any subscriber's receiver is on its hook, a magneto bell, in series with a condenser, is across the two lines. The calling subscriber now depresses a push-button, which action again earths the first wire of his own loop and actuates a relay at the exchange, which applies the generator to the required line.

After conversation, both subscribers hang up their receivers, this action momentarily earthing both wires of each loop. In the case of the originating subscriber, the effect of this is to "clear," and to restore to normal his mechanism at the exchange.

At the exchange end of each loop a separate switch is placed, the mechanical outlines of which are given in Fig. 2 and the electrical connections in Fig. 3. Considering the former, we have an upright steel shaft L which has on its upper portion a series of horizontal teeth, cut the whole way round the shaft. VM is an electromagnet having a pawl on the end of its armature, the latter being pivoted at PP. When VM is energised, this pawl lifts the shaft by means of one of the horizontal teeth. Below these teeth the diameter of L is much increased, and on the surface of the cylinder thus formed, a series of vertical grooves or teeth are cut. RM is another electromagnet, the armature of which, pivoted at PP, carries at its extremity a second pawl. When this armature is attracted L is forced round a tooth. The double pawl Q engages with both the horizontal and vertical teeth, and prevents the return of the shaft after its movements in an upward and rotary direction. Each of these two electromagnets is placed, in turn, in the local circuit of a relay at the required time, and whenever an impulse passes through VM the shaft L is raised a tooth, whilst an impulse through RM causes the shaft to be rotated a tooth. They are therefore termed the "vertical" and "rotary" magnets. CM is the clearing magnet; when this is energised, its armature strikes the double pawl Q and causes it to release the shaft. The latter, in its previous turning movement, winds up a spring, and on its release the spring brings it back, and by its own weight the shaft falls to its normal position.

At the lower end of L two arms are carried which, when desired, make connection with any one of a series or "bank" of contacts. The essential parts of these contacts and of the arms are best seen in the right-hand lower corner of Fig. 2. First we have a thin semicircular strip of fibre or other insulating material. On the upper surface of this ten thin strips of metal are placed radially, and on the under surface ten other similar strips are placed. To an upper and a lower metal piece the lines of each loop are connected, so that one semicircular piece carries the twenty contacts of ten loops. Above this horizontal row of ten circuits a second, third, and tenth semicircular pieces are placed, each being separated from its upper and lower neighbours by further insulation. We have thus the contacts of a hundred loops arranged in ten layers of ten each.

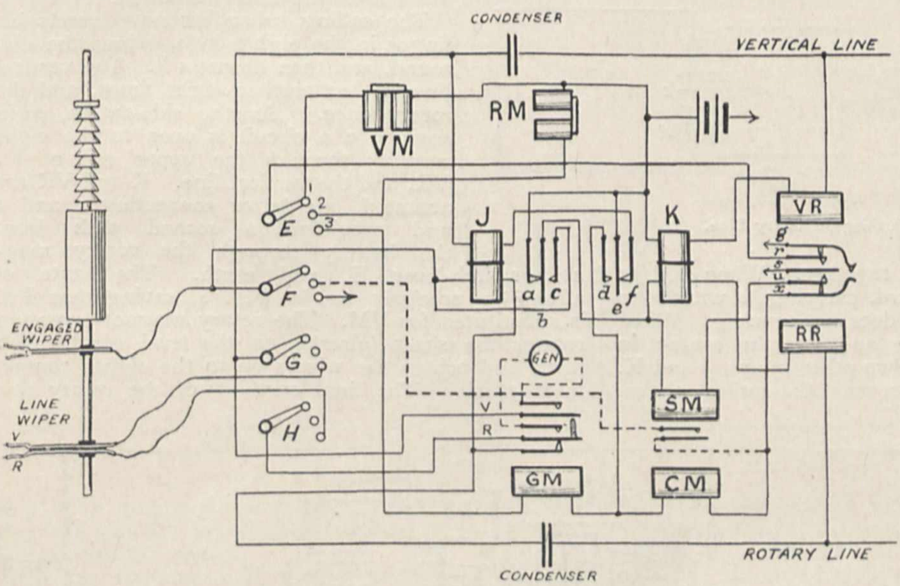


FIG. 3.—Subscriber's Switch—Connections.

As already seen, every subscriber has one of these switches, and the banks are all multipled together. That is, No. 58 line is brought to the fifty-eighth position on the banks of all the hundred switches constituting the exchange.

The two arms, or "wipers"—so called from their brushing or wiping action in passing over the contacts—each consist of two metallic strips, insulated from each other and from the shaft, the outer ends having a slight inward tendency, so that when they engage the two springs of a loop there is sufficient friction to ensure electric contact.

As will be seen from Fig. 2, there are two banks of contacts, one above the other, and two arms or wipers to engage with them. On the lower bank are the hundred loops as already detailed. The upper bank is employed for giving the "busy" signal. Its arm has the two contacts connected together, so that only a single connection is made in any one of the hundred positions. Like the lower bank, these are multipied on all the switches of the exchange. There are indeed, two multiples, the line multiple and the "busy," or "engaged," multiple. In the normal position of the shaft the wipers are just to the left of the banks and just beneath them. When L is raised one, two, &c., teeth, the wipers rise to the level of the first, second, &c., row. A single rotary movement then brings the wipers to the first loop in the row; two three, or more rotary movements bring the wipers to corresponding loops on that horizontal level.

Returning to the upper mechanism of the switch. BB is an arm pivoted at PP, and carrying on its left a four-lever switch. On its right it engages with the escapement U, which is carried on a long extension of the armature of the switch-magnet SM. A spring S keeps the right-hand end of BB against U. When SM is actuated, the movement of attraction and release allows BB to slip forward one step in the escapement, and causes E, F, G, and H to quit their first contact and move to the second. The action of this "side-switch" is to bring the various pieces of apparatus into action at the required time. A second movement of SM allows BB to move forward another step in U and brings the side-switch into the third position. Any further movement of SM does not affect BB. When, however, the clearing magnet CM is actuated, the movement of Q restores BB to its original position, the escapement springs opening and allowing the right-hand end to pass. The side-switch thus returns to position 1.

The electrical conditions are shown in Fig. 3. VM, RM, CM, and SM are the electromagnets already described. VR and RR are the vertical and rotary relays, mounted side by side. The armatures of these when attracted act upon the contacts shown between them. If VR is energised, *g* is pressed forward together with *r*. The latter then makes contact with the centre spring *s*, but the movement is not suffi-

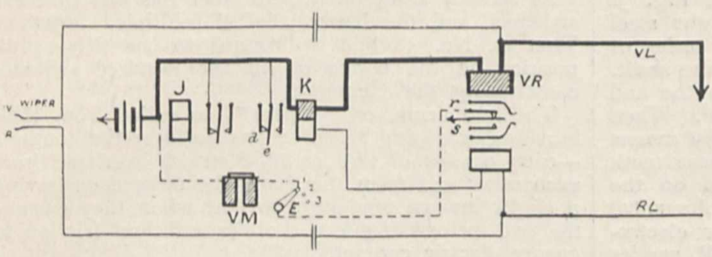


FIG. 4.—Earthing of Vertical Line.

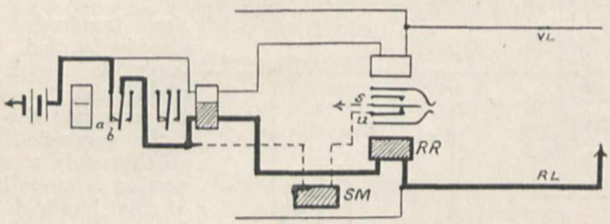


FIG. 5.—Earthing of Rotary Line.

cient to bring *g* and *x* together. When RR is actuated *x* is pressed forward, carrying *u* with it to make contact with *s*, but *x* does not reach *g*. When both relays are energised, *g* and *x* make contact in addition to the other two. Two other relays, J and K, are mounted together, and act upon the springs shown between them. Each of these two relays has two coils. If current circulates in one coil the armature responds: similarly if current flows in both coils in the same direction. If, however, the two currents are in opposite directions, they nullify each other's effects, and the armature is not attracted. The movement of J's armature breaks the contact between *b* and *a*, and makes a new one between *b* and *c*. Similarly with K: *e* breaks from *f* and makes with *d*. GM is the generator magnet. When this is actuated the two long springs move upwards, disconnecting from the lowest and bringing the generator on to the levers G and H of the side-switch, and thence (when in position 3) *via* the line wiper to the desired subscriber's line.

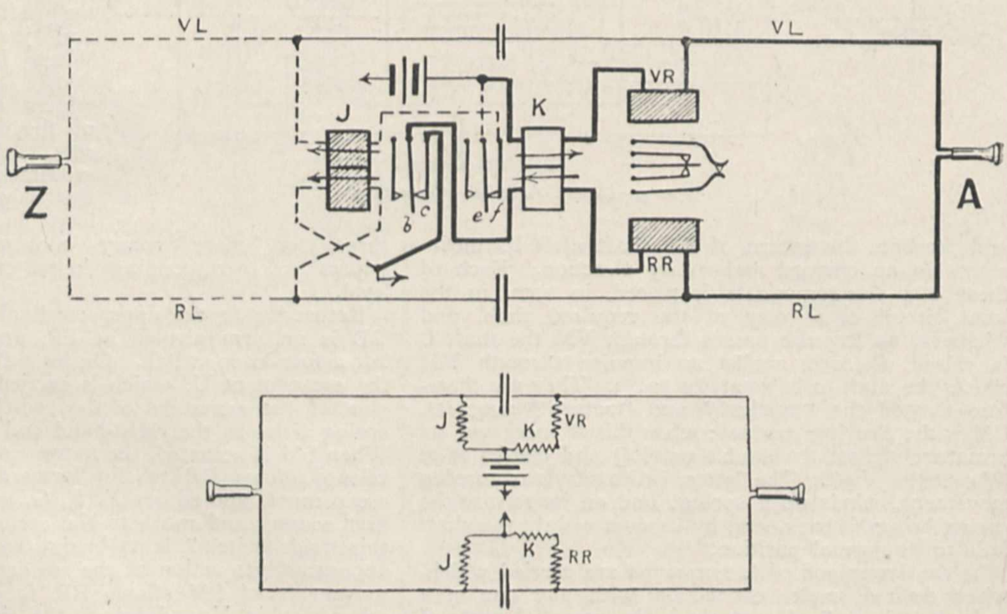


FIG. 6.—Two Subscribers "through."

We are now able to trace the results of the subscriber's call. He desired No. 58. By the first movement of his disc we saw that he earthed the vertical line five times and the rotary line once. Fig. 4 gives the result of this. By the earthing of the vertical line (as indicated by the arrow-head) a path, shown as a heavy line, is open to the battery from its positive pole through one coil of K and the vertical relay and line to earth. This current actuates both K and VR, as shown by the shading. The spring *r* being earthed at *s*, a second path, shown dotted, is open to the battery *via* VM and the lever E of the side-switch. The shaft L is therefore raised five teeth, corresponding to the number of current impulses passed over the vertical line. The earthing of the rotary line (once), as shown in Fig. 5 by the heavy line, actuates K by its lower coil and RR. The latter closes *s* and *u* and completes the circuit (shown dotted) of the switch magnet SM. This brings the side-switch into position 2.

The calling subscriber now inserts his finger in the eighth hole, brings the disc round, and then liberates it. The vertical line is then earthed eight times, and the rotary once. As the side-switch is in position 2 a circuit is open to the eight currents through the upper coil of K, VR, and the vertical line. K and VR are actuated, the latter connecting *r* and *s* and providing a second path from the battery through the rotary magnet, switch-lever E, and earth. The state of affairs is precisely as in Fig. 4, saving that RM is substituted for VM. The rotary magnet armature rotates the shaft (already on the level of the fifth row), and brings the wipers on to the eighth contact in that row. The final earthing of the rotary line repeats the operation shown in Fig. 5, and shifts BB another tooth in the escapement U, thus bringing the side-switch into position 3.

The wipers are now on the contacts of the desired loop and the calling subscriber depresses his push-button, which operation again earths the vertical line. VR is operated, and spring *r* making contact with *s* puts earth on the left-hand side of GM by way of switch-lever E (position 3). K also is operated by its upper coil, and the closing of its springs *e* and *d* brings the battery on the right-hand side of GM. The movement of GM's armature puts the generator (which is running continuously) on to the wipers, and thence to the required subscriber's (Z) loop, across which is placed his magneto bell, in series with a condenser. When Z replies, the current circulates through springs *e, f*, through the upper coil of J, round the loop, through J's lower coil, switch-lever F (position 3) to earth. J's two coils are now assisting each other, and spring *b* moves over to *c*. As *b* is joined to K's lower coil, this movement takes the battery from K's lower coil and puts on earth instead. The current now passes through K's upper coil, through VR, round A's loop, through RR and K's lower coil to earth *via c*. The currents in K, however, are opposing each other, so that the armature is not affected. The two subscribers are now "through," as in Fig. 6. The path traversed by the current on the left is shown by the dotted lines, and on the right by the heavy lines. The arrows through J and K show the direction through the separate coils, and the shading indicates the energised relays. The small skeleton diagram in Fig. 6 shows how the speaking circuit is made up. On Z's side the two coils of J serve as impedance coils, whilst K's upper coil, plus VR and K's lower coil, plus RR, serve the same function on A's side.

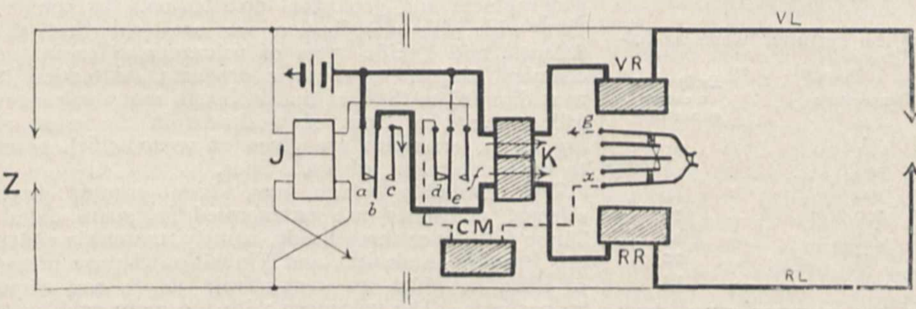


FIG. 7.—Clearing.

On the conclusion of the conversation both subscribers hang up their receivers. In its passage downwards the switch-hook (momentarily) earths both the vertical and rotary lines simultaneously. The result of this action on A's part is that his rotary line is earthed at both ends. RR and the lower coil of K are thus short-circuited. K is then actuated by his upper coil, and by the movement of *e* from *f* to *d* current is cut off from J, which, ceasing to be energised, allows its armature to fall back. This causes *b* to leave *c* and return to *a*, substituting the battery for earth on the lower coil of K. Current now passes through both coils of K in the same direction, and thus continues to energise K, whilst both VR and RR being actuated, their outer springs make contact with each other and put earth on the right of the coils of CM, the clearing magnet. The other side of CM being connected with the battery through *d e*, the clearing magnet is energised. This is shown in Fig. 7, where the dotted line indicates the circuit of CM. The shaft is thus restored to its normal position and the circuits are cleared.

When a second caller attempts to get through to another subscriber who is already engaged, the following action takes place. As shown in Fig. 6 the earth on the left hand of J's lower coil is made by the lever F of side-switch in its third position. This puts earth on the "engaged" wiper, and through it on to all Z's contacts in the busy multiple. The new caller turns his disc twice in the usual way, thus getting on to Z's contacts in the line multiple. His (the newcomer's) side-switch, however, is still in position 2, so that, although his line wiper is on the required contacts, the wiper itself is still isolated. The final current over his rotary line causes RR and SM to be actuated. A contact on the latter (shown only in Fig. 3) is closed. The battery is already connected to the left hand of the newcomer's clearing magnet by means of his springs *d* and *e*. The closing of the contact on SM put the right-hand side of CM through to the earthed busy bank by way of lever F (position 2) of his own side-switch. His clearing magnet thus acts and his lever L returns to zero. By another contact (not shown) the busy signal from the generator is given over the newcomer's line, advising him that the required subscriber is engaged.

From the foregoing brief sketch it is hoped that the principle of working may be seen: the actual arrangements in practice involve large modification and extension. As only a certain percentage of the switches are in use at the same time, it is easily seen that it is unnecessary to provide one for every subscriber. A much simpler piece of apparatus, the "line switch," is therefore substituted, and only a comparatively small number of switches proper provided. The function of the first is simply to put a calling subscriber through to a disengaged switch—now slightly modified and called a "selector"—by which a certain group is selected. The subscriber having got through to the required group, now utilises a second switch, arranged practically as we have described and termed a "connector," through which he obtains access to the required correspondent. A still larger exchange will require a first selector, a second, &c., selector, and finally a connector. Taking the common case of an exchange with a maximum of 9999 subscribers: the line switch puts the caller through to a first selector, by which the thousands digit is selected. The hundreds figure is then picked out by the second selector, and the tens and units by the vertical and rotary movements of the connector.

ARTHUR CROTCH.

THE SUMMER OF 1911.

THE summer of 1911 has been remarkable in so many ways that without doubt it will receive the special attention of meteorologists, and will in course of time be dealt with very thoroughly, as it well deserves to be. Having for many years past kept touch with the published Greenwich weather records, a comparison of the present summer with the observations of the past seventy years, from 1841, may be of interest from one not officially attached to the Royal Observatory.

The exceptional character of June, July, and August lead naturally to the supposition that the summer proper, as limited to the three months, would beat all previous records in many ways, and this impression is amply supported by weather statistics.

The summer six months, April to September, can also claim a record so far as temperature is concerned. The mean temperature for the six months is

60·7°, which is the highest for any similar period since 1841. The next means are 60·6° in 1893, 60·4° in 1868, and 60·1° in 1865. These are the only summer six months with the mean temperature at Greenwich above 60°, and there has not been any summer with the mean temperature above 58° since 1901.

The following are the results for the several months:—

	Air Temperature			Rainfall		Sunshine
	Mean max.	Mean min.	Mean	Days	Total	Hours
	°	°	°		Inches	
April	55	39	47	13	1·75	150
May	69	47	58	9	1·88	212
June	71	51	61	12	2·11	224
July	81	56	68	3	0·26	335
Aug.	81	57	69	8	1·35	260
Sept.	72	50	61	8	1·34	234

The aggregate rainfall for the six summer months is 8·69 inches, which is more than 3·5 inches less than the average; there are several summers, comprised by the six months April to September as dry.

The mean temperature for the three summer months June, July, and August is 66·1°, which is 4·9° in excess of the average for the past seventy years; this is 1° warmer than any previous summer. The next warmest three summer months occurred in 1868, when the mean was 65·1°, and in both 1859 and 1899 the mean was 65·0°. August was the warmest summer month, the mean being 1° higher than in July.

The warmest days during the summer were as follows:—

Day	Temperature	Daily mean n excess of average
	°	°
July 21	94	15
„ 22	96	15
„ 28	92	14
Aug. 9	100	19
„ 13	91	14
Sept. 7	92	12
„ 8	94	13

There were in all during the summer seven days with a temperature above 90°, and the only other summer during the last seventy years with an equal number of warm days is 1868. In 1876 there were six days with the thermometer above 90°, whilst the only other years with as many as four such warm days were 1846, 1881, 1893, 1900, and 1906. There were forty-five days during the summer, from April to September, with the shade temperature at Greenwich above 80°, and previously the greatest number of such warm days was forty in 1868.

The absolute temperatures are very exceptional:—95·6° was recorded on July 22, which was the highest previously recorded at any period of the summer since 1841, with the exception of 97·1° on July 15, 1881, and 96·6° on July 22, 1868. The maximum reading of 100° at Greenwich on August 9 is 3° higher than any previous record at the Royal Observatory since 1841. On September 8 the shade temperature was 94·1°, which is higher than any previous reading in September, and the mean of the maximum readings from September 1 to 8 was warmer by 2° than the mean for any corresponding period since 1841. The mean maximum temperature for August is 81·1°, which is the first occasion of the mean of the highest day readings in August exceeding 80°.

The aggregate rainfall at Greenwich for June, July, and August is 3·72 inches, which is 2·80 inches less than the average. The only instances of a drier summer are 3·65 inches in 1849, 2·91 inches in 1869, and 2·50 inches in 1864. The driest month of the summer was July with 0·26 inch.

The periods of absolute drought were twenty-three days from July 1 to 23 and seventeen days from August 2 to 18.

There was an unusual amount of bright sunshine throughout the summer—the aggregate duration in the three months, June to August, was 819 hours, which is 189 hours more than the average for the last fifteen years.

The black-bulb thermometer exposed to the sun's rays exceeded 160° on July 22, August 4 and 9.

CHAS. HARDING.

A VULCANOLOGICAL INSTITUTE.

IN the *Nuova Antologia* of July 16, a copy of which has recently reached us, there is an interesting article by Mr. Immanuel Friedlander, in which he points out reasons which justify the attempt now being made to establish an International Vulcanological Institute. This is a matter to which we have already referred (see NATURE, April 6, 1911, p. 180). Among the many reasons why volcanoes should receive special attention is the fact that they bring to the surface fused silicates and other materials from the deeper parts of the crust of our earth which otherwise we should not be able to reach. Two lines of study are open to us. One is to investigate the phenomena presented by a given volcano, whilst the other is based upon the consideration of their geographical and geological distribution. In connection with this distribution we are told that the Atlantic and Pacific types of volcanoes differ in the chemical characters of their products. Attention is next directed to the fact that although many volcanoes follow faults or lines of weakness in the crust of the earth, examples are given of vents which seem to be independent of such lines.

The materials which have been erupted from selected volcanoes are enumerated in some detail. These fall under three heads, namely, materials which are Basaltic, Andesitic, and Trachitic, the quantities of silica in which are respectively 56, 60 and about 70 per cent. The volcanoes with the more acid lavas are the most irregular and violent in their activity. A curious feature connected with volcanic eruptions is that the nature of the material ejected is not necessarily constant. The first eruption from Panteleria was basaltic, after which materials which were andesitic together with acidic Liparites appeared. The last efforts at this island, like the first, revealed materials which are basic.

From the softening of glassware and the ignition of various materials, the temperature of the dust-cloud which was shot out laterally to destroy St. Pierre and its 30,000 inhabitants was estimated at about 600 or 800 degrees. The needle-like pinnacle which grew upwards from the crater of this mountain is compared with the one which in 1909 grew in the crater of Mount Tarumai in Yezo.

These, together with many other curious appearances and phenomena observed by the vulcanologist, suggest that much remains open for investigation.

One interesting section in the paper is a brief discussion of certain theories respecting the cause of volcanic action. It is pointed out that water could not pass to regions of heated rock through cracks or fissures. Suess considers that the aqueous vapour which escapes from volcanic vents represents water which reaches the surface of the earth for the first time, while Alfred Brun, of Geneva, denies the presence of water in volcanic eruptions. Stübel, who has worked amongst the volcanoes of Central America, holds the view that each volcano derives its materials from a special reservoir left in the crust of the earth during its solidification, but he does not explain why these reservoirs are arranged in chains or lines. With a few words respecting the part that radio-activity and the expansion of silicates in solidification may play in connection with volcanic action, the writer points to these various theories as indications of the uncertain and contradictory knowledge we possess respecting such phenomena. After a brief *résumé* of the investigations to be carried out at the new institute, the author tells his readers that the International Institute of Weights and Measures at Paris, that of Seismology at Strasburg, and that of Agriculture at Rome, have conferred upon those cities a great prestige. In like manner an International Institute of Vulcanology will be a new glory for Italy and for Naples.

J. M.

THE ARCHÆOLOGICAL DEPARTMENT OF INDIA.

LORD CURZON has done good service to the cause of archæology by his spirited protest published in *The Times* of October 7 against the change of system in regard to the ancient monuments of the country proposed by the Government of India. Up to the time when, as Governor-General, the attention of Lord Curzon was directed to this question, the State policy in connection with the excavation of sites of historical interest and the conservation of the Buddhist, Hindu, and Mahomedan religious and civil buildings was ill-considered and ineffectual. In the early days of our rule these buildings, which are due to the munificence of vanished dynasties or the religious devotion of their subjects, were usually neglected and often desecrated. Excavations were undertaken by unskilled workers in a haphazard way, and many objects of interest and value were lost or destroyed. Under General Cunningham as director, between 1870 and 1885, some useful excavations were carried out. But the result of the work as a whole was not commensurate with the expense which had been incurred.

When Lord Curzon took up the question in 1902, the department was reorganised under Mr. J. H. Marshall, a good scholar and competent archæologist, as director-general. Lord Curzon quotes many examples to show the urgent necessity of this course of action. At Lahore the exquisite Pearl Mosque had been converted into a Government treasury, the Audience Hall into a barrack, the Sleeping Hall of Shah Jahan into a church. The beautiful mosque at Ahmedabad was used as a revenue office; the pavilion at Selimgarh in the Agra Fort as a canteen; the marble pavilion of Shah Jahan at Ajmer as the Commissioner's dining-room; a fine mosque at Lahore as the office of the railway traffic superintendent; one at Mijapur as a dâk bungalow, another as a post-office; the gilded palace at Mandalay had been utilised partly as a church, partly as a clubhouse.

Under the new system such destruction and desecration were discontinued. Many beautiful buildings have been tenderly repaired. Museums have been opened at the chief historical cities, and whenever excavations have been conducted the scientific principles established by the work of Prof. Flinders Petrie in Egypt, the British School at Athens, and in many other places, have been followed. Mr. Marshall has published a series of progress reports which have been received with admiration by scholars in Europe and America.

Now it is proposed, from some petty considerations of economy, to bring to a close this admirable work, which costs 30,000*l.* *per annum* out of a revenue of eighty millions. The control of the head archæologist is to cease, and the provincial governments are to start again the inefficient methods of which we have had disastrous experience. These governments are habitually pressed for funds, and they neither possess nor can employ a staff competent to undertake the care of the ancient buildings or to conduct excavations.

Now that this proposed change of policy has been brought to the knowledge of the scientific world by the one man competent to express an opinion on such a subject, the result cannot be doubtful. The indignant protests of archæologists throughout Europe and America must compel the Indian Government to abandon these ill-considered proposals. It will be a bad omen for the future administration of India if, in the year when his Majesty the King-Emperor visits the country, a scheme which has commended itself not only to archæologists, but to the princes and rulers of India, is suddenly, without adequate reason, brought to an end, and the old system of neglect and maladministration re-established.

LOUIS JOSEPH TROOST.

BY the death of Troost, on September 30, at the ripe age of eighty-five, France loses the last surviving member of that group of workers—pupils of Henri Sainte-Claire Deville at the École Normale—who created, mainly under his inspiration and leadership, what was practically a new department of chemical science. Thermal chemistry, as we understand it to-day, may be said to have originated in mid-Victorian times. It may be urged that the relations of chemistry to heat are so intimate that the study of these relations is necessarily as old as the study of chemistry itself. But it was only at the beginning of the latter half of the last century that the subject of thermal chemistry was attacked. Systematically, and for the most part in France, at the instigation of Deville, who, with the aid of Troost, Debray, Isambert, Hautefeuille, and Ditte, laid the foundations of that imposing superstructure to which this special department of knowledge has now attained.

Troost, who was born in 1825, was educated at the Lycée Charlemagne. He entered the École Normale in 1848, becoming an assistant there in 1851, and receiving his doctorate of science in 1857. For some time he taught in the provinces, but ultimately took charge of the chair of chemistry at the Lycée Bonaparte at Paris, and then, in 1868, became Maître de Conférences at the École Normale. In 1874 he became a professor in the faculty of sciences of Paris, where he remained until 1900, when he retired. In 1884 he succeeded Wurtz at the Academy of Sciences. For many years he was a commander of the Legion of Honour.

Troost was an indefatigable experimentalist and a prolific writer. His published memoirs, either alone or in association with Deville, Marie-Davy, and Hautefeuille, number close upon a hundred. His earliest essays were in pure inorganic chemistry: he prepared and studied the salts of lithium, which, in the middle of the nineteenth century, was regarded as a rare element. By the student, however, Troost is mainly remembered by reason of his work with Deville on the determination of vapour densities at high temperatures, the study of which had received an enormous impetus on account of the applications of the doctrines of Avogadro and Ampère. The values so obtained have become classical and are to be found in practically every systematic treatise of chemistry. With Deville, he largely developed the conception of dissociation, and his memoir on the vapour density of chloral hydrate gave rise to a memorable controversy on the value of volumetric considerations in the determination of equivalents. In conjunction with Hautefeuille he followed Debray in elucidating the laws governing dissociation, the recognition of the fundamental phenomena of which we owe to Deville. In this connection we may cite the memoirs on the conditions determining the absorption of hydrogen by palladium, potassium, and sodium, the dissociation of the sesquichloride of silicon, and the transformations of cyanogen into paracyanogen, and of cyanic acid into cyanuric acid. With Deville he studied the porosity of metals at high temperatures, and with Hautefeuille the solubility of gases in metals.

Troost was a frequent contributor to metallurgical chemistry, and made important contributions to our knowledge of the parts played by silicon and manganese in determining the physical properties of the various forms of commercial iron. His treatise of chemistry, which originated out of his connection with the Sorbonne, has gone through innumerable editions, and for many years past has been a standard text-book to successive generations of pupils.

Troost, in spite of his advanced years, enjoyed excellent health up to a short time before his death. He preserved his faculties practically unimpaired, and was active and industrious to the last on the numerous commissions in which he took part, and more particularly on the Commission des Inventions at the Ministry of War, of which he had been president for some years past.

NOTES.

WE notice with regret the announcement of the death, on October 7, of Dr. J. Hughlings Jackson, F.R.S., consulting physician to the London Hospital, at seventy-six years of age.

THE Decimal Association announces that a weights and measures law, rendering the use of the metric system compulsory in Bosnia-Herzegovina, will come into force on September 1, 1912.

THE Harveian oration will be delivered by Dr. C. Theodore Williams at the Royal College of Physicians of London on Wednesday next, October 18.

RECENT progress in model or small-power engineering, both as a hobby and as a useful factor in technical education, will be demonstrated at the Model Engineer Exhibition—the third of its kind—to be held at the Royal Horticultural Hall, Westminster, on October 13–21.

WE notice with regret that the death is announced, on September 25, in his sixty-eighth year, of Prof. Auguste Michel-Lévy, the distinguished geologist and member of the Paris Academy of Sciences.

THE *Terra Nova* of Captain Scott's British Antarctic Expedition returned safely to Lyttelton, N.Z., on October 7. Lieut. Filchner, the leader of the German South Polar Expedition, left Buenos Aires a few days ago for the Antarctic in the *Deutschland*. It is announced from Sydney that the fund for Dr. Mawson's Antarctic Expedition now amounts to 43,000*l*.

DR. J. H. H. TEALL, F.R.S., director of H.M. Geological Survey, will take the chair at the first of the Selborne lectures of the season, to be held on Monday, October 16. The subject will be "The Evolution of Scenery," and the lecturer Mr. F. W. Rudler.

DR. W. E. ADENEY, of Dublin, who has devoted particular attention to questions of sewage pollution, has been invited by the Metropolitan Sewage Commission of New York to advise it in reference to the over-pollution of the waters of the harbour of that city. Dr. Adeney served as a member of the recent "Whisky Commission."

DR. WILHELM DILTHEY, whose death is announced at the advanced age of seventy-seven, was professor of philosophy at the University of Berlin until 1905, when he resigned owing to ill-health. He held his chair as successor to Lotze, and had previously been professor of philosophy in Basel, Kiel, and Breslau. Although, perhaps, best known for his "Leben Schleiermachers," which brought him into notice in 1870, he published a number of other essays and books, some of which are of considerable philosophical importance.

IN connection with the Exhibition of British Fisheries, &c., at Manchester, which was opened on Saturday, October 7, by his Excellency the Greek Minister, the Hull Museums Committee has an extensive exhibit of old whaling appliances, paintings, models, &c., of the old whaling ships. Mr. T. Sheppard, the curator, has issued an illustrated guide to the collection (32 pages, one penny) which is a useful account of the various weapons and tools used by the old Hull whalers. It is interesting to learn that both the present enormous fishing and oil industries at Hull have developed from the whaling trade.

THE fifty-seventh report of the Postmaster-General on the Post Office, which has just been issued as a Blue-book (Cd. 5868), records that the number of radio-telegrams dealt with showed a satisfactory increase, the outward messages to ships reaching a total of 5640, as compared with 3266 in 1909–10, and inward messages from ships 34,161, as compared with 27,727, the total increase being 8808, or 28·4 per cent. During the year 97 licences, covering 107 land stations, were granted under the Wireless Telegraphy Act, and, with one exception, these were for experimental purposes. Connected with this subject, we notice the announcement in *The Morning Post* that the wireless telegraph station at Spitsbergen is now completed and ready for use. The machinery is working satisfactorily, and messages are received at Spitsbergen from Poldhu, in Cornwall, and communication is being established with the station at Ingö, in the north of Norway.

COAL is said to have been discovered on the estate of Sir Harry Verney, Bart., at Calvert, in Buckinghamshire, within fifty miles of London. It appears that exploratory work has been carried on intermittently for several years at this locality, and that a boring, which was sunk six years ago in quest of water, encountered coal-gas under pressure of about 60 lb. per square inch at a depth of 470 feet. Two bore-holes are now being sunk, and it is announced that one of them, after passing through an outburst of gas, reached coal at a depth of only 530 feet from the surface. Should this announcement be confirmed, it will justify the belief of those who hold that concealed coalfields may exist at workable depths between the Midland fields and those of Bristol and Somerset. So far back as 1877 a famous boring at Burford, in Oxfordshire, struck Coal-measures at a depth of 1184 feet, beneath a cover of Jurassic and Triassic rocks. At Batsford, in Gloucestershire, Coal-measures have likewise been found beneath Secondary strata.

AT the monthly meeting of the Pharmaceutical Society, held on October 4, the president, Mr. C. B. Allen, handed the Hanbury gold medal and a cheque for 50*l*. to M. Eugène Léger, of Paris. The Hanbury gold medal is competed for every two years, and the winner receives also

50*l.* from a fund left by the late Sir T. Hanbury, brother of the late Mr. Daniel Hanbury, of whom the medal is a memorial. The council of the Pharmaceutical Society are the trustees of the fund, and the adjudicators the respective presidents of the Linnean, Chemical, and Pharmaceutical Societies and of the British Pharmaceutical Conference, together with Mr. Walter Hills. M. Léger is a member of the committee of revision of the French Pharmacopœia, and his work in connection with the chemistry of the active constituents of drugs is well known. A short time ago M. Léger was elected an honorary member of the Pharmaceutical Society.

THE trustees of Lake Forest University, Illinois, send particulars of the second decennial prize of 6000 dollars on the Bross Foundation. The prize was founded in 1879 by William Bross, of Chicago, as a permanent memorial of his son, Nathaniel Bross, who had died in 1856. Its object is to stimulate the production of the best books or treatises "on the connection, relation, and mutual bearing of any practical science, or the history of our race, or the facts in any department of knowledge, with and upon the Christian religion." The scope of the gift is so comprehensive that any phase of science, of literature, of human history, or of modern life that may throw light upon the Christian religion, or upon any phase of the same as it is received by the great body of Christian believers, would be a fitting theme for a book offered in the competition. The prize will be given to the author of the best book on any of the lines above indicated which may be presented on or before January 1, 1915. The manuscripts, accompanied by a sealed envelope containing the name of the writer, must be sent on or before the above date addressed to the President of Lake Forest College, Lake Forest, Illinois. It is requested that no manuscript be sent in before October 1, 1914. A copy of the circular containing all the essential conditions made by the deed of gift, or any further information desired as to this competition, may be obtained on application to President John S. Nollen, Lake Forest, Illinois.

A LECTURE on "Emotions and Morals" was delivered on October 4 by Dr. William Brown at the inauguration of the new session at King's College, London. In the course of his address, Dr. Brown said that modern theories of ethics are finding it more and more necessary to take account of the psychological nature of man in formulating their moral ideal. This is particularly the case with respect to the emotional side of consciousness, since it is in the emotions that all values reside. After rapidly reviewing the more important modern theories held as to the nature of the emotions, and their classification under the two main headings of simple and complex, and showing by a detailed analysis that love and hate are not emotions, but systems of emotional dispositions dominated by a fixed idea, he proceeded to sketch out the modern theory of *values* in its most general form, and to show (after Ribot) that the feelings have a logic of their own, distinct from, and not necessarily inferior to, that of pure reason, and that the logical primacy of pure reason over feeling, though generally held by the classical philosophers, is not by any means complete. In a digression on the psychology of music he discussed the intellectual "arabesque" theory of Hanslick and the more generally accepted emotional theory to which Schopenhauer and all the great creative musicians have subscribed, and stated his own view that music expresses a system of emotions *sui generis*, but in dynamic relation with the ordinary emotions, and is therefore of ethical importance. The imperative of duty may be expressed in the form, "Seek always the highest good," which would seem to be personality for ourselves and others.

The Times of October 4 announces the death, in September, at Bandra, a suburb of Bombay, of Lieut.-Colonel A. S. G. Jayakar, late of the Indian Medical Service, who when stationed at Muscat—latterly as surgeon-general—collected and presented to the British Museum during the last two decades of the nineteenth century a number of specimens of mammals, birds, reptiles, and fishes indigenous to the Oman district of south-eastern Arabia and the adjacent sea. When describing the mammals in 1894 (Proc. Zool. Soc.), Mr. Thomas remarked that Colonel Jayakar's collection was the first ever received from that district; it included a new and small species of thar (*Hemitragus jayakeri*), a genus of wild goats previously known only from India, and a new hare, while it also showed that the range of the Syrian hyrax extended to Oman. The birds included a new eagle-owl, described by Dr. Sharpe in *The Ibis* for 1886, and a new bee-eater, figured by Mr. Dresser in his monograph of that group. A fine skeleton of the short-beaked sword-fish (*Histiophorus brevirostris*), exhibited in the fish gallery at the British Museum (Natural History), was the gift of Colonel Jayakar, although there is no intimation of that fact on the descriptive label. Colonel Jayakar was born in Bombay in 1845, where he received the first part of his education; in 1867 he came to London, where, after taking the degrees of M.R.C.S. and L.R.C.P., he entered the Indian Medical Service, to which but few natives had been admitted up to that date. The greater part of his service was passed as residency surgeon at Muscat, where he remained for thirty years.

WE regret to announce the death of Dr. Joseph Bell, one of Edinburgh's distinguished surgeons. He was born in Edinburgh in 1837, educated at the Academy and University, and graduated M.D. in 1859, becoming soon afterwards resident house-surgeon under Prof. Syme. He thus followed the family tradition, for his father, grandfather, and great-grandfather had been surgeons. Dr. Bell became a Fellow of the Royal College of Surgeons of Edinburgh in 1863; in the same year he commenced to teach systematic surgery, and in the following year operative surgery. These courses were continued, with growing success, until 1878, when Dr. Bell was appointed senior acting surgeon in the Royal Infirmary. On his retirement he was made consulting surgeon, an appointment which he held to the last. Dr. Bell was one of the originators of the Royal Edinburgh Hospital for Incurables, and was surgeon to this, to the Eye Hospital, and the Royal Hospital for Sick Children, and consulting surgeon to many medical institutions in the city. He was the author of a manual of the operations of surgery, of useful notes on surgery for nurses, and of papers, describing some of his most interesting cases, published in *The Edinburgh Medical Journal*, of which he was editor for twenty-three years. For many years Dr. Bell was examiner in surgery in the Royal College of Surgeons, Edinburgh; for some time he was honorary treasurer, and later, for a period of six years, president, an office which his father had held twenty years previously. Dr. Bell was a man of strong and sympathetic personality, and was highly esteemed in the community in which he worked so zealously. He possessed to a remarkable degree the power of keen perception and of quick deductive reasoning; his surprising deductions from apparently trivial details suggested to Sir A. Conan Doyle, who was a student under Dr. Bell, the character of Sherlock Holmes.

MR. R. CAMPBELL THOMPSON, in *The Times* of October 9, has issued a further report on the excavations at Carchemish, which were started in the early part of the present year by Mr. D. G. Hogarth. The mound presents a record of continuous human occupation, beginning with that of a primitive race using flint knives, obsidian flakes, and hand-made pottery. These people were succeeded by the Hittites, who were enabled by the use of bronze weapons to overcome the primitive occupants of the site. Finally, in B.C. 717, the Assyrians captured the place, and bricks have been found inscribed with the title of "Palace of Sargon, King of Nations, King of Assyria." A remarkable result of these excavations is the discovery of numerous small pottery horses, which served some religious purpose or were used in some game. The Hittite sculptures already unearthed add considerably to our knowledge of the beliefs of that people, consisting of guardian door figures, winged lions, and protecting demons, like those of Assyria. A remarkable bas relief depicts the overthrow of an Assyrian, and proves that the latter race practised circumcision.

PROF. BOYD DAWKINS, in *The Times* of October 6, remarks that the discovery of an ancient canoe on the edge of the Baddiley Mere, used for the water supply of Nantwich, reminds us that the recent drought offers an exceptional opportunity for the examination of the desiccated margins of all sheets of water in Great Britain. A similar protracted failure of rain in 1853–4 led to the discovery of numerous pile dwellings in Switzerland. Similar erections are found in considerable numbers in Ireland and in Scotland; but, so far, the discoveries of this kind in England and Wales are singularly poor. In the Lake District only one settlement of the Neolithic age, that on Ehenside Tarn, has been discovered. Wales has yielded one of doubtful age in the lake of Llangorse, Breconshire. There is one in the Vale of Pickering and the Marshes of Holderness, and in Norfolk one in Barton Mere and two near Thetford, all three of the Bronze age. If we add to these the three lake settlements at Glastonbury and Mere, the total amounts only to eight. Prof. Boyd Dawkins believes that careful search during this exceptional season, before the lake margins are covered by the autumn rains, would reveal prehistoric settlements in almost every county, and throw as much light on the daily life of the early inhabitants as the discoveries made elsewhere have done. It is not yet too late to seize the present unusually favourable opportunity for making these investigations.

THE August issue of *The National Geographic Magazine* is largely and appropriately devoted to Morocco and Tunis. It includes an interesting article by Mr. G. E. Holt, American Vice-Consul General, describing two religious dances performed at Tangier. These displays are provided by two separate sects which have widespread influence, not only over Morocco, but in Algeria, Tunis, and even so far eastward as Egypt. One of these is the Aisawa, followers of the saint M' Hammed Bin Aisa; the second the Hamadsha, founded by Sidi Ali Bel Hamdush, a later and less influential body than the former. Each motion in these dances is a symbol of some phase of the Mohammedan religion or of one of the sectarian beliefs. One position, for instance, represents Islam on the defensive against Christianity; another the final triumph of the faith of the Prophet. Women share in these performances; and in one movement a male and female dancer bend down and tear the earth with their teeth, symbolising the Creation, when Adam and Eve lived on the fruits of the soil, an ideal of the simple life recommended to their descendants. These dances, well illustrated by photographs, describe an interesting phase of that active sectarian fanaticism which, in the near future, is likely to be a serious embarrassment to those European Powers which are at present engaged in adventures in North Africa.

WE have received the September number (vol. i., No. 12) of *The Child*, a monthly journal devoted to child welfare, which completes the first year's issue. This number, which is well printed and illustrated, contains, among others, an excellent article by Dr. Mary Scharlieb on adolescent girls from the viewpoint of the physician. Valuable advice is given on diet, exercise, dress, and moral training for the adolescent girl.

MESSRS. E. LEITZ, Oxford House, London, W., have issued a circular respecting dark-ground illumination and ultra-microscopic vision. They direct attention to the fact that these methods of microscopical investigation, while often rendering visible objects which by ordinary illumination cannot be seen, do not enhance resolving power. The methods depend on the principle that brightly illuminated objects can be better seen on a black background than on one which is itself bright.

THE *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* for July (T. 115, No. 7) contains a report by M. F. Grenet on porous porcelain filters, particularly the form known as the Pasteur-Chamberland. By osmotic pressure determinations, it is calculated that the pores vary in size from $1{\cdot}08\,\mu$ to $2{\cdot}16\,\mu$ ($\mu=0{\cdot}001$ mm.) as minima and maxima. Collodion tubes also form extremely fine-pored filters, capable of retaining ultramicroscopic particles. By using a porous porcelain filter tube as a support for the collodion tube, the "life" of the latter may be much prolonged; M. Grenet has had one in use for a year, and it is still perfect.

THE variation of micro-organisms, particularly bacteria, is at the present time attracting considerable attention. Mr. Cecil Revis describes the artificial production of a permanent variety of *Bacillus coli* (*Centr. f. Bakt.*, 2te Abt., Bd. xxxi., 1911). It was obtained by growing a strain of *B. coli* in broth containing 0·05 per cent. of malachite-green. After fifteen subcultivations, at intervals of about three days, its power to produce gas (formerly active) in lactose, dulcitol, mannitol, and glucose was completely lost, but the capacity to produce acid was retained. With salicin, at first acid was formed, but after the treatment this substance was no longer attacked. Acid-formation and curdling in milk remained practically unaltered, as well as the characters of the growth on gelatin. The new physiological condition of the organism is quite permanent, and all attempts to reproduce the power of gas-formation have been unavailing.

A FORM of paralysis, particularly attacking certain muscles of the lower limbs in children, and known as infantile paralysis, has been the subject of much research by Flexner, Levaditi, Landsteiner, and others during the last two or three years. The disease is sudden in onset, and sometimes occurs in epidemics, and is due to an inflammatory condition of the large motor cells in the anterior horns of the grey matter of the spinal cord. In the *Revue générale des Sciences* for September 15 Dr. Levaditi gives a good summary of our present knowledge of the causation, &c., of the disease. It is infective, *i.e.* is due to a micro-parasite, which is so minute that it passes through the pores of a porcelain filter, and is hence beyond the limit of visibility with the microscope. The disease can be transmitted to apes, injection of material from a human case reproducing the disease in these animals.

IN No. 1860 (vol. xli., p. 297) of the Proceedings of the U.S. National Museum Mr. C. W. Gilmore describes, under the new generic and specific name of *Brachychampsa montana*, a crocodilian skull from the Cretaceous of Montana. The specimen indicates an alligator-like reptile, distinguished from all other members of the alligator-group by the absence of a posterior expansion of the hinder part of the premaxillæ to roof over the front of the nares. There are fourteen pairs of upper teeth, five of which are borne by the premaxillæ.

A NEW species (*B. tener*) of the stegocephalian genus Branchiosaurus, from the Rothliegendes of north-western Saxony, is described by Mr. G. Schönfeld in the *Abhandlungen Ges. Isis* for 1911, p. 19. It is characterised by the gills persisting at least to a late period of life, by the slenderness of the bones of the middle of the roof of the skull, the presence of teeth on the vomers and palatines, and in the young state on the pterygoids, and by the small scales being marked with a radiating sculpture and concentric growth-lines.

THE "Bibliotheca Geographica" for 1907 has been published by the Gesellschaft für Erdkunde of Berlin, having been edited, as in the preceding years, by O. Baschin. In size this most useful volume of reference remains about the same; a few changes in the classification have been made as experience has shown to be desirable, and this sixteenth volume fully maintains the high reputation of its forerunners as a most convenient and comprehensive guide to geographical literature.

IN the *Mitteilungen der k.k. Geographischen Gesellschaft* of Vienna (Heft 8) a detailed account is given of the construction of a map from the photographs taken by Dr. Pietschmann during a recent expedition in Mesopotamia. An ordinary camera and stand, slightly modified to enable him to take rounds of views suitable for cartographical purposes, enabled him, it is claimed, to obtain material sufficient for producing a far more complete and accurate map than he could otherwise have done, and that without too great interference with his other occupations.

IN the August and September numbers of *The Geographical Journal* Mr. J. C. Brauner discusses at some length the geological structure of Bahia and the form and position of the principal mountain ranges of this part of Brazil, in which he spent eight months in 1907 when studying the geology. The paper contains a great deal of interesting geological material, but, as a geographical description, lacks that coordinating treatment which is needed to give a full and explanatory account of an area.

PROF. OTTO NORDENSKJÖLD, in the September number of *The Geographical Journal*, discusses some questions of general importance relating to the nature of the Antarctic regions. The general orography of the north-western portion, which faces the South American continent, is sketched out, and the Antarctic climate and the character of its glaciation is considered, especially with reference to the influence of land-ice. The great masses of it which collect lower the summer temperature and tend to make that of winter somewhat milder, so that the land is gradually wrapped in ice, and vegetable and animal life is extremely sparse. Full discussion of such matters will appear in the course of the year in the geographical part of the results of the Swedish South Polar Expedition.

THE Meteorological Chart of the North Atlantic Ocean for October, published by the Deutsche Seewarte, shows that at the beginning of September icebergs were seen in the Belle Isle Strait, and were still met with to the eastward on the ocean routes. A useful series of synoptic charts illustrates the very stormy weather which occurred between the Azores and the European coast from April 18–22, 1909, inclusive. It rarely happens that storms of hurricane force travel eastwards from the Azores in April. The monthly charts show that at this period depressions originating to the west of those islands usually take a northerly course. The disturbance in question travelled in an E.N.E. direction until April 21 at the rate of 400–500 miles a day, then struck northwards, joined an area of low pressure coming from N.W., and arrived off the south of Ireland early on April 22. The sudden and unexpected appearance of this storm is referred to in the report of the Meteorological Committee for the year ended March 31, 1910.

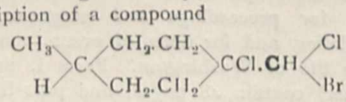
WE have received the first four numbers of the Journal of the Washington Academy of Sciences, to be published semi-monthly except in July, August, and September, when monthly. The academy publishes a series of Memoirs, of which the first volume is dated 1866, the second 1884, the third 1885, and the remaining volumes at somewhat irregular intervals; these memoirs contain long papers. In 1899 a series of Proceedings was commenced containing papers shorter than those in the Memoirs, issued to members at intervals; at the end of each year these are collected into volumes, with indexes and title-pages. The present serial will replace the Proceedings, and is intended for shorter papers written or communicated by resident or non-resident members of the academy, for abstracts of scientific literature published in or emanating from Washington, for proceedings and programmes of the affiliated societies, and for notes of events connected with the scientific life of Washington. Parts i. and ii. (published together) contain 48 pages, and part iii. 56 pages. Many of the papers are of considerable interest, and extend over a wide range of subjects. The abstracts appear to be well done; the references give the name of the publication, the volume and pages of the beginning and end of the paper, and they are all from papers of the present year, indicating the desire to print the abstracts so soon as possible after the appearance of the originals. The Journal of the academy will be more useful both to residents and non-residents than the Proceedings of which it takes the place.

THE July number of *Science Progress*, which was not received until last month, while particularly strong on the biological side, is sufficiently catholic in its articles to ensure that its readers have a wide and accurate knowledge outside their own special grooves. Dr. Waller, one of the advisory committee of the journal, proves that to Magendie rather than to Bell must be ascribed the discovery of the functions of motor and sensory nerves. Dr. Russell shows how the work of the Bureau of Soils of the United States Department of Agriculture has suffered materially owing to their neglect of the biological, as distinct from the chemical, processes going on in the soil. Prof. Bragg gives an outline of the facts of radio-activity, and shows that they force us to give up the idea of the impenetrability of matter.

PUBLICATION No. 149 of the Carnegie Institution of Washington consists partly of a reprint of a paper from *The Philosophical Magazine*, partly of new matter, and deals with a detailed investigation by Prof. C. Barus and his son of the conditions under which light produced by diffraction at a plane grating can be made to give interference fringes. The grating is mounted at one end and the eye-piece at the other end of a rod, the ends of which slide along tracks at right angles to each other, as in the

Rowland mounting for a concave grating. If a beam of parallel light from a collimator falls on a transmission grating, and is observed through a telescope after reflection, the spectrum is crossed by bands, which are due to the interference of rays diffracted at the grating surface and reflected from the back surface; rays transmitted through the grating surface without diffraction, then reflected and diffracted on their return; and, lastly, rays diffracted at the grating surface only. The authors develop the method, and produce an interferometer which is easily set up and possesses two degrees of sensitiveness, the higher corresponding to about half a wave-length of light.

AN interesting sequel to their observations on optically active substances containing no asymmetric carbon atom (NATURE, 1910, vol. lxxxvi., p. 93) is described by Profs. Perkin and Pope in the August number of the Journal of the Chemical Society. For this type of asymmetry they propose the name "centroasymmetric," and their last communication deals with the conversion of "centroasymmetric" compounds into derivatives containing asymmetric carbon atoms, and *vice versa*. It is shown that, although two isomeric derivatives are sometimes produced, the optical activity of the compounds persists in all cases in which the molecule remains asymmetric. The models used by Prof. Pope in describing his observations to the Chemical Section of the British Association at Portsmouth are reproduced as photographs, the careful orientation of which makes them even easier to understand than the original solid figures. A point of considerable interest is the description of a compound



which owes its optical activity to an asymmetric atom linked to the three univalent radicles H, Cl, Br, the asymmetric carbon atoms of all active compounds described hitherto having been linked to at least two other carbon atoms.

A NUMBER of new uses of explosives in agriculture are described by Mr. F. H. Gunsolus in the Journal of the Franklin Institute for August. In the North-Western Pacific States dynamite is largely used for clearing land of tree-stumps; but a more novel application is to drill holes from 2 to 5 feet into the soil and to explode dynamite cartridges in them, in order to break up and loosen the subsoil. This process may be carried out on land where orchards have already been planted, the quantity of dynamite used varying from 25 to 100 lb. per acre. Explosives are also being used very largely in the Western States for digging ditches, especially in swampy clay ground. Slanting holes are punched at intervals of about 2 feet along the line of the proposed ditch; the middle hole is loaded with two or three cartridges, the explosion of which serves to detonate the charges in the other holes, with the result that a mile or more of ditch may be blasted simultaneously. The earth from the ditch is scattered evenly over the adjoining land, and the presence of stumps, trees, and underbrush interferes scarcely at all with the success of the operation.

A COPY of the October issue of the catalogue of second-hand instruments for sale or hire, by Mr. C. Baker, of High Holborn, London, has been received. The list contains particulars of more than 1500 pieces of apparatus, including a large selection of microscopes and astronomical telescopes. Customers unable to call at the showrooms to inspect pieces of apparatus can, on certain conditions, have them on approval for three days.

THE latest catalogue of general chemical apparatus and laboratory accessories issued by Messrs. A. Gallenkamp and Co., Ltd., of Sun Street, Finsbury Square, London, E.C., is likely to become a much consulted work of reference in chemical laboratories. The profusely illustrated volume runs to 800 pages, and provides full particulars, conveniently arranged, of all apparatus required for general use in the laboratories of every grade of educational institution, and those of industrial works where apparatus for research is employed.

OUR ASTRONOMICAL COLUMN.

BELJAWSKY'S COMET, 1911*g*.—From positions determined on September 29 and October 1 and 3, Dr. Kobold has calculated the following elements for the orbit of comet 1911*g*, which has now become an object for evening observations:—

$$T = 1911,\ \text{October } 10{\cdot}196.$$

$$\left.\begin{aligned}\omega &= 71^\circ\ 39'\\ \Omega &= 88^\circ\ 44'\\ i &= 96^\circ\ 38'\end{aligned}\right\}1911{\cdot}0$$

$$\log q = 9{\cdot}4823$$

From the ephemeris derived from these elements we give the following:—

Ephemeris 12h. Berlin Midnight.

1911	α (true) h. m.	δ (true) ° '	log *r*	log Δ	mag.
Oct. 12	... 13 37·6 ...	+8 59·1 ...	9·4931 ...	0·0051 ...	2·4
,, 14	... 14 1·0 .	+6 30·3 ...	9·5190 ...	0·0201 ...	2·6
,, 16	... 14 21·2 ...	+3 43·9 ...	9·5545 ...	0·0375 ...	2·9
,, 18	... 14 38·5 ...	+0 54·3			
,, 20	... 14 53·2 ...	−1 52·6 ...	9·6355 ...	0·0752 ...	3·4

The calculated magnitude at perihelion was about 2·3, but, owing to the rapid increase in distance, from both the sun and the earth, it is decreasing rapidly, and with the decreasing northerly declination the object is becoming a difficult one to observe; as the tail is approximately vertical, however, it may be possible to observe it, low down in the west, after the head has set, as was done in the case of comet 1910*a*.

Observations show that the tail, unlike that of Brooks's comet (1911*c*), is of the broad parabolic type often associated with great comets and small perihelion distances.

According to a *Times* communication, Mr. Hinks observed the comet between 16h. 30m. and 16h. 45m. on October 5, and estimated the magnitude of the nucleus as 3·5; only about 2° of the tail was visible. He also saw a strong zodiacal light just before dawn.

A tail 15° long was seen by Prof. Nijland, at Utrecht, on October 1.

QUÉNISSET'S COMET, 1911*f*.—The following is a further extract from Dr. Ebell's ephemeris for comet 1911*f*, which is still observable throughout the earlier part of the night:—

Ephemeris 12h. M.T. Berlin.

1911	α (true) h. m.	δ (true) ° '	log *r*	log Δ	mag.
Oct. 12	... 15 33·1 ...	+38 19·3 ...	9·9903 ...	0·0252 ...	6·7
,, 14	... 15 35·2 ..	+35 11·9			
,, 16	... 15 37·0 ...	+32 14·4 ...	9·9707 ...	0·0499 ...	6·7
,, 18	... 15 38·5 ...	+29 26·4			
,, 20	... 15 39·8 ...	+26 47·5 ...	9·9519 ...	0·0754 ...	6·8

All these positions lie near to a line joining μ and δ Coronæ, the comet's apparent path lying almost due south.

BROOKS'S COMET, 1911*c*.—Brooks's comet passed the sun on October 12, and became a morning comet; as shown in the following abstract from Dr. Kobold's ephemeris, its apparent path now lies through Coma:—

Ephemeris 12h. M.T. Berlin.

1911	α (true) h. m.	δ (true) ° '	log *r*	log Δ	mag.
Oct. 11	... 13 10·8 ...	+30 2·5 ...	9·7970 ...	9·7899 ...	4·3
,, 13	... 13 2·6 ...	+27 10·7			
,, 15	... 12 55·4 ...	+24 14·5 ...	9·7583 ...	9·8178 ...	2·8
,, 17	... 12 49·1 ...	+21 16·1			
,, 19	... 12 43·9 ...	+18 15·5 ...	9·7241 ...	9·8498 ...	2·8
,, 21	... 12 39·7 ...	+15 13·1			

The last four lines are taken from Dr. Ebell's continuation of the ephemeris, which appears in No. 4528 of the *Astronomische Nachrichten*.

THE SYDNEY OBSERVATORY.—In these columns on March 23 (vol. lxxxvi., p. 122) we expressed regret that the proposal to reorganise the New South Wales State observatory was not being taken up by the Government of that State. We now learn from a Sydney correspondent that at last the Government has agreed to the proposal, and has issued instructions for the appointment of a State astronomer, who is also to be professor of astronomy in the Sydney University; at present, we understand, there is no chair of astronomy in Australia.

In making this appointment, the Public Service Board is acting with the University authorities, and they have fixed the salary at 800*l.* per annum, with 100*l.* for quarters; the professorship will carry with it the usual pension allowance.

The first duty of the new State astronomer will be to organise the erection and equipment of a new observatory, for, as we pointed out previously, the present site is condemned; and since the death of Mr. H. C. Russell the work has, despite the untiring efforts of Mr. Raymond, fallen seriously into arrears.

The intended appointment is about to be advertised, and will, we understand, be dealt with by an influential committee in London. When this is done, and the Federal Government has organised its proposed Solar Physics Observatory at the new capital, it is hoped that astronomy will again flourish in Australia; meteorology has already been taken over by the Federal Government.

A NEW MINOR PLANET.—Advices from Vienna announce that Prof. Palisa has discovered a new minor planet which, having an increasing right ascension at opposition, may prove to be another object of the Eros type. The position on October 3 is given as

$$\text{R.A.} = 0\text{h. } 42\text{m. } 5\text{s.}, \text{ dec.} = +0^\circ\ 15'\ 38'',$$

and on October 4 was

$$\text{R.A.} = 0\text{h. } 43\text{m. } 59\text{s.}, \text{ dec.} = -0^\circ\ 17'\ 49''.$$

In No. 4528 of the *Astronomische Nachrichten* Prof. Palisa gives the daily motion as +2m. 8s., −32′, and the magnitude as 12·0. The advance in R.A. is greater than that of Eros at opposition, so that it may prove that the new planet, 1911 MT., approaches nearer than does Eros. It would appear that the orbit has a great eccentricity, and that the planet is near perihelion.

NEW WATER SUPPLY WORKS.

THE town of Birkenhead, containing a population of 120,000 inhabitants, at present depends for its supply of water on local sources; the wells in the Wirral Peninsula, however, are liable to salt water filtering from the sea and rendering the supply brackish. The Corporation of Birkenhead so far back as ten years ago realised that the condition of the water supply was not satisfactory, and appointed a committee to inquire as to a source from which a purer supply could be obtained. After a long inquiry, and acting on the advice of their consulting engineer, the late Mr. Deacon, a site was selected in Wales, fifty miles distant, which involved the construction of a large reservoir in the Denbighshire mountains on the River Alwen, a tributary of the Dee. In 1907 an Act was obtained conferring the necessary powers for carrying out the scheme and borrowing the money required. A few days ago these works were inaugurated with some ceremony by the Mayor and Corporation, a large granite block being fixed in one of the masonry piers of the dam now in course of construction, the contract for which has been placed in the hands of Messrs. McAlpine and Co. The amount of the contract for the reservoir is 186,153*l.* This dam is 1250 feet above sea-level; its length is 458 feet, and height 90 feet. The reservoir will be three miles long and about 350 yards wide, and will hold three thousand million gallons of water. The area of the ground from which it will be supplied covers 6300 acres, part of which is covered by peat, which in some places is 20 feet deep. This will all have to be removed. The average rainfall over the district is 51 inches, and the estimated average yield of water eleven million gallons a day. At the present time a large staff of men is employed on the works, about 400 being housed in wooden huts erected for the purpose. The water is to be conveyed to Birkenhead through steel and iron pipes varying in diameter from 20 to 30 inches. The estimated total cost is 1½ million pounds. The works have been designed and are being carried out under the direction of Sir A. Binnie and Co., who took the matter up after the death of Mr. Deacon.

At Lincoln on October 4 was inaugurated with much ceremony, including a service at the Cathedral, the opening of the new waterworks which have been constructed for supplying the city with a pure supply of water. A few years ago Lincoln was afflicted with a very serious outbreak of typhus fever, the cause of which was traced to the pollution of the water in the River Witham, from which the supply was then obtained, and water for drinking purposes had for some time to be brought by railway in tanks. After much inquiry it was found that an entirely fresh source must be obtained. Boring in the locality was first tried, and, after sinking to a great depth and encountering considerable difficulties and delay, although a plentiful supply was reached, the quality of the water was not sufficiently good for use, and had to be abandoned. Parliamentary powers had then to be obtained for authorising the works now completed. The water is obtained from the pebble beds in Nottinghamshire at Eckersley, near the River Trent, at a depth of 500 feet below Sherwood Forest, the distance from Lincoln being twenty-three miles, the mains being carried across the river by a bridge built for the purpose. The water is raised from four boreholes 570 feet in depth, and pumped into 21-inch mains by engines of 500 horse-power, capable of raising 3,600,000 gallons a day. The machinery is all in duplicate, so as to provide against any accident that may occur. The total cost of the work is about 230,000*l.* The whole of the scheme has been carried out under the direction of Mr. McBarron, the city waterworks engineer.

PRECIOUS STONES.

THE chapter on precious stones which Dr. G. F. Kunz contributes to vol. xix. of *The Mineral Industry*, dealing with mining operations in 1910, contains, in addition to statistics of output, prices, and sales, much of general interest. Two-thirds of it is occupied with diamond. The main shaft of the Kimberley Mine has reached the considerable depth of 3527 feet. The extreme variation in the quality of the stones from the different mines is evinced by the average price per carat; thus 85*s.* is obtained for the stones from the Vaal River diggings, and 45*s.* from the De Beers group, while the Lüderitz Bay stones realise 26*s.* 6*d.*, and the products of the Premier Mine only 14*s.* per carat. The occurrence of microscopic diamonds in decomposed olivine, with enclosed chromite, at Olivine Mountain, in the Tulameen River, Yale district, British Columbia, is of considerable scientific interest, though of no commercial importance. Students of political economy will be interested in the means whereby the powerful International Diamond-cutters' Union, with an income of about 3000*l.* a week, maintains a high level of wages. Apprentices are selected from sons of members of the union only, and their number is restricted to 5 per cent. of the whole. The great difference in price between manufactured and natural rubies calls for the note of warning that the qualifying term—scientific or artificial—demanded by law is sometimes inconspicuously written on the invoice. A specimen, weighing 98¾ carats, of the pink beryl, morganite, was discovered in Madagascar, and a magnificent aquamarine in Brazil; Madagascar is also supplying fine tourmalines. Unworked deposits of peridot have been found in the islands Rahamah and Kad-Ali, in the Red Sea. It is curious to learn that peridots have been dug up at Alexandria, where apparently they had been buried some 1500 years ago in the foundations of the houses in the belief that they would add to their stability. The best means for preserving the pearl-mussel is being studied at the station recently provided by Congress at Freeport, Iowa, U.S.A.

MATHEMATICS AND PHYSICS AT THE BRITISH ASSOCIATION.

THE address of the president of Section A, Prof. H. H. Turner, has been already printed in this journal (August 31, p. 289).

COSMICAL PHYSICS AND ASTRONOMY.

The address was followed by a meteorological paper by Prof. W. J. Humphreys (of the U.S. Weather Bureau) on the earth as a radiator. Since our climates are not now perceptibly growing either colder or warmer, the total amount of heat received by the earth is substantially equal to the loss during the same time. But this statement does not apply to limited regions; and therefore to map the earth as a radiator it is necessary first to obtain temperature records within the isothermal region, where radiation alone is the controlling factor. From the experimental results the author deduces that the outward radiation is least near the equator, where the inward radiation is greatest, and greatest in temperate latitudes, a secondary minimum at the pole being indicated by the ascents in high latitudes. In the discussion it was pointed out that the results depend largely on the assumption that the atmosphere acts as a "grey" body. The values might be subject to considerable correction for irregularities in the absorbing power for different spectral regions. Dr. Shaw directed attention to the need for examining the influence of different thicknesses of water vapour in the atmosphere, and considered that reflection from cirrus clouds would introduce a considerable disturbing influence. A suggestion by Prof. Hicks that possibly the results were a consequence of the preponderating amount of ocean near the equator was met by Dr. Humphreys replying that the same results were obtained over ocean as over land.

Mr. L. Vegard, of Christiania, contributed a suggestive paper on the radiation producing aurora borealis, in which he starts from Birkeland's view that auroræ are caused by electric solar radiations, and endeavours to deduce the properties of these radiations. From the form and structure of the luminosity he infers that the electric radiations behave as though they are α rays. It is found, from the relation between range and velocity, that α rays will get down to heights varying between 70 and 300 km., which agrees with observations. Further, calculations show that α rays will strike the atmosphere at an angular distance from the magnetic axis of about 17°, which gives the right position of the auroral zone. The equidistant bands so characteristic of the draperies he explains by assuming groups of homogeneous rays, starting under the same initial conditions, such as would be provided by radium and its disintegration products in the sun. The author made a strong case for his explanation of these interesting phenomena.

Dr. W. N. Shaw communicated an account of the thunderstorms of July 28 and 29. The London storm on July 28 was accompanied by a squall of wind which reached fifty-four miles an hour at South Kensington, and the storms on July 29, which occurred over nearly the whole of England and Ireland, were preceded by violent squalls which raised clouds of dust, particularly noticeable in South Wales. At Watlington (Mr. W. H. Dines) the disturbance occurred while the passage of a depression was in progress, and the barograph curve took an M form instead of the usual ✓¯. The records of temperature, wind direction, and rainfall have still to be examined with the object of tracing the physical processes underlying the disturbance.

In the same department Commander Campbell Hepworth communicated a paper on the effect of the Labrador current upon the surface temperature of the North Atlantic, and of the latter upon the air temperature and barometric pressure over the British Isles. The purpose of the paper was to show the importance of the Labrador current in modifying the influence of the Gulf Stream.

Dr. Shaw showed models representing air currents up to heights of 10 kilometres which had been obtained from the observations of pilot balloons made at Ditcham Park by Mr. Cave. The models showed some of the types of motion which occur, and were very instructive to those unfamiliar with the details of upper-air observations.

Dr. Humphreys read a paper on the water vapour in the atmosphere on clear days, a quantity of great importance in the determination of the solar constant. He found a value of 87 per cent. of the value found by Hann from observations made in all kinds of weather.

Mr. Gold gave a brief account of the results obtained from the ascents in Ireland, undertaken by the committee for the investigation of the upper atmosphere. Three successful ascents had been made from Mungret College, Limerick, in the present year, and on July 6 values for the temperature had been obtained up to 21 km.

Dr. Dickson put forward the suggestion that the treatment of general atmospheric circulation might be simplified by taking the equatorial circulation to form a system by itself. It was pointed out in the discussion that general dynamical considerations rendered such an hypothesis untenable.

Mr. Craig read a paper by Dr. Ball and himself on the use of diagrams in the classification of climate. The diagrams dealt with temperature and humidity, and showed the annual course of these elements by a single closed figure for each of a selection of places from different parts of the world. The shape and orientation of the figure varied with the climate, and showed at once its principal features. Mr. Craig pointed out how they could be used not only by the man who was considering his health, but also in connection with such problems as cotton-growing.

Prof. J. Milne presented the sixteenth report of the committee on seismological investigations. Of the many interesting things in this report we may instance the observations on tidal load at Ryde in the Isle of Wight. By means of an instrument installed in a cellar in the Royal Victoria Yacht Club at Ryde and with its boom oriented east and west, a 10-foot tide in the Solent is found to produce an angular deflection of 0·85″. At Bidston a 10-foot tide gives at a distance of two miles a tilt of 0·2″. A curious feature of the Ryde photograms is the flatness of many of the crests and hollows of the deflections, which seems to indicate that from time to time the water remains high (or low) for several hours. When the boom was pointed north, or toward the advancing and retreating tide, the resulting photograms were practically straight lines.

Prof. H. H. Turner read a note on the periodogram of earthquake frequency from seven to twenty years, in which he investigated by Schuster's methods the possibility of periodicities in earthquakes, making use of the data in the "Catalogue of Large Earthquakes" recently edited by Prof. Milne. Within the range of periods examined, the only chance of a real periodicity is one of nineteen years, suggesting a nutational effect depending on the moon's nodes.

A paper by Mr. F. Napier Denison, on horizontal pendulum movements in relation to certain phenomena, was read by Prof. Milne, who also read one on the solar cycle, the Jamaica rainfall, and earthquakes cycles, by Mr. Maxwell Hall, dealing with observations extending from 1870 to 1910. Excepting a rainfall minimum in 1875, the minima for rainfall follow sun-spot maxima and minima by 1½ or 2 years. The rainfall maxima are more irregular. The earthquake maxima follow solar maxima by 2 years, while the minima follow solar minima by 2 or 3 years. Prof. O. Pettersson followed with a very interesting paper on parallactic tides set up in the bottom layers of the sea by the moon (see report of Section E).

Stellar Distribution.

The proceedings on Tuesday, September 5, commenced with a discussion on stellar distribution and movements, opened by Mr. A. S. Eddington, who stated that in attempting to form a conception of the structure of the universe as revealed by modern researches, we have to take into account the following principal phenomena. The great mass of the stars are distributed in a lens- or bun-shaped system, in which our sun occupies a nearly central position; round this, and in the same plane, are coiled the clusters, which make up the Milky Way. In the central parts of this the stars form two great streams moving in opposite directions; this is most easily explained as being the result of two more or less independent systems of stars having become intermixed. We have also to take note of "moving clusters," that is, groups of stars widely separated in space, which have almost identical motions, and are thus clearly connected in their origin. A whole class of stars, those of the helium type of spectrum, are exceptional, as they do not show the phenomenon of the two star-streams, and have very little motion of any sort, individual or systematic. This is perhaps due to the fact that they are extremely remote, and lie beyond the region through which the star-streams prevail. Finally, there is the recently discovered connection between spectral type and linear motion; the later the type of spectrum (as regards evolutionary development) the greater the average speed of the stars.

By considering the stars known to have a parallax greater than 0·2″ (seventeen in number), some important results are illustrated, notably the sparsity with which stars are distributed in space, the very heavy proportion of binary systems, the very different degrees of intrinsic brightness of stars, and the fact that the relative frequency of the different spectral types as seen in the sky is utterly misleading as an indication of their abundance in space. The publication by Prof. Boss last year of more than 6000 well-determined proper motions of stars distributed over the whole sky has greatly assisted investigations of the two star-streams. The bipolarity of the stellar motions is very clearly shown in the new data. Besides the theory of two star-drifts, an ellipsoidal theory, and more recently a three-drift theory, have been employed to represent the distribution of velocities. The theories have much in common, and it will be very difficult to distinguish between them. An attempt has been made to arrive at the law of velocities directly from the observations, without recourse to a particular theory; but the work, which involves an integral equation, has presented some difficulties, and is not yet completed.

The remarkable result that a star's motion appears to increase with its age, apparently implying that a star is born with practically no motion, leads us to inquire into the causes which produce stellar motions. From the consideration of the moving clusters it appears that the chance approaches of neighbouring stars have no appreciable effect, and the cause must be the resultant attraction of the whole mass of stars—a solution which, however, is not without its difficulties. Dr. Halm has suggested a law of equipartition of energy among the stars implying that the dependence of velocity is not really on the spectral type, but on the mass of the star; it seems that the stars of later types are progressively less heavy than those of early type. A third possibility is that distance from the centre of the stellar system is the determining cause. The hypothesis has recently been revived that the stellar system forms a spiral nebula similar to the thousands of spiral nebulæ in the sky. This theory, though highly speculative, appears to represent fairly well the observed distribution of the stars and the Milky Way, and the double-branched spiral form presumably involves motion in two opposite directions in the centre of the system similar to that presented by the two star-streams.

During the subsequent discussion Prof. Turner exhibited a model of the Ursa Major "moving cluster," specially showing that the component stars were nearly in one plane. Mr. A. R. Hinks emphasised that at present we are only getting at the central parts, and we do not know what fraction this part bears to the whole. In reference to the bun-shaped system, he considered that absorption of light had not been taken account of as it should be. He thought the spiral nebula conception was unnecessarily grandiose; he did not think that the star clouds of the Milky Way were well represented by the arms of a spiral nebula, as the latter seemed generally to be gaseous. He questioned whether anyone had yet explained the dynamics of the spiral motion in a nebula. He considered it premature to assume that there were not more than seventeen stars with parallax greater than 0·2″. He also criticised various points in nomenclature; in particular, the term star-cluster was being used in two senses.

The Astronomer Royal (Prof. F. W. Dyson) emphasised the value of the information given by measured parallaxes and the importance of making more determinations. The real difficulty is a lack of a knowledge of the actual distances of stars. He thought that the best way was to try to explain the velocities of stars gravitationally, and alluded to Lord Kelvin's satisfactory attempt in this direction to connect the total mass of the stars with the observed velocities. Prof. Turner and Mr. F. Bellamy explained the work done at Oxford in determining large proper motions; these were (unlike the stars as a whole) distributed nearly uniformly round the sky, the slight excess being in directions at right angles to the Milky Way. Father Cortie asked if there was not a contradiction in the fact that whereas the later-type stars had the larger velocities, yet they were relatively more abundant in the slow-moving drift than in the fast one. Mr. S. Stratton pointed out the anomalous position of the planetary nebulæ; their large velocities would place them at the end as the last stage of evolution. Mr. H. Hilton asked whether the velocity would not be least at the centre of a system of stars and increase outwards.

Mr. Eddington, replying to Prof. Turner, explained that the excess with large proper motions at right angles to the Milky Way was due to the solar motion coming in with greatest effect there in the Oxford zone. Replying to Mr. Hilton, he explained that he had regarded the stars not as moving in orbits, but as moving from outside to inside, and *vice versa*. Replying to Father Cortie, he explained that it is the individual motions of later-type stars that are greatest, as distinct from the drift motions.

Father Cortie and Mr. J. H. Worthington gave some particulars in regard to endeavours to view the recent eclipse.

The programme for Wednesday, September 6, contained two papers by Mr. S. Stratton, which in his enforced absence had to be taken as read. One of these, on an unusual meteor observed at Portsmouth on August 31, described a meteor with an apparent path in the form of a letter J, which probably arose from foreshortening accompanied by swerve. The swerve might be traced to spin and resistance or to unequal heating effects. The second paper, on the possible relations between sun-spots and the planets, contained a discussion of sun-spot material tabulated to show phase effects due to Venus and Jupiter. The conclusion is against the validity of conclusions come to recently by Prof. Schuster in connection with the influence of Venus and Mercury. A longer period of observation is apparently necessary before trustworthy results can be obtained.

MATHEMATICS.

In the department of mathematics Lieut.-Colonel Allan Cunningham, R.E., read a paper on Mersenne's numbers. These numbers are of the form $M_q = 2^q - 1$, where q is a prime number. Since the appearance of Mr. W. W. Rouse Ball's paper in 1892 Prof. F. N. Cole has factorised M_{67}, Lieut.-Colonel Allan Cunningham has factorised M_{71}, M_{163}, and M_{197}, while H. J. Woodall has recently factorised M_{181}. This leaves still unverified (as composite) only fifteen out of the forty-four numbers (with $q<257$) originally affirmed by Mersenne to be composite, viz. when

$$q = 101, 103, 107, 109, 137, 139, 149, 157, 167, 173, 193, 199, 227, 229, 241.$$

A complete list of all the possible divisors <1 million of these fifteen numbers has been prepared by Mr. A. Gérardin (of Nancy, France) and Lieut.-Colonel Allan Cunningham, working independently. These trial divisors have been tested by the latter up to 500,000 without success (every "trial divisor" was tried twice).

Prof. J. C. Fields read a paper on relations between the double points and branch points of a plane algebraic curve $F(x,y) = y^n + F_{n-1}y^{n-1} +$, &c., which presents no singularities at infinity and the finite point singularities of which consist of nodes and ordinary cusps. On representing an arbitrary polynomial in (x,y) of degree $n-2$ by the notation $G(x,y) = \Sigma_{rs} d_{rs} x^r y^s$ a simple proof was given of the formula $\Sigma_\lambda c_\lambda \frac{G(a_\lambda, b_\lambda)}{F''_{b_\lambda}(a_\lambda b_\lambda)} = d_{o, n-2}$ where the summation is extended to all points $(a_\lambda . b_\lambda)$ which are ordinary branch points, nodes, or cusps of the curve, the coefficient c_λ having as value either 1, 2, or 3, according as the corresponding point is an ordinary branch point, a node, or a cusp.

Mr. H. Bateman then contributed a note on the transformation of an electromagnetic field into itself. It is hoped that a discussion of the infinitesimal transformations will lead to equations of motion which will complete the electromagnetic scheme. Following the work of Mr. Hargreaves on the effect of an infinitesimal transformation on certain integral forms, it is assumed that these integral forms are invariants for the infinitesimal transformation. The analysis then indicates that two forms are exact differentials. Some types of infinitesimal transformations satisfying the conditions were obtained for particular electromagnetic fields, and the transformations were interpreted geometrically.

An account of the report of the committee for the further tabulation of Bessel and other functions was given by Mr. Nicholson. In the report tables are given (calculated by Mr. J. R. Airey) of the Neumann functions $G_n(x)$ and $Y_n(x)$ to seven decimal places for $n=0$ and $n=1$, and for values of the argument from 0·1 to 16·0 by intervals of 0·1. During the course of the year Sir G. Greenhill has brought forward a scheme for the rearrangement of the elliptic functions tables on a new basis. This scheme has now received the approval of the association, and a grant has been made towards the expenses of computation.

In this department Mr. H. Bateman contributed a paper on a geometrical theorem connected with six lines in space. PP′, QQ′, RR′ are three pairs of lines in space. LL′ are the common transversals of QQ′, RR′; MM′ the common transversals of RR′, PP′; and NN′ the common transversals of PP′, QQ′. If QQ′RR′ belong to a regulus, then MM′NN′ also belong to a regulus.

Mr. H. Hilton read a paper on the canonical form of an orthogonal substitution. After pointing out a short method of reducing a real orthogonal substitution to a canonical form, he discussed the analogous problem for an orthogonal substitution with complex coefficients. A canonical form was obtained in which the linear equations of the substitution were arranged in blocks, some of which contained two and others only one member. The leading coefficient occurring in one type of block was the reciprocal of the corresponding coefficient occurring in an associated block.

Prof. J. C. Fields read a paper on proof of certain theorems relating to adjoint orders of coincidence, viz.:—(1) In the reduced form of a rational function of (z, u), which is adjoint for the value $z=a$ (or $z=\infty$), the coefficient of u^{n-1} is integral with regard to the elements $z-a$ (or $\frac{1}{z}$). (2) If a rational function is adjoint for the value $z=\infty$, the degree of its reduced form is $\leqq N-1$. (3) The reduced form of a rational function adjoint for the value $z=a$ is integral with regard to the element $z-a$ if the equation $f(z, u)=(u-P_1)\ldots(u-P_n)=0$ (where $P_1 \ldots P_n$ are power-series in an element $z-a$ (or $\frac{1}{z}$) with exponents integral or fractional) is integral with regard to this element.

The Principle of Relativity.

The proceedings on Friday, September 1, opened with a discussion on the principle of relativity, led by Mr. E. Cunningham, who pointed out that the scope of the hypothesis of relativity is exactly coincident in extent with its scope in Newtonian dynamics. The acceleration of a point is not physically indeterminate as its velocity is. The theory of relativity is, for example, quite consistent with the magnetic effects apparent to terrestrial observers being explained as arising from the rotation of the earth with a nearly stationary distribution of charge. Within the limits indicated above and within the realm of phenomena in which the sole determinative laws are those of the electron theory, the hypothesis becomes a mathematically demonstrable fact in the sense that it is not possible to choose a unique frame of reference for which alone the laws will hold good. Mr. Cunningham then sketched the transformations connecting the measurements made according to two frames of reference, each of which is equally adequate to express known phenomena, and explained what deductions can be drawn.

In the subsequent discussion Dr. W. F. G. Swann pointed out that the compliance of a system with the electromagnetic scheme is by no means a sufficient criterion for the possibility of its existence; for instance, a system of two singularities, moving along at a constant distance apart, with the field at each point the sum of the ordinary fields due to the separate motions, is a system in accordance with the scheme, but it is one impossible of existence in practice. The explanation of the impossibility of the existence of such systems is to be found in the fact that they could never evolve out of any actually existing system. In fact, if we take the electromagnetic scheme as complete, those uniformities in nature which we call "laws" are to be looked upon as due in part to the compliance of the universe with the scheme and in part to the individuality of the initial system started. A complete knowledge of the field at every point in space, both inside and outside the molecules, would, in conjunction with the electromagnetic scheme, theoretically give us all that we should need to ascertain both the past and subsequent history of the universe. Since we cannot know the complete field at some instant, we are driven to make up for our incomplete knowledge by formulating certain "subsidiary laws," such as laws involving the conception of forces between the singularities, electrical surface conditions, gravitation, &c., the function of these laws being to *restrict those systems which satisfy the scheme, and are also to be considered as possible of existence, to those which can spontaneously evolve out of the actually existing universe.*

Mr. H. Bateman emphasised the mathematical interest attached to the principle, because it unites several branches of mathematics, such as geometry, partial differential equations, generalised vector analysis, continuous groups of transformations, differential and integral invariants, &c. He pointed out that there are two different types of transformations which can be used to transform one mathematical specification of an electromagnetic field into another. Those transformations which depend upon the electromagnetic fields which they can be used to transform form a much wider class than the spherical wave transformations, which can be applied to any electromagnetic field. The new transformations provide us with some very interesting analogues of mental phenomena.

Prof. P. Zeeman stated that the value of Fresnel's coefficient is easily deduced by means of the principle of relativity provided that no account is taken of dispersion. In that case the results of Fizeau's and Michelson and Morley's experiments on the propagation of light in flowing water agree with theory. The agreement is not so good if a dispersion term formally calculated by Lorentz be introduced. He asked whether the correction term would be the same if the principle of relativity were applied from the beginning to a dispersive medium. Prof. G. N. Lewis outlined some of the views which he has recently expressed in full in *The Philosophical Magazine*. Prof. A. E. H. Love warned one to be on the alert, because in the factor $K=(1-\beta^2)^{-\frac{1}{2}}$ we may be dealing only with a first approximation. Secondly, he suggested that it was conceivable that terrestrial magnetism might be only an apparent phenomenon due to the rotation of the earth. He had, however, tested whether by taking rotatory axes one could obtain effects of the magnitude of terrestrial magnetism; but they turn out to be very small, and it seems hopeless to think of magnetism as due solely to the rotation.

Dr. C. V. Burton, after expressing his satisfaction that none had confessed a disbelief in the æther, urged the importance of a search for residual phenomena not falling within the electromagnetic scheme. Conceivably gravitation is such a phenomenon. There is, further, a question as to whether neighbouring electrically neutral masses exert forces upon one another in virtue of their motion through the æther. Such forces would be non-electromagnetic: experiments designed to detect them are in progress, but have so far given a null result. The entire absence of such forces would imply that matter takes up no room (positive or negative) in the æther.

So much time had been taken up by the discussion that none was left to Mr. Cunningham to reply adequately to the numerous points raised. His scholarly paper introducing the discussion has been ordered to be printed *in extenso*; we look forward to perusing it in its extended form, and no doubt the answers to many of the questions will appear therein.

GENERAL PHYSICS.

In the department of general physics Mr. N. E. Dorsey gave an account of the work done at the Bureau of Standards on the absolute measurement of electric current. The measurements were made with a balance of the Rayleigh type; the coils were wound bifilarly, of enamel-insulated wire, upon brass forms. A novel feature of the fixed coils is the provision, in the forms and back of the windings, of a channel, through which water can be pumped so as to maintain the coils at a constant temperature. A double-walled jacket with water circulation surrounded the movable coils for the same purpose. The mean value obtained of the electromotive force of the mean Weston normal cell (as defined at the Washington conference) at 20° C. in terms of the international ohm and the Bureau balances is $1{\cdot}01822_4$ (with a mean deviation of 9×10^{-6}), which is 4 in 100,000 higher than the value obtained at the National Physical Laboratory. The cause of the discrepancy is not settled.

Prof. F. T. Trouton followed with a paper on peculiarities in the adsorption of salts by silica. Starting with very dilute solutions and gradually increasing their strengths, the amount of salt adsorbed first increases fast, then more slowly (or even decreases), then more quickly again. The thickness of the layer which exhibits the anomaly is calculated as being comparable with the usually given value for the range of molecular forces.

Dr. J. W. Nicholson contributed a paper on the atomic structure of the elements, with theoretical determinations of their atomic weights, in which an attempt was made to build up all the elementary atoms out of four protyles containing, respectively, 2, 3, 4, and 5 electrons in a volume distribution of positive electricity. Representing the protyles by the symbols Cn (coronium), H (hydrogen), Nu (nebulium), Pf (protofluorine), the accompanying table indicates the deductions of the author with regard to the composition of several elements, allowance being made for the mass both of the positive and negative electrons.

Gas	Formula	Atomic weight	
		Calc.	Obs.
Helium	Nu. Pf.	3·99	3·99
Argon	$5He_2$	39·88	39·88
Krypton	$5\{Nu_4(Pf.H)_3\}$	83·0	82·9
Xenon	$5\{He_4(Pf.H)_3\}$	130·29	130·2
Neon	$2(Pf.H)_3$	20·21	20·2

The coincidence between the calculated and observed values is very great, but the general attitude of those present seemed to be one of judicial pause pending the fuller presentation of the paper, stress being laid on the fact that any true scheme must ultimately give a satisfactory account of spectra. The rest of the morning was occupied with the reading of the reports of the committee for establishing a solar observatory in Australia and the committee on magnetic observations at Falmouth Observatory.

Prof. F. R. Watson contributed the results of experiments undertaken in connection with curing the echoes and reverberations in the auditorium at the University of Illinois. In accordance with theory, it is found that a broad sheet of warm air drawn over the head of the speaker and out at the rear of the auditorium acts as a partition, and more or less reflects and refracts the speaker's utterances to the audience. In the absence of the author, a paper by Mr. J. W. Gordon describing an ingenious new micrometer was taken as read.

Mr. W. H. F. Murdoch gave an exhibition and description of a friction permeameter. This is a development of one previously designed by the author. In the new form the defects of the old form are removed. Dr. J. A. Harker followed with a paper (by himself and Mr. W. F. Higgins) on the methods and apparatus used in petroleum testing. He stated that it is well known that the Abel-Pensky apparatus gives a higher result for the same oil than the Abel. The results of experiments made at the National Physical Laboratory by the authors show that large differences of temperature exist throughout the oil cup and vapour space above it at any stage during an experiment amounting to 5° F. or more, and they are different in the different types of apparatus. The size of the test flame is also shown to be of importance. The difference of temperature in the two types is found to be due to the cover in the Abel-Pensky form containing much more metal, and therefore requiring longer to warm up.

The proceedings on Monday, September 4, began with a joint discussion with Section G on mechanical flight. A special article on this discussion has appeared elsewhere in this journal, and consequently it will not be further mentioned here.

Corpuscular Radiation.

A discussion was opened by an extremely lucid and persuasive paper by Prof. W. H. Bragg on corpuscular radiation. Such radiation he defined as consisting of entities or "quanta" each moving in a straight line with uniform velocity and unchanging properties unless impressed forces cause a change. The α and β rays are corpuscular, but not sound or light as ordinarily conceived. With regard to X (and γ) rays, it must be observed that the speed and direction of a β ray produced by an X-ray depend on the quality of the X-ray and not on the nature of the atom. The energy of the β ray, therefore, cannot come from the atom; nor yet can it be the result of the accumulation in the atom of energy extracted from many X-rays, for it can hardly be supposed that the accession of the last infinitesimal amount of energy required would determine so effectively the direction in which the β ray is ejected. Therefore one X-ray provides the energy for one β ray, and *vice versa*, and Whiddington's results show that very little energy is lost in the transformation. Again, since the speed of the secondary β ray is independent of the distance which the X-ray has travelled, the latter cannot diffuse its energy as it proceeds. Again, X-rays can excite X-rays of less, but not greater, penetrating power than themselves; and they must have arisen from β rays of energy exceeding a certain limit, viz. that characteristic of the X-corpuscle of that substance. The spreading pulse of Stokes and the kink in a tube of force (Thomson) fail to account for these facts; only a corpuscular theory will do this. Prof. Bragg's working model of such a corpuscle is a "neutral pair."

Sir Wm. Ramsay in the ensuing discussion asked whether a similar explanation might not account for the sun remaining hot so long, assuming it only sends out radiations in the directions for which a body exists to receive them. He also directed attention to experiments of his own in which radium enclosed in a glass tube surrounded by a second vessel gradually excited radio-activity in the latter. If the outer vessel is dissolved, an active substance can be chemically precipitated. His own theory is that the β rays shot out from the radium excite an actual chemical change in which a radio-active substance is produced.

Dr. Lindemann suggested that a crucial test between corpuscular and wave theory is supplied by the value of radiation pressure being twice as great on the corpuscular theory, but the reply came that the pressure is too small to be measured at present. Pulses of genuine delight ran through the meeting while Prof. Bragg expounded his views, and it was clear that many were impressed by the cogency of his arguments.

In a paper on the dependence of the spectrum of an element on its atomic weight, Prof. W. M. Hicks showed how to represent by formulæ the lines of a spectrum which are related to the well-known series in the same way as the second or third set of a doublet or triplet series depends on the first, or as the satellite lines of a D series depend on the more intense set. Examples were given from the sharp series of Mg, Ca, and Sr, but the other series show similar connections. In the absence of Major E. H. Hills a paper by him on the arc spectra of certain metals in the infra-red (λ 7600 to λ 10,000) was taken as read. This paper details the results of measurements made on photographic plates coated with a collodio-bromide emulsion, as originally used by Abney in 1880. Measurements by others have usually been made with a thermopile or bolometer.

Dr. Harker read a paper, on behalf of Mr. H. C. Green-wood, outlining an investigation on specific heats of metals, especially in the neighbourhood of their melting points, and determinations of the latent heat of fusion. The metals dealt with in this paper are aluminium and zinc.

The first paper read on Wednesday was by Mr. H. Davies, on the laws of solution. Mr. Davies showed how the formula of Rudolphi, which had been suggested to represent the cases where Ostwald's law of dilution breaks down, can be placed upon a theoretical basis. Hitherto it has been held as a purely empirical formula (see in relation to this subject the address of the president of Section B, NATURE, p. 297). Mr. Davies's contribution is of great importance to the physical chemist, inasmuch as it elucidates "the outstanding practical problem in the domain of electrolytic solutions."

Prof. P. V. Bevan contributed a paper on anomalous dispersion and solar phenomena. If light from a non-uniform source, such as an arc light, be sent through a tube containing non-homogeneous vapour of a metal which can show anomalous dispersion, and then an image of the source be focussed on the slit of a spectroscope, an apparent double reversal of certain lines may be produced. An explanation is given based upon the bright images of the two poles of the arc being formed on a darker background of light which has come from elsewhere through the vapour; the essence of the explanation is that the source shall be non-uniform. It was suggested that such apparent reversals might have a bearing upon solar phenomena.

LINKS WITH THE PAST IN THE PLANT WORLD.[1]

UNDER the heading "Links with the Past," several letters were published in *The Times* rather more than a year ago in which the writers gave instances of human longevity, showing how in certain cases a chain of a very few individuals suffices to connect the present with a comparatively remote past. One writer, for example, said that his grandmother, who died about forty years ago, used to boast that her grandfather was twelve years old when Charles I. was beheaded. Striking as such instances are when applied to man, on the other hand they serve to illustrate the relative insignificance of the length of time represented by human lives as contrasted with the duration of many forest trees. It is probably not an exaggeration to say that a single oak tree may form a link between the present day and the Norman Conquest; a very short series of ancestors suffices to carry us back to the days when the progress of the Roman invaders was seriously impeded by dense forests, which have long since disappeared, and farther back to the age of Neolithic man, whose flint implements are occasionally met with in the submerged forests round our coasts.

It would be interesting, if time permitted and my knowledge were adequate, to consider some of our forest trees from the point of view of their past history. The great majority of existing woods in Britain are the result of cultivation, and do not come within our purview in dealing with links with a remote past. Moreover, many of our familiar British trees, such as the common elm, the lime, the chestnuts, and others, have no claim to be classed as native, but were introduced in Roman or post-Roman days. In a few places in Inverness-shire and Perthshire patches of primæval forest survive; one of them is represented by the group of Scots pines growing in the Black Wood of Rannoch, in north-west Perthshire. Excavations in the Scotch peat-moors have revealed a succession of forests and wet moorland; in some places, *e.g.* in the Outer Hebrides, these buried forests occur in districts which are now almost treeless. As shown in sections recently published by Dr. Lewis, a cutting through 20 or 30 feet of Highland peat gives us an epitome of the changing physical and climatic conditions from the close of the Glacial period to the present day. The remains of Arctic willows, the crowberry (*Empetrum nigrum*), and other northern species immediately above the glacial deposits testify to the influence of the Ice age. The Arctic plants are succeeded by vegetation indicative of a milder climate; layers of bog-moss and stumps of pines point to an alternation of forests and wet moorland.

The spruce fir, one of our best known trees, affords an example of a species which was once a native, but is no longer found in a wild state. The cone of the spruce fir shown on the screen was recently recorded by Mr. and Mrs. Clement Reid, together with the seeds and fruits of many other plants, from deposits on the Norfolk and Suffolk coast which were formed shortly before the Glacial period. The plants of this pre-glacial flora indicate a temperate climate, but the nearer approach of more severe conditions is shown by the Arctic willow and dwarf birch which have been found in beds next above those containing the spruce fir.

The occurrence of the Glacial period is a fact of primary importance in relation to the antiquity of the present flora of this country. We know that Britain in comparatively recent times, speaking geologically, was in very much the same condition as Greenland is to-day. Over nearly the whole of Scotland, Ireland, Wales, and England, with the exception of a narrow strip in the south, there is clear evidence of ice action on a large scale and of the presence of ice-sheets and local glaciers. Under these Arctic conditions it can hardly be doubted that only a very small proportion of the vegetation could survive. Opinions differ as to the extent to which the Ice age proved fatal to the pre-glacial flora, but it is perhaps not too much to say that the present flora, as a whole, is of post-glacial date. The vegetation which grew in this part of Europe before the Glacial period reached its maximum must have been in great measure destroyed or driven south beyond the British area. The important point is that what we call our native flowering plants may safely be described in general terms as immigrants from other lands, aided, it may be, by land-connections across the North Sea and English Channel.

Special interest attaches to a few plants which occur in the west and south of Ireland, and to a less extent in Cornwall and elsewhere in the south-west of England. In Connemara in the west of Ireland, where hard frosts are unknown and winter snows rare, there are three kinds of heath, St. Dabeoc's heath (*Dabeocia polifolia*), the Mediterranean heath (*Erica mediterranea*), and *Erica Mackaii*, which are not found elsewhere in the British Isles or in the whole of northern Europe, but reappear in the Pyrenees. The London pride (*Saxifraga umbrosa*), another Pyrenean species, grows on the south and west coasts of Ireland from Waterford to Donegal. *Arbutus Unedo* (the strawberry tree), scattered through the Killarney woods, has a wide distribution in the Mediterranean region, its nearest continental station being in the south-west of France.

The presence of this small group of Mediterranean and Lusitanian plants in Ireland has long been a puzzle to naturalists. A few years ago I came across a solution to the problem of these southern plants in Ireland in a collection of stories entitled "A Child's Book of Saints." An Irish monk, Bresal, was sent to teach the brethren in a Spanish monastery the music of Irish choirs. In later years he longed for a sight of his native land, to which he at length returned; his thoughts reverted to Spain, and he saw once more the little white flowers of the Saxifrage and the strawberry tree from which he had gathered the orange-scarlet berries. With heavenly vision the prior of the Spanish monastery, seeing Bresal gazing at the flowers of Spain, commanded them to go and make real his dream. Thus, to gladden the heart of the monk, were these southern plants miraculously introduced into Ireland.

One view is that Arbutus and its companions are entitled to be regarded as a very old section of the British flora, survivals from a time, the so-called Tertiary period, when the climate was much milder than it is to-day. It is believed by some authorities that these plants migrated from Portugal to Ireland long before the Glacial period, and by means of a land-bridge, which afterwards sank below the waters of the Atlantic Ocean. This explanation is open to criticism; even granting the former existence of a land-connection, it is difficult to believe that the strawberry tree, which is restricted to one of the warmest districts in the British Isles, could have survived the rigours of the Glacial period. Moreover, as Mr. Clement

[1] Evening discourse delivered before the British Association at Portsmouth on September 4 by Prof. A. C. Seward, F.R.S.

Reid asks, why do we not also find in Ireland Portugal laurels and oaks, which are hardier than Arbutus? An alternative view is that Arbutus and its compatriots came to Ireland *after* the Glacial period, not by migration overland, but by natural means of dispersal, which would be favoured by the small size of their seeds as contrasted with the larger seeds of oaks and other southern plants, which never reached our shores.

The possibilities of plant dispersal by natural agencies have recently received a striking demonstration in the recolonisation of the island of Krakatau, in the Sunda Straits. In 1883 Krakatau, then covered with a dense tropical vegetation, was partially destroyed by a series of exceptionally violent volcanic explosions. It is believed that no vestige of life remained. In 1906, twenty-three years after the sterilisation of the island, 137 species of plants were collected, and the vegetation was in places so dense that a party of botanists penetrated with the greatest difficulty beyond the coastal belt. Some of the trees had reached a height of 50 feet. The nearest islands, except the small island of Sebesi, about twelve miles distant, are Java and Sumatra, separated from Krakatau by a stretch of water twenty-five miles in breadth. This new flora, introduced by ocean currents, by wind, and by the agency of birds, affords a useful object-lesson in regard to the efficiency of plant-dispersal without the aid of land-connections.

Before passing to the consideration of questions necessitating frequent reference to different periods of geological history, it is essential to direct attention to the sequence of chapters as revealed by the earth's crust. It is from the scanty records of plant life preserved in the sedimentary deposits of former ages that we obtain such evidence as we have in regard to the relative antiquity of different types. The crust of the earth, as Darwin wrote, "with its imbedded remains, must not be looked at as a well-filled museum, but as a poor collection made at hazard and at rare intervals."

The oldest rocks, largely composed of gneisses and other products of igneous action, throw no light on the nature of the organisms which existed in the earliest epochs of the earth's history. The complex structure of the oldest known animals and plants compels us to believe that they are the descendants of simpler forms of much greater antiquity. As the Cambridge professor of modern history has aptly said, "All the epochs of the Past are only a few of the front carriages, and probably the least wonderful, in the van of an interminable procession." The foundation-stones of the earth's crust have been so much folded and altered in the course of geological time that it is no wonder they have been searched in vain for records of primitive life. Passing higher up the series through the vast thickness of Cambrian, Ordovician, and Silurian strata, it is in the Devonian rocks of Ireland and elsewhere that we first discover the records of Palæozoic floras, and these bear a fairly close resemblance to the still richer floras of the succeeding Carboniferous epoch.

Turning, now, to the top of the geological series, the submerged forests round our coasts and the tree-stumps buried in peat form connecting links between existing plants and those of a prehistoric age. A little further down occur the Boulder Clay and other legacies from the Glacial period, and below these are the fragmentary relics of a pre-glacial vegetation. Further down the plants become less familiar and show a closer agreement with those of subtropical and tropical countries than with the recent vegetation of Britain. From the London Clay, a marine deposit, which underlies London and Portsmouth, and is exposed in the Isle of Wight, the Isle of Sheppey, and in other places, fossil seeds and fruits have been found practically identical with those of existing tropical species. One of the London Clay fruits may be mentioned as an especially interesting sample of the early Tertiary flora, namely, the genus Nipadites, so called because of the very close resemblance it bears to the fruits of the common tropical plant Nipa. *Nipa fruticans*, often described as a stemless palm, grows in the brackish estuaries of many tropical countries. The occurrence of fossil fruits of this type in Tertiary beds in England, Belgium, and France affords a striking instance of changes in the distribution of an ancient plant now restricted to warmer regions.

Below the Tertiary rocks we descend to the Chalk period, when a clear and comparatively deep sea covered the areas now occupied by chalk downs and cliffs. "During the Chalk period," as Huxley wrote, "not one of the present great physical features of the globe was in existence. Our great mountain ranges, Pyrenees, Alps, Himalayas, Andes, have all been upheaved since the Chalk was deposited." Below the Chalk in the Weald district of Kent and Sussex a rich Wealden flora has been discovered in sediments laid down in a shallow lake which occupied the south of England and extended across what is now the English Channel. The Wealden plant-beds have as yet furnished no satisfactory specimen of a flowering plant. It is one of the most interesting facts in the history of the vegetable kingdom that the highest class of plants which now overspreads almost the whole world did not come into prominence until after the close of the Wealden period. When, in the course of evolution, the flowering plant became a competitor in the struggle for existence, it spread with amazing rapidity.

The sandstones and shales in the Yorkshire cliffs and slightly older rocks on the Dorsetshire coast have supplied data which enable us to reconstruct in some measure the vegetation of that stage in the earth's history known as the Jurassic period. Below the Jurassic strata in some parts of the world, as in the south of Sweden, Germany, and elsewhere, from rocks of Rhætic age numerous fossil plants have been obtained. Descending further, the plant records from strata belonging to the early days of the Triassic period afford evidence of changes in the nature of the vegetation, which become more pronounced in the still older Permian and Carboniferous floras. It is, however, not my intention to deal with the vegetation of the coal forests and other Palæozoic floras; they are composed of plants for the most part much less closely related to existing types than those which I have selected as examples of links with the past.

Probably the human race made its entrance on to the world's stage at some time during the Tertiary period; but in Britain abundant evidence of man's presence is not met with until after the Glacial period. An additional illustration of the enormous antiquity of some of the plants to be described later is furnished by the absence of flowering plants in the rich floras below, or even including, those of Wealden age.

The widely distributed class of ferns supplies some notable instances of links with the past. It is not infrequently the case that plants which are now characterised by a restricted geographical range have a wide range in time, and, conversely, plants which are now more or less cosmopolitan may be of comparatively recent origin. Antiquity and restricted distribution often go together. The bracken fern, which we are apt to regard as essentially British, occurs also in Tasmania, in the Malay Peninsula, in British East Africa, in the Himalayas, and in many other countries; it is one of the most cosmopolitan of all living ferns. It would seem probable that this injurious species is one of the more modern members of its class. On the other hand, the family to which the royal fern (*Osmunda regalis*) belongs, though widely spread at the present day, has been traced into the Palæozoic era. The recent researches of Dr. Kidston and Prof. Gwynne Vaughan have demonstrated the existence in the Permian flora of Russia of ferns exhibiting a close relationship to existing members of the Osmunda family. The section shown on the screen was cut from a petrified fern stem of Permian age, which shows in its anatomical characters a remarkable resemblance to a stem of Osmunda. Some of the commonest fern leaves in the Jurassic rocks of Yorkshire and in many other parts of the world, both north and south of the equator, may be referred with a considerable degree of certainty to the Osmunda family, the relationship being indicated, not by mere external resemblance, but by the structure of the spore-capsules, and in a few cases by the occurrence of petrified stems. It is by no means improbable that the royal fern and other existing members of the family are entitled to the distinction of an ancestry which extends farther back into geological time than that of any other section of living ferns.

The next example of an old type of fern is one which is widely spread in the warmer regions of both the Old and New World. Gleichenia may, as a rule, be easily recognised by the regular forked branching of the fronds, as also by the structure of its spore-capsules and by the anatomy of its stem. Fragments of fronds hardly distinguishable from those of some surviving species have been found in Upper Jurassic rocks on the Sutherland coast and in Wealden strata on the Continent. In rocks of Wealden age near Brussels, pieces of stems have been discovered by Prof. Bommer sufficiently well preserved to be submitted to microscopic examination, and showing anatomical features exactly like those of the living species. The occurrence of numerous Gleichenia fronds in sedimentary rocks of Lower Cretaceous age near the edge of the Greenland ice-sheet on Disco Island, in lat. 70° N., points to climatic conditions very different from those which now prevail. This is one of many instances revealed by a study of ancient floras of remarkable changes in geographical distribution as in climate. Gleichenia, like many other plants which have long ceased to exist in Europe, was formerly a common northern genus, and may have had its origin in the far north, whence it was driven by adverse conditions to seek a home in more congenial surroundings.

The fern genus Matonia is now represented by two species in the Malay region; one of them was discovered a few years ago by Mr. Hose in a locality in Borneo, and has not been found elsewhere; the other and better known species, *Matonia pectinata*, occurs in the Malay Peninsula and on the mountains of Borneo. It is a fern with a creeping stem, from which are given off large spreading fronds borne on slender stalks reaching a height of 6 to 8 feet. It is recognised by the shape of the leaf and by other more important characters, notably by the structure of its stem, in which it differs from all other members of the fern class.

Its isolated position among the ferns and its limited geographical range are in themselves suggestive of antiquity. The records of the rocks abundantly confirm this inference. Fossil fern leaves closely resembling those of *Matonia pectinata* occur in strata of Rhætic age in Germany and in other parts of the world. In England this type has been found in the Jurassic beds on the Yorkshire coast and in Wealden strata not far from Hastings. From Wealden rocks in Belgium pieces of stems have been obtained exhibiting anatomical features identical with those of the recent species. Fronds practically identical with those of the Malayan fern are recorded from an Austrian locality from rocks higher in the Cretaceous series, but no satisfactory evidence is available of the persistence of the Matonia family in Europe or in the northern hemisphere during the latest phase of the Cretaceous or throughout the whole of the Tertiary period. The existing species of Matonia are the last survivors of a family which once flourished over a wide area in Europe and extended to the other side of the Atlantic. Exposed to unfavourable climatic conditions, and possibly affected by the revolution in the plant-world consequent on the appearance of the flowering plants, Matonia gradually retreated across the equator until this "living fossil" found a last retreat in Malaya, the home of not a few links with a remote past.

Brief reference may be made to another fern, the genus Dipteris, which grows in association with Matonia on Mt. Ophir and elsewhere in the Malay Peninsula. Dipteris is represented by more species and has a wider geographical range than Matonia; it occurs in northern India, central China, in New Caledonia, and other islands. The fronds are distinguished by their long, deeply cut segments, spreading from the top of a slender stalk. In the Rhætic plant-beds of northern and central Europe, North America, Tonkin, and elsewhere, numerous fossil leaves have been discovered which bear a close resemblance to existing species of Dipteris. Similar fronds have been found in the Jurassic rocks on the Yorkshire coast and in Sutherland. It is impossible to say with confidence how nearly these Jurassic ferns are related to the existing species, but there can be no reasonable doubt that Dipteris, like Matonia, is a fern which connects the present with a past too far off to be measured by ordinary standards of time.

The large class of plants known as the conifers—though the name is in certain cases a misnomer, as some members bear no cones—including the pines, larches, firs, and several other trees, has a very much longer past history than the flowering plants. In rocks of all ages down to the Upper Palæozoic strata the remains of leafy shoots, pieces of petrified wood, seeds, and cones are abundant fossils, but the difficulty is to piece together the *disjecta membra* and to determine the degree of relationship between the extinct and the living.

I will confine myself to two genera of conifers which are especially noteworthy as persistent types—plants, like the fern Matonia, which formerly played a much more conspicuous *rôle* in the world's vegetation than they do now. Everyone is familiar with the Californian trees known as Sequoia or Wellingtonia.

The redwood, *Sequoia sempervirens*, occupies a narrow belt of country, rarely more than twenty or thirty miles from the coast, 300 miles long from Monterey in the south to the frontiers of Oregon. The tapering trunk, rising to a height of more than 300 feet, gives off short horizontal branches thickly set with narrow leaves dispersed in two ranks, as in the yew. The female flowers have the form of oblong cones from three-quarters to one inch long, and each woody cone-scale bears several small seeds on its upper surface. The second and more familiar species, *S. gigantea*, the mammoth tree, which is commonly cultivated in this country, has an even more restricted range, being confined to groves on the western slopes of the Sierra Nevada between 3000 to 9000 feet above sea-level. This species is at once distinguished from the redwood by its stiff, sharply pointed and scale-like leaves, and by its rather larger cones.

In the British Museum there is a section of a mammoth tree which shows on its polished surface 1335 rings of growth. On the assumption that each ring marks a year's growth, the tree when felled in 1890 was 1335 years old, and when Charles the Great was crowned Emperor at Rome it had already flourished for more than 200 years. These two giant conifers, remarkable as being probably the tallest trees in the world, become even more impressive when we know something of their past. The investigation of the herbaria buried in the earth's crust reveals the occurrence of similar, and in some cases apparently identical, species in many parts of Europe and in American localities far from their present home. It has been demonstrated that the big trees of California are the survivors of a once vigorous family which formerly flourished in many parts of the Old World, but as the result of altered circumstances, changed physical conditions, or unequal competition with other types in the struggle for life, dwindled in numbers and narrowly escaped extinction.

At Bovey Tracey in Devonshire there is a basin-shaped depression in the granitic rocks of Dartmoor filled with clay, gravel, and sand—the flood-deposits of a Tertiary lake containing the waifs and strays of the vegetation from the surrounding hills. Among the commonest plants is one to which the late Oswald Heer gave the name *Sequoia Couttsiae*, and his reference of the specimens to Sequoia has recently been confirmed by the researches of Mr. and Mrs. Clement Reid. This Tertiary species is represented by slender twigs almost identical with those of *S. gigantea* and by well-preserved cone-scales and seeds. Moreover, it has been possible to examine microscopically the carbonised outer skin of the leaves, and to demonstrate its close agreement with that of the superficial tissue in the leaves of the Californian tree. With the Bovey Tracey Sequoia are associated fragments of Magnolia, Vitis, the swamp cypress of North America, as well as other types which have long ceased to exist in the British Isles. Twigs and cones identified as those of Sequoia are recorded from several continental districts from both Cretaceous and Tertiary strata. The genus occurs in abundance in Tertiary beds on Disco Island and in Spitsbergen. Dr. Nathorst has obtained specimens from the Arctic Ellesmere Land almost as perfect as herbarium specimens. Remains of Sequoia have been found also in Tertiary rocks on the banks of the Mackenzie River, in Alaska, Saghalien Island, Vancouver Island, and elsewhere.

One of the most remarkable instances of the preservation of trees of a bygone age is supplied by the volcanic strata of Lower Tertiary age exposed on the slopes of Amethyst Mountain, in the Yellowstone Park district. At different levels in the 2000 feet of strata as many as fifteen forests are represented by erect and prostrate trunks of petrified trees. The microscopical examination of some of these trees shows that they bear a close resemblance to *S. sempervirens*. In a photograph given to me by Dr. Knowlton, of Washington, one sees living conifers of other genera side by side with the lichen-covered and weathered trunks of the fossil Sequoia, contiguous but separated in time by millions of years. From Cretaceous rocks of South Nevada, not very far from the present home of Sequoia, petrified wood has been described possessing the anatomical characters of the mammoth tree. While there is little doubt that Sequoia formerly had its maximum distribution in the northern hemisphere, there is some evidence, though not conclusive, that the genus once existed in Madagascar and in New Zealand.

The Araucaria Family.

Another and even more venerable section of the conifers is represented by the Araucaria family, which includes two genera, Araucaria and Agathis. The best known species of Agathis, or Dammara as it is sometimes called, is the Kauri pine, probably the finest forest tree in New Zealand. The stems reach a height of 160 feet, terminating in tiers of spreading branches bearing thick and narrow leaves 2 to 3 inches long. The almost spherical cones consist of a central axis bearing overlapping, broadly triangular scales, each of which carries a single winged seed. Other species of Agathis occur in the Malay Archipelago, the Philippines, Queensland, and elsewhere. The genus Araucaria, with the exception of the familiar Monkey Puzzle (*Araucaria imbricata*) and a Brazilian species, is confined within the geographical area occupied by Agathis. In addition to the Monkey Puzzle, introduced into England in 1796 from Chile, the Norfolk Island pine (*A. excelsa*) is a commonly cultivated pot-plant in this country; it was introduced to Kew in 1793 by Sir Joseph Banks soon after its discovery by Captain Cook.

Before we consider the past history of the Araucaria family, a word must be added in regard to the characters which enable us to recognise Araucaria and Agathis in a fossil state. The wood of these two genera differs in certain minute structural features from that of other conifers; the examination of a radial longitudinal section of a branch of one of the Araucarias under a microscope shows on the walls of the elongated tubular elements of which the wood consists small polygonal areas technically known as bordered pits; these occur in one or more rows, and may be described as circles converted into polygons by mutual pressure. In pines and other conifers these bordered pits are circular or oval in form, and not, as a rule, contiguous. The foliage shoots of Araucaria, though fairly distinctive in the form and arrangement of the leaves, may be confused with branches of other genera, and are in themselves of secondary importance for diagnostic purposes. On the other hand, the seed-bearing scales of the large cones afford much more trustworthy means of identification; each scale bears a single seed either immersed in the scale or lying in the middle of its upper face. In other conifers two or more seeds occur on each scale. It is not possible as yet to give a definite answer to the question: How far into the past can we trace the direct ancestors of existing species of Araucaria and Agathis?

From Permian and Upper Carboniferous rocks foliage shoots have been obtained almost identical in form with those of the Norfolk Island pine, and there is other evidence of a more satisfactory kind pointing to the probable existence in Palæozoic floras of trees closely akin to Araucaria. Araucarian types are recorded from Triassic strata, but from rocks of Jurassic age Araucarian cones and seed-bearing seeds, together with wood and foliage shoots, have been found in greater abundance. Petrified wood practically identical with that of the living species is recorded from Lower Jurassic rocks at Whitby, and there is reason to believe that some of the Whitby jet owes its origin to Araucarian wood.

A good example of a cone agreeing closely in structure, as in size, with the cones of some species of Araucaria was described in 1866 by Mr. Carruthers from Jurassic rocks at Bruton, in Somersetshire. Cone-scales exhibiting the characteristic features of Araucaria have been found in the Middle Jurassic rocks of Yorkshire, in Jurassic rocks of north-east Scotland, Cape Colony, Australia, India, and in the eastern States of North America. In a collection of Jurassic plants obtained a few years ago by members of a Swedish Antarctic expedition in Graham's Land, Dr. Nathorst has recognised some seed-scales of the Araucarian type. As we ascend the geological series and pass into Cretaceous strata, evidence of the wide distribution of the Araucarieæ is still abundant. Araucarian wood has been discovered in Cretaceous rocks in Egypt, East Africa, Dakota, and elsewhere; and from beds of this age in New Jersey Prof. Jeffrey and Dr. Hollich have recently described several different types of fossils represented by petrified leafy shoots and cone-seeds, some of which are closely allied to Araucaria, while others are nearer to Agathis.

In Tertiary floras undoubted Araucarian species are less common; it is not improbable that some foliage shoots from the plant-beds of Bournemouth, described by Mr. Starkie Gardner as Araucaria, may belong to a species nearly related to the Norfolk Island pine. From the extreme south of South America Araucarian wood and branches have recently been recorded, and, at the other end of the world, Tertiary rocks on the west coast of Greenland have yielded fragments which, with some hesitation, may be classed as Araucarian.

One conclusion, which seems almost unavoidable, is that the species of Araucaria and Agathis which survive in South America and in the islands of the Pacific have in the course of successive ages wandered from the other end of the world. We can only speculate as to the causes which have contributed to the changes in the fortunes of the family; but one thing is certain, namely, that few existing plants are better entitled to veneration as survivors from the past than are the Monkey Puzzle and other species of Araucaria.

The Maiden-hair Tree.

In recent years the maiden-hair tree of China and Japan, introduced into Europe early in the eighteenth century, has become fairly well known in English gardens. There is probably no other existing tree with so strong a claim to be styled a "living fossil," to use one of Darwin's terms. In 1712 the traveller Kaempfer proposed for this plant the generic name Ginkgo, and Linnæus adopted this designation, adding the specific name *biloba* to denote the characteristic bisection of the wedge-shaped lamina of the leaf into two divergent segments. In 1777 the English botanist Sir J. E. Smith expressed his disapproval of what he called the uncouth name Ginkgo by substituting the title *Salisburia adiantifolia*; but the correct botanical name is *Ginkgo biloba*. In its pyramidal habit Ginkgo agrees generally with the larch and other conifers; its leaves, which are shed every year, are similar in form and venation to the large leaflets of some maiden-hair ferns. The seeds, borne on fairly long stalks, are enclosed in a thick green flesh, and in appearance resemble small plums. For many years Ginkgo has been recognised by botanists as an isolated and probably ancient type. It used to be placed near the yew among the conifers; but in 1896 a Japanese botanist, Hirase, made the important discovery that the male reproductive cells of the maiden-hair tree are characterised by the possession of innumerable cilia which enable them to swim in fluid like the male cells of ferns and many other plants. In the true conifers the male cells have entirely lost the power of independent movement. Without going into details, the important point is that Hirase's discovery confirmed suspicions based on other characters, that Ginkgo was not a true member of the conifers, and supplied a cogent reason for promoting it to a class of its own, the Ginkgoales.

Though some travellers in China have spoken of Ginkgo trees in a wild state, the balance of opinion is in favour of regarding the genus as represented at the present day solely by cultivated specimens. China was, no doubt, its last stronghold; in that country, as in Japan, it is regarded as a sacred tree, and planted in the groves of temples, and it would seem that the fact of its being held in veneration by the priests has saved it from extinction.

As in many other cases, so in regard to Ginkgo we cannot speak with certainty as to its first appearance in the world's vegetation. Leaves constructed on a similar plan have been found in Permian, Carboniferous, and Upper Devonian rocks in England, Germany, France, the Arctic regions, South Africa, Kashmir, the Ural Mountains, and elsewhere, but we still lack decisive evidence as to the systematic position of these plants.

It is, however, an undisputed fact that the maiden-hair tree is connected by a long line of ancestors with the earliest phase of the Mesozoic epoch. From many parts of the world large collections of fossil plants have been obtained from strata referred to the Rhætic period or to the upper divisions of the Triassic system. The vegetation in those far-off days, extending from Australia, Cape Colony, and South America to Tonkin, the south of Sweden and North America, was much more uniform in character than is the case with widely separated floras at the present day. One of the most widely spread plants in this vegetation is one known as Baiera, which possessed leaves differing only in the greater number and smaller breadth of their segments from those of the maiden-hair tree. In the later Jurassic rocks of Yorkshire true Ginkgo leaves, as well as those of Baiera, are fairly common, and a few fragments of flowers have also been found. Both genera are recorded from Jurassic rocks of Germany, France, Russia, Bornholm, and elsewhere in Europe; they occur abundantly in Siberia, and are represented in the Jurassic floras of Franz Josef Land, the east coast of Greenland, and Spitsbergen.

The abundance of fossil Ginkgo leaves and seeds in Jurassic strata in East Siberia has led to the suggestion that this region may have been a centre where the Gingkoales reached their maximum development in the Mesozoic period. The occurrence of fossil species in the Jurassic rocks of King Charles Land (78° N.) and in the New Siberian Islands (75° N.), in central China, Japan, Turkestan, California, South Africa, Australia, and Graham's Land, demonstrates the cosmopolitan nature of the group. During the Tertiary period Ginkgo flourished in North America, in Alaska, and in the Mackenzie River district, Greenland, Saghalien Island, and in several European regions. In the Island of Mull beautifully preserved leaves of Ginkgo, indistinguishable from those of the living tree, have been found in sediments deposited on the floor of a lake during a pause in the volcanic activity which in the early days of the Tertiary era produced the thick series of basaltic rocks to which is due the characteristic contour of the Inner Hebrides.

The recent cultivation in Britain of the maiden-hair tree is thus a reintroduction of a plant which formerly flourished in this part of Europe. Where and when this genus first appeared, and why a type once so vigorous has narrowly escaped extinction, are questions which we cannot answer with confidence; we are, however, certain that the maiden-hair tree links the present with a past inconceivably remote; it is a tree "sacred with many a mystery," antedating by millions of years the advent of man and far surpassing the flowering plants in antiquity.

As we search through the fragmentary records scattered through the sediments of former ages, we discover evidence of a shifting of the balance of power among different classes of plants. Plants now insignificant or few in number are found to be descendants of a long line of ancestors stretching back to remote antiquity. Others which flourished in a former period no longer survive. We can only speculate vaguely as to the cause of success or failure. As Darwin said, "We need not marvel at extinction; if we must marvel, let it be at our own presumption in imagining for a moment that we understand the many complex contingencies on which the existence of each species depends."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

GLASGOW.—Dr. J. D. Falconer, late principal officer of the Mineral Survey of Northern Nigeria, and formerly assistant to Prof. James Geikie, has been appointed to the lectureship in geography, vacated by Captain Lyons, F.R.S.

Mr. J. S. Dunkerley has been appointed a university lecturer in zoology, with special reference to protozoology. Dr. Carl H. Browning, hitherto lecturer in bacteriology, has been appointed lecturer in clinical pathology and director of the new clinical laboratory at the Western Infirmary. Dr. A. Maitland Ramsay has been appointed university lecturer in ophthalmology. Principal Sir Donald MacAlister, K.C.B., has been appointed a member of the executive committee of the Carnegie Trust for the Universities of Scotland in succession to Prof. William Stewart, resigned.

His Majesty in Council has approved a new Ordinance, whereby geography is added to the subjects which may be offered in the final examination for the B.Sc. degree.

LONDON.—An appeal has been issued, with the authority of the Senate, for funds to build the Francis Galton Laboratory at an estimated cost of 15,000*l.* As stated in an article in NATURE of March 16, Sir Francis Galton in his will expressed a hope that his bequest for the promotion of eugenics, amounting to about 45,000*l.*, would not be used for the provision of buildings, fittings, or library. The income is accordingly being used for the salaries of the professor (Karl Pearson, F.R.S.) and his staff. A site for the proposed laboratory has been allocated by the University at University College, and sketch plans, prepared by Prof. Simpson, are printed with the appeal showing adequate accommodation for lecture-room, museum, research laboratories for eugenics and biometry, together with a room for Galtoniana. The appeal directs attention to the importance of the work to be carried on in the laboratory in relation to future legislation dealing with social problems. "It is essential that the statistical facts on which such legislation may be based shall be analysed in a purely scientific manner by workers who can give time and energy to investigation, quite independently of any ulterior end or party bias." Already the laboratory, in spite of the difficulties due to inadequate accommodation, is carrying out on a considerable scale the founder's wish to "provide information, under appropriate restrictions, to private individuals and to public authorities." Contributions and promises of support will be gratefully received by Sir Edward Busk, chairman of the Galton Laboratory Committee, at the University.

SIX lectures on "The Causes and Economic Effects of Changes in the General Level of Prices" (illustrated from the history of the nineteenth century) are being delivered by Mr. W. T. Layton at University College (University of London) on Tuesdays at 5.30 p.m., the first having been given on October 10 The lectures are open to the public without fee or ticket.

A SPECIAL course of twelve lectures, dealing with illumination, will be delivered at Battersea Polytechnic during the coming session, the first six being delivered on Tuesday evenings, beginning on October 17, and the last six on Fridays, commencing January 12, 1912. The course will be open to students and all interested in the subject. The course will deal with all illuminants, including electric, gas, oil, and acetylene lighting, the effect of light on the eye and the hygienic aspects of illumination, the measurement of light and illumination, &c. Practical problems, such as the lighting of schools, streets, factories, &c., will also be treated. The lecturers will be Prof. J. T. Morris, Mr. J. G. Clark, Mr. E. Scott-Snell, Dr. W. J. Ettles, and Mr J. S. Dow.

ADDITIONAL buildings of the Royal Albert Memorial University College, Exeter, will be formally opened by the Lord-Lieutenant of Devon, the Earl Fortescue, on Friday, October 20. The buildings are the first instalment of an enlargement scheme which was approved by the governors in 1904. The steady development of the college work has necessitated periodical enlargement of the building accommodation. The last extension, in 1899, was formally opened by his Royal Highness the Duke of York (now King George V.), and the previous extension, in 1895, by the late Duke of Devonshire. The present addition has been erected on a site purchased at the rear of the main building of the Royal Albert Memorial at a cost of 8675*l.* for land and about 16,400*l.* for the building. This occupies only about half of the site acquired. The new buildings consist of two blocks, one for the University College and the other for the Day Training College.

THE opening lecture of the course of instruction on "Colloids" was given by Mr. E. Hatschek at the Sir John Cass Technical Institute on Friday, October 6, when the chair was taken by Dr. Rudolf Messel, president of the Society of Chemical Industry. Mr. Hatschek commenced his lecture by referring to the early work of Thomas Graham on colloids, and then dealt with the subsequent development of the subject as a borderland study between physics and chemistry. The characteristics of colloids were then examined, and an account given of laboratory products that have been prepared and of the large number of natural organic products which can be dissolved direct to form colloidal solutions such as starch, gelatine, agar, and the albumins. The importance of the subject in relation to industrial problems was next specified, reference being made to the tanning and dyeing industries, the photographic plate and paper industry, the fermentation industries, and the treatment of effluents and sewage. At the close of the lecture an experimental demonstration of the properties and methods of preparation of some colloidal solutions was given.

AMONG the scientific lectures arranged this term for advanced students, in connection with the University of London, we notice the following. A course of eight lectures on "Principles of Systematic Botany (Flowering Plants)" will be given by Dr. C. E. Moss, curator of the herbarium, University of Cambridge, in the botanical department, University College, on Thursdays, at 5 p.m., beginning on October 19. Informal meetings for the discussion of important contributions to current meteorological literature will be held at the Meteorological Office on alternate Mondays, at 5 p.m., beginning on October 23 and ending on March 25, 1912. Students who wish to attend are requested to communicate with the Reader at the Meteorological Office. A course of eight lectures on "The Manipulation and Theory of the Microscope" is being given by Mr. J. E. Barnard at King's College, on Wednesdays, at 5 p.m. A course of four lectures on "The History of Plague" will be given by Dr. C. Creighton at the University, South Kensington, on Fridays, October 20 and 27, and November 3 and 10, at 4 p.m. In all cases the lectures are addressed to advanced students of the University and to others interested in the subjects, and the admission is free, without ticket.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 2.—M. Armand Gautier in the chair.—The president announced the loss, by death, of Auguste Michel-Lévy and Joseph Louis Troost.—Émile **Picard**: Continuous solutions of integral equations of the third species.—Paul **Appell**: Functions of the fourth degree.—MM. **Esclangon** and **Courty**: Observations of the Quénisset comet and of the Brooks comet made with the large equatorial (38 cm.) of Bordeaux Observatory. Dates are given for September 26, 27, and 28. The Quénisset comet appeared as a circular nebulosity of 4′ to 5′ diameter, with a clear nucleus. The tail of the Brooks comet has been visible to the naked eye since September 17.—M. **Borrelly**: Observations of the Quénisset comet (1911*f*) made at the Marseilles Observatory with the comet finder. Positions of the comet are given for September 27 and 28. It appeared to be nearly circular, about 2′ diameter, with glimpses of a small nucleus of about the twelfth magnitude.—F. **Baldet** and F. **Quénisset**: Observation of the *gegenschein*. Attention is directed to the remarkable intensity now exhibited by the *gegenschein*, or zodiacal counterglow; it is pointed out that there is no satisfactory explanation for this phenomenon.—M. **Giacobini**: Observations of the Quénisset (1911*f*) and Beljawsky (1911*g*) comets made at the Observatory of Paris with the eastern tower equatorial of 40 cm. aperture. Positions are given for September 25, 27, and 30 for the Quénisset comet, which appears as a nebulosity of sensibly elliptical shape 45″ to 50″ in extent. The nucleus is well defined, and is of the eighth magnitude. The positions of the Beljawsky comet are given for September 30 and October 1. This comet is exceptionally bright, and has a nucleus of the third magnitude. The tail is about 15° long.—D. **Pompéiu**: The functions of complex variables.—Et. **Delassus**: Non-linear linkages.—G. **Reboul** and E. Grégoire **de Bollemont**: The transport of metallic particles under the action of heat. Sheets of copper or silver, near which is placed a sheet of porcelain or another metal, give deposits on the latter when heated. The amount of metal deposited is shown to depend to some extent upon the nature of the gas between the two plates.—Auguste **Marie** and L. **MacAuliffe**: The asymmetry of the Neanderthal, Cro-Magnon, and Spy No. 1 skulls. The application of the method proposed by M. Chervin to casts from these three skulls shows that all are asymmetrical. Three diagrams are given showing the deviations observed.—Paul **Marchal** and J. **Feytaud**: A parasite of the eggs of Cochylis and Eudemis.—E. **Roubaud**: New contribution to the biological study of Glossina. Some data on the biology of *G. morsitans* and *G. tachinoides* from the Nigerian Sudan.—L. **Boutan**: Some peculiarities relating to the mode of fixing of the crustacean *Gnathia halidaii*.

NEW SOUTH WALES.

Linnean Society, July 20.—Mr. W. W. Froggatt president, in the chair.—P. **Cameron**: Parasitic Hymenoptera from the Solomon Islands, collected by Mr. W. W. Froggatt. The parasitic Hymenoptera of the Solomon Islands are practically unknown. Mr. Froggatt's collection comprised representatives of seventeen undescribed species—Chalcididæ, 2; Braconidæ, 6; Evaniidæ, 1; and Ichneumonidæ, 8.—R. J. **Tillyard**: Further notes on some rare Australian Corduliinæ, with descriptions of new species. Seven new or rare Australian Corduliinæ are dealt with. Two new genera, Lathrocordulia and Hesperocordulia, are proposed, and four new species described. One of these is the beautiful yellow and black *Hemicordulia superba* from Pallal, New South Wales. From the same locality the female of *H. intermedia*, hitherto unknown, is also described. Two fine new species sent by Mr. G. F. Berthoud, of Waroona, West Australia, viz. *Lathrocordulia metallica* and *Hespercordulia berthoudi*, form the types of two new and interesting genera, which further bridge the gap between the two main groups of the subfamily. The latter species has a bright red and black coloration, unique amongst Corduliinæ. Lastly, a female of a magnificent new Macromia, *M. viridescens*, taken at Cape York, completes the list of new species.—R. J. **Tillyard**: The genus Cordulephya. This peculiar aberrant genus, originally monotypic and far removed from all existing forms, is enlarged by the addition of a new species, *C. montana*, from the Blue Mountains. The two species, *C. pygmaea*, Selys, and *C. montana*, are described and compared, and their full life-histories given. An interesting "theory of the two broods" is offered as a solution of the differentiation between the two, which occur at different seasons of the year.

August 30.—Mr. W. W. Froggatt, president, in the chair.—Dr. T. H. **Johnston** and Dr. J. Burton **Cleland**: The Hæmatozoa of Australian reptiles, No. 2.—A. M. **Lea**: Descriptions of new species of Australian Coleoptera, part ix. The paper contains notes on some of the types of King's and Macleay's Pselaphidæ; notes on *Xylopsocus bispinosus*, Macl., a species of Bostrychidæ, of which the male protects the female during her egg-laying period, and probably for some time afterwards; and descriptions of new species of Staphylinidæ (1), Pselaphidæ (23, including a new genus), Silphidæ (9), Byrrhidæ (1), Scarabæidæ (2), Lymexylonidæ (2), Ptinidæ (7), Tenebrionidæ (2, including a new genus, with one species of blind insects, the first blind beetle to be recorded from Queensland), and Erotyllidæ (1).—Dr. R. **Greig-Smith**: Contributions to a knowledge of soil fertility. No. 2. The determination of Rhizobia in the soil. From a perusal of the literature upon the fixation of nitrogen by the bacteria in the soil, one is led to believe that Azotobacter is the most active. It is not known how many of these organisms may be contained in 1 gram of soil; and, from Löhms's work, we imagine that the members of nitrogen-fixing bacteria are small. By making use of a special medium described in the paper, the author has found as many as three millions of nitrogen-fixing Rhizobia in 1 gram of agricultural soil. The foremost place in the work of nitrogen fixation should, therefore, be given to Rhizobium rather than to Azotobacter, until it is found that the latter is at least half as numerous as the former. The numbers of Rhizobia in the soil afford an indication of its comparative fertility.

CAPE TOWN.

Royal Society of South Africa, August 16.—Mr. S. S. Hough, F.R.S., president, in the chair.—L. **Péringuey**: A note on the Heidje Eibib, or stone mound of Namaqualand. The name Heidje Eibib is usually given to artificial mounds of stone occurring in certain places in Namaqualand and elsewhere, the formation of which is ascribed to the Hottentots, who whenever passing the spot add a stone to the cairn, taking great care, however, that in so doing their shadow is not projected on the mound. But so far there was nothing to prove that these cairns were really a kind of sepulture. Lately, however, one such mound was opened, and it was found that the accumulation of stones covered parts of a body; the skull is, to all appearances, that of a Bush. But the Rev. Mr. Kling informs the author that there are two kinds of Heidje Eibib. The one opened is known as Heidje Eibib Garedje, and would be the grave of a Bush witch doctor, erected by his people. But it is not yet proved that the Hottentot's Heidje Eibib is a grave.—E. **Nevill**: The secular acceleration of the orbital motion of the moon. The paper begins with a critical examination of the records of the principal ancient eclipses of the sun mentioned as being total, or very nearly total, by different Assyrian, Babylonian, Grecian, and Chinese records. The exact conditions of each eclipse have been calculated from the best modern theoretical data according to Hansen's method of computation. As a result, it is shown that with our present knowledge it is not possible by any system of data consistent with the modern observations of the sun and moon to bring all the principal eclipses recorded by ancient authorities as having been total into accord with the tables. The second portion of the paper assumes the existence of a secular acceleration in the motion of the earth around the sun, and proceeds to consider what might be the origin, and to what degree the existence of this cause will modify the motion of the different members of the solar system, and how far the deduced consequences are in harmony with observation. It is shown that the case of the terrestrial tidal effect due to the action of the sun and moon does not form a conservative system, and that the principle of conservation of angular momentum does not hold for any non-conservative system of forces. No other origin for a secular acceleration being apparent, the great difficulty in reconciling the consequences of such a secular acceleration with the known motion of the sun and moon render it preferable to look to one of the other permissible causes as a means of reconciling the existing theories of the sun and moon with the records of the ancient eclipses of the sun and moon.—A. **Theiler**: Some observations concerning the transmission of East Coast fever by ticks. In the experiments it has been proved:—(1) That brown tick imago which as larvæ had become infected with East Coast fever, and had transmitted the disease in their nymphal stage, were no longer infective for susceptible cattle. Four batches of ticks proved their infectivity in the nymphal stage on eight animals, but in their adult stage failed to transmit the disease to two susceptible animals. (2) Ticks belonging to the same batches which were feeding on two animals rendered immune to East Coast fever by inoculation, in the nymphal stage, did not transmit the disease in their adult stage to six animals, thus proving that the brown tick which has become infected in one stage cleans itself in the following stage by feeding on an immune or susceptible animal. (3) Ticks which became infected with East Coast fever in their larval stage, and passed their nymphal stage on a rabbit, did not prove to be infective in their adult stage for susceptible cattle. This conclusion bears out that given above (2), showing that a tick loses its infectivity the first time it feeds on an animal susceptible or immune to East Coast fever. (4) Clean or infective ticks feeding on an animal which has recovered from an attack of East Coast fever do not transmit the disease in their next stage. This conclusion is in support of experiments undertaken eight years ago (*vide* Annual Report of the Government Veterinary Bacteriologist, 1904–5). (5) It has been demonstrated that certain batches of ticks collected at the same time, and which fed under similar conditions, did not transmit the disease in their next stage, even when infected in great numbers and on numerous animals. Other batches of ticks reared in exactly the same way and under similar conditions only infected a few animals, whilst again other ticks proved infective in almost every instance, even when a minimum number were used. It is difficult to give an explanation of this fact, but it is quite likely that outside conditions have some influence. The ticks which did not transmit the disease were bred during the coldest time of the year.

DIARY OF SOCIETIES.

TUESDAY, OCTOBER 17.

FARADAY SOCIETY, at 8.—*Adjourned discussion*: The "Paragon" Electric Furnace and Recent Developments in Metallurgy: J. Härden.—Progress in the Electrometallurgy of Iron and Steel: Donald F. Campbell.—The Hering "Pinch Effect" Furnace: E. Kilburn Scott.

WEDNESDAY, OCTOBER 18.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Structural Details of *Coscinodiscus asteromphalus*: T. W. Butcher.—Abstract of Paper on the Wheat Plant: A. Flatters.—New British Enchytræids: Rev. Hilderic Friend.—Instantaneous Exposure in Photomicrography: Walter Bagshaw.

ENTOMOLOGICAL SOCIETY, at 8.

FRIDAY, OCTOBER 20.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—The Endurance of Metals; Experiments on Rotating Beams at University College, London: E. M. Eden, W. N. Rose, and F. L. Cunningham.

CONTENTS.