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THE BIRDS OF CELEBES.

The Birds of Celebes and the Neighbouring Islands. By A. B. Meyer and L. W. Wiglesworth. Two volumes. Pp. xxxiii, 392 and 590; with 45 plates and 7 maps. (Berlin: R. Friedlander und Sohn, 1898.)

FEW regions of the world approach in interest to the naturalist the wide Archipelago strung upon the equator, between the Asiatic and the Australian continents, both of which claim a share in the broken lands between which Wallace's Line rides the marches. Of all these islands none perhaps have attracted more attention than Celebes, notably on account of its strange configuration, but especially from its central position in the archipelago which has given a remarkable character to its fauna, the affinities of which have bandied it from one to the other of the two zoological realms between which it lies. To which of them it will finally appertain must still remain an open question till it has been more fully explored, botanically as well as zoologically. Towards the settling of this question, however, Dr. Meyer, the distinguished Director of the Royal Museum in Dresden, in collaboration with Mr. L. W. Wiglesworth, has made a notable contribution in the work under notice, wherein the ornithology of the Celebesian area (as the authors name the main island plus the neighbouring islet groups in its immediate vicinity) is discussed. Both authors have brought special qualifications to their task, for both have large experience as observers in the field, Dr. Meyer having several years' personal knowledge of the area in question. That every care has been taken by them in the preparation of this monograph is testified to by the six years of constant toil which the subject has exacted from them.

The systematic account of the individual species found in the area is prefaced by a valuable introduction of 130 pages, in which the authors give a short biographical note concerning the naturalists and collectors who have worked or written upon the birds of Celebes. This is followed by an account of the seasons and winds (illustrated by two coloured maps) in the East Indian Archipelago, in their relation to the dispersal and distribution of the birds. A section is next devoted to migration in the archipelago, with reference to which the authors remark that "during our studies it has become abundantly evident to us that ornithologists are not generally aware that migration goes on in the East Indies to the great extent it does." They enumerate fifty-four "of the more prominent migratory birds of Celebes," with tables which tend to "prove that each species has its own route or routes of migration." Some of these species come from Norway *viâ* Siberia, China and the Philippines to North Celebes, and go no further; others hold on their course to New Guinea, Australia and New Zealand; while yet others fly directly from Northern Asia and Japan to the Philippines, North Celebes or the Moluccas, hugging the coast of the Western Pacific. In their return journey the migrants do not appear "always to return in spring by the route pursued in autumn, often apparently being rare or absent in districts through which they pass in abundance in other seasons," while a few remain and probably breed in their winter quarters. As to the causes of migration, however, the authors afford us no new facts or suggestions tending to bring us nearer the solution of the "mystery of mysteries" of bird life.

A further section of the introduction is devoted to the subject of "variation or modification of structure and plumage" among the birds of Celebes, under the headings of individual and of geographical variation; seasonal changes; sexual differences, and changes depending upon age. Under the last heading the authors provide "some evidence drawn from Celebesian birds that modifications of shape . . . of feathers are caused by the ever-repeated action of mechanical attrition . . . and are ultimately transmitted to offspring," and they take as one of their examples the case of the racket tail feathers of *Prioniturus*. The two middle tail feathers of these birds "are prolonged much beyond the others, and in adult birds the over-reaching portion of these two rectrices is converted into a bare shaft tipped with a spatule of ordinary web." Drawings are given from specimens in the Dresden Museum showing that the feathers come in in the adult birds with the shafts bare, a character which must therefore be congenital and hereditary. According to the authors, the course of events must have been as follows:—the two middle tail feathers becoming (for no specified or known reason) a little longer than the rest, were by attrition on the twigs of trees, walls of their nesting-holes, &c., narrowed at the tips; the friction reacting on their roots resulted in still greater lengthening of the feathers; further attrition resulted in half-formed rackets [why?]; still further continued attrition and further lengthening of the feathers resulted in the "production of other stages up to the most advanced development of the present time"—"a process of ages, more and more advanced results being obtained in successive generations and transmitted by heredity." Their "arguments in proof that these rackets are the inherited effects of attrition" are shortly: (1) that such can easily be formed artificially by scraping; (2) where the shafts are not exposed to attrition they are not bare; (3) rackets do not occur on unexposed feathers sheltered from attrition; (4) rackets are present in birds having no affinity with one another over the most varied positions; (5) remains of the web are often to be found on the shaft of the racket; (6) there appears to be no other means for accounting for their origin—they are not sexual, not useful, and not "recognition markings"; (7) the Motmots which produce these racket tail feathers by biting, now produce incipient rackets hereditarily. These arguments (?) hardly carry conviction; but if the truth be that the rackets are the inherited effects of attrition, one asks why so few feathers specially exposed to attrition by twigs and sides of holes, &c., as the external rectrices and remiges of all birds, and specially the exterior *lengthened* feathers of wedge-shaped tails (*Dicrurus*), are neither bare nor racket-shaped nor incipiently so. One points also to the middle tail feathers of the male *Paradisea rubra*, which—judging their development by the progress of their moult, as the authors do—*begin* "rather *shorter than the rest of the tail*," then are "moderately lengthened and with webs narrowed in the middle," and finally end in a "black horny riband, bearing at its extremity a spatulate web" (Wallace). Why have the females of *Parotia sexpennis* no spatulate occipital plumes, and those of the spatulate or bare rachised-tailed Birds of Paradise no rackets, if the character is a non-sexual one? In the case of the Motmots, may not the narrowing of the web of the tail feathers be due to some physiological, pathological, or other cause, which attracts the bird's notice to the spot, causing it to peck at the feather and eventually bite away its webs; a habit which might become as fixed as the biting of the nails is from parent to children in many families. In the specimens which lived in the Zoological Gardens in London the central tail feathers came in with the webs on and were bitten off by the birds. The spatulate feathers would not arise, or would be lost, probably, if the Motmots left their tails alone. The very varied positions in which these singular plumes appear (altogether only in a few groups of birds), seem to indicate that it is not a question of attrition or excitation on objects with which the feathers come in contact, otherwise the occurrence of similar feathers would be far more common than it is, especially in the families to which the birds sporting such ornaments belong, since their habits, flight, and movements are similar. And if the rush of air through the feathers of the wing of certain pigeons can produce attenuation of their first primary, the same, or at least some, effect ought to be produced by the same cause, not only in many other pigeons, but also in hosts of other birds.

The final section of the introduction discusses the geographical distribution of the birds of the Celebesian area, and shows that it is inhabited by 393 species, and that fifteen genera and 108 species are peculiar to it. Each species is fully treated of in the systematic part of the work, as to its synonymy and diagnosis, with interesting and often lengthy accounts of its distribution and habits. Of these, seventy-seven are figured in forty-five plates by Herr Geisler, the artist of the Dresden Museum, who has, at the request of the authors, represented "the exact hue of the specimens painted, sometimes at the cost of the artistic effect and clearness of tint seen in the English productions." The work is also embellished by seven maps—two climatological, two topographical, and three devoted to geographical distribution.

As a result of their laborious investigations, the authors find that

"one-half of the peculiar birds of Celebes have their nearest affinities in the Oriental Region, and one-fifth only in the Australian Region; but the Australian forms seem to be, on the average, rather more strongly differentiated than the Oriental forms. . . . The origin of the Celebesian avi-fauna is principally an Asiatic one, but Celebes, as a whole or as a group of islands, was separated early from the Continent, or never was intimately connected with it. . . . The special faunas of Celebes, however, . . . are far from worked out. . . . The future, therefore, only can decide whether the ornithological facts as at present known teach us correctly that Celebes belongs to the Oriental Region and not to the Australian . . ."

The authors are to be congratulated upon the production of one of the best and most exhaustive ornithological monographs of a special region that have for a long time appeared either in England or on the Continent.

PUMPING IN MINES.

Mine Drainage; being a Complete Practical Treatise on Direct-Acting Underground Steam Pumping Machinery. By Stephen Michell. Second edition. Pp. xviii + 369. (London: Crosby Lockwood and Son, 1899.)

As a somewhat heterogeneous collection of statistics, drawings and descriptions of pumping machinery, the work before us probably stands unrivalled in our own or any other language. It is profusely illustrated by means of excellent phototypes and woodcuts of pumping engines, as well as the details of their valves and valve gear, and contains minute verbal descriptions of their construction and mode of action. According to the author, most of the drawings have been supplied by the engine-makers, a fact with which no fault can be found, since there is no better source from which illustrations for a work like this can be obtained. But when we come to a consideration of the verbal descriptions the matter assumes a different aspect. Except in those cases in which an author feels himself bound to explain the views or original work of another author with precision, so as to avoid the possibility of misconstruction, descriptions quoted verbatim are out of place. In describing appliances with which he is, or ought to be, familiar, he should do so in his own words and from his own point of view, and at the same time give the reader the benefit of his opinions and criticism. If he quotes page after page from trade catalogues as our author does, not omitting even letters of commendation from customers, he abdicates his claim to the position of an author and becomes a simple compiler.

The work before us partakes far too much of this character, being to a large extent a compilation of the contents of catalogues; and as this is a class of information that is liable to vary with the issue of each new catalogue, and can be always obtained post free, it is a pity to swell the bulk of a volume by inserting it without measure.

The first twenty-two pages of the book contain introductory matter, including a few definitions and a history of the Worthington and other pumps; then follow four pages filled with the names of pumps and their makers, and thereafter the subject-matter is proceeded with. Hydraulic and electric pumps, together with four and a half pages of "Hydraulic and other memoranda," are, for no apparent reason, relegated to an appendix; and the volume closes with a good index.

In linking up the subjects and in venturing to express his own opinions, the author is not always equally happy in his remarks. For instance:—

"Height is essential to effectiveness in an air-vessel, mere lateral extension of volume adding little to its value" (p. 72)

"The pump valves act a most important part in the action of the pump. Indeed, their function is a most important one, and they may fitly be described as the 'lungs' of the pump" (p. 82).

"A speed of 100 feet per minute is quite sufficient for small steam pumps if an excessive resistance in the rising main is to be avoided" (p. 94).

Apart from the resistance due to the head, which is the same whether the pump is large or small, a pump encounters no other resistance in the *rising main* or discharge pipe, except that due to the friction of the ascending water. The amount of that resistance is a function of the velocity of flow, the area in cross-section, and the length of the discharge pipe, and is in no other way related to the size of the pump.

"The Kaselowsky system is similar to that of Messrs. West and Darlington, originated many years ago, and developed in the last dozen years in the Scotch collieries by Mr. Moore. The chief features in which it differs therefrom are the use of accumulator pressure and a very long stroke, admitting of considerable reduction in the dimensions of the underground engine" (p. 340).

Just before summing up in this way, our author has filled two and a half pages with a description of Kaselowsky's system, furnished by the Berliner Maschinenbau Actien-Gesellshaft, which he says "may be comprehensible."

Moore and Kaselowsky both transmit power by means of a forcing pump actuated by steam at the surface through two pipes filled with water to a pumping engine situate at the point in the mine from which water is to be raised. In Moore's pump, the water in each pipe moves first in one direction, and then in the opposite direction, acting the part of a rigid rod in its downward stroke, and the pumping engine in the mine oscillates in exact synchrony with the water in the pipes and with the forcing pump at the surface. Thus, if there were no leakage of motor water, each pipe would always remain filled with the same water that was originally put into it. Neither the forcing pump at the surface nor the pumping engine in the mine requires to have any distributing valves. The principal objection to this pump is that the pipes being subject to variations of pressure, expand and contract alternately, so that part of the stroke of the forcing pump, and consequently part of the work expended in driving it, is lost.

In Kaselowsky's pump, on the other hand, the motor water flows in a closed circuit, descending in one of the pipes and ascending in the other. The excess of pressure in the former over that in the latter is created by the forcing pump on the surface, and is expended in working the pumping engine in the mine. Both the forcing pump and the pumping engine are necessarily provided with distributing valves.

The pumping engine in the mine consists of two complete engines and pumps fixed side by side on the same bed plate, each of which actuates the distributing valves of the other in exactly the same way as this is done in a Worthington pumping engine. The accumulators to which our author refers are three in number. Their purpose is to prevent the occurrence of shocks in the motor water when the distributing valves open and close. The motor water, travelling from the forcing pump towards the pumping engine, passes under the plunger of the first accumulator just after it leaves the forcing pump at the surface, under that of the second just before it enters the distributing valve chest of the pumping engine in the mine, and under that of the third just after it leaves the same valve chest. They act exactly the same part towards the motor water as an air-vessel does towards the water discharged by a pump.

The difference between Moore's pump and Kaselowsky's is therefore a very wide one, and does not consist in "the use of accumulator pressure and a very long stroke," as we are so confidently informed.

In the hydraulic and other memoranda we find:

"Dia. of circle or cylinder + ·7854 = area."

This must certainly be an oversight.

The rules for finding quantities are very arbitrary, as the two following examples will show, and no explanation is offered as to how they have been concocted.

Thus:—

"Square of dia. in feet × five times the depth in feet = gallons."

"Square of dia. in inches = lbs. of water for 3 feet long ÷ 10 = gallons."

Although the book is called "A Complete Practical Treatise," there seems to be no good reason why the hydraulic and other memoranda should have been pitched upon such a low level as to appeal only to the capacity of those who can do little more than read or write. The School Boards and the Science and Art Department, now Board of Education, have for a number of years past been training many boys and men who are destined to irresistibly supplant the rule-of-thumb class for whom such rules were originally framed. The least of these would scorn to have a set of hard and fast rules thrust upon him without some kind of explanation, and no writer of the present day can afford to ignore this fact if he expects his work to be appreciated and to have a permanent value.

Mr. Michell's book is altogether too voluminous. In the first paragraph of his preface he strikes the key-note that should have been his guide in writing it, namely:—"Many of the engines in use when the work was first published have, in the severe ordeal of underground work, maintained their position as useful and effective pumping agents; others have failed, and are now only a name in the chronicle of mine pumps."

Thus, judging by the past, we may be quite sure that many more of those now in use will likewise disappear from the scene. If, instead of describing as many pumps now in use as he could find space for, our author had instituted careful inquiries to find out the most economical and trustworthy amongst them, if he had confined his attention solely to these, condensed his book to about one-quarter of its present size, and embodied a few leading formulæ in their proper places in the text for the use of the student and the educated man who is now, and is also yet to come, he would have produced a more interesting, readable and useful work than the one now before us.

We differ entirely from the views expressed by him to the effect that "In collieries with plenty of refuse coal and slack of no commercial value, much of it, perhaps, worth only a shilling or two per ton, a small initial outlay rather than economy in working, and a plant that occupies little space in the pit . . ." can ever be a consideration of such great importance in the eyes of a properly educated colliery manager as to determine him to adopt an uneconomical pump because of its cheapness in first cost. Such a man would foresee that additional boiler-power and additional labour for stoking the boilers would be required to supply steam to the wasteful pump.

He would therefore spend an additional sum on the pump itself rather than on the purchase of boilers and in stoking, and he might even be sufficiently far-seeing to capitalise the value of the coal he would save, and spend part of that amount also upon the pump.

In conclusion, the opinions expressed by our author to the effect that a pump placed in a chamber underground is for that reason necessarily neglected, and subjected to rough and unskilful treatment, that it cannot be so economical as an engine working on the surface, that steam pipes in the shaft heat the workings, and so on, all tend to betray a want of knowledge of the practice of educated and observant engineers and managers of the present day. They sound rather like an echo from the uninstructed past, or a dirge of the days that are now passing rapidly away. W. GALLOWAY.

THE PALAEONTOLOGY OF THE INVERTEBRATA.

Text-Book of Palaeontology. By Karl A. von Zittel. Translated and edited by Charles R. Eastman, Ph.D. Vol. i. Pp. viii+706; with 1476 woodcuts. (London: Macmillan and Co., Ltd., 1900.)

ENGLISH-SPEAKING geologists and palæontologists have awaited with eagerness the long promised translation of Prof. K. A. von Zittel's well-known "Grundzüge der Palaeontologie" which appeared early in 1895. At last we have received the first volume, which completes half the work, namely, to the end of the Invertebrata. It proves, however, to be much more than a translation of the German original. It is illustrated by the same beautiful woodcuts, with few additions; it is also similar in general plan; but most of the chapters have been entirely rearranged and rewritten, to express the views of the various American and English authors who have co-operated with Dr. Eastman. It is, therefore, virtually a new work, and the scheme of classification adopted is very different from that accepted by the eminent Professor of the University of Munich.

The only part of the "Grundzüge" which remains almost unchanged in the present translation comprises the admirable introductory chapter and the account of the sub-kingdoms Protozoa and Cœlenterata. Here the student will find Prof. von Zittel's own summary of his important researches on the structure and classification of the fossil sponges, which it is well to have left untouched. Changes begin with the Echinodermata, and attain their maximum in the Cephalopod Mollusca, becoming less noteworthy again in the Arthropoda, which conclude the volume.

Of the Echinodermata, the Crinoidea and Blastoidea were revised by the late Charles Wachsmuth. He added much new matter, and described and classified the crinoids in accordance with Wachsmuth and Springer's "Monograph on the Crinoidea Camerata of North America," which is here said to be "as yet unpublished," but really appeared in 1897. The sections on Asterozoa and Echinozoa have been extended, and in some respects much improved, by Mr. Percy Sladen, who has completely rearranged the Euechinoidea in accordance with the researches of the late Martin Duncan. The short description of the Vermes has been revised and slightly enlarged by Dr. G. J. Hinde. The chapter on Bryozoa is no longer that of Prof. von Zittel, but the work of Mr. E. O. Ulrich, who has added many new figures. It is not quite up to date, there being no references to Dr. Gregory's "British Museum Catalogue" or his memoir on early Tertiary Bryozoa, published by the Zoological Society. The Brachiopoda, revised and partly rewritten by Mr. Charles Schuchert, are arranged according to Beecher's classification, which is described in von Zittel's original as "one-sided," being based only on embryology. The rearrangement of the Mollusca has been undertaken by Messrs. Dall, Pilsbry and Hyatt, who deal respectively with the Pelecypoda, Gastropoda and Cephalopoda. Here it is difficult to recognise any of the original "Grundzüge" except the figures. In the description of the Arthropoda, Prof. Charles E. Beecher has added much important new matter to the section on Trilobita, which students will be glad to have. The treatment of the higher Crustacea and Merostomata is also much changed by the revision of Profs. Clarke and Kingsley; but the Arachnida, Myriopoda and Insecta, edited by Mr. Scudder, remain almost as in the original German work.

With so many collaborators, it has naturally been impossible for Dr. Eastman to obtain uniformity of style throughout the volume; and the judgment which teachers and original workers will pass upon it depends largely on the section which they happen to consult. On the whole, we are disposed to prefer the original volume in the form in which it was issued by the distinguished teacher who prepared it. With all due deference to the eminent specialists who have devoted so much labour to the translation and revision, we cannot refrain from expressing our opinion that they have converted an admirable student's manual into little more than an index to certain technical memoirs, which are as yet by no means accepted classics in palæontology. As Prof. von Zittel himself remarks in his preface, many of these memoirs are founded on certain embryological and phylogenetic considerations, which may soon prove to be baseless assumptions; while the old methods of comparative anatomy are often almost abandoned in favour of some one-sided hypothesis. We would also note that a large proportion of the generic names adopted are quite unknown in the original works on geology and palæontology which the average student will have to consult at the beginning of his career. In short, if the translators and revisers had devoted more attention to the correction of errors or the incorporation of new facts, and displayed less eagerness to infuse their own personal idiosyncrasies into the work, they would have done much more valuable service than they have actually accomplished.

The subject is too technical to enter into detailed criticism, and it must suffice merely to allude to three points in illustration of the difficulties which are placed in the way of the student.

One of the first fossils which every student must learn to know is the brachiopod *Terebratula*. Accordingly, Prof. von Zittel, in his "Grundzüge," gives a concise description of this shell as ordinarily understood in standard literature. Mr. Schuchert's translation, on the other hand, has :—"*Terebratula*, Klein, 1753 (Fig. 551). Genus not well known. Mesozoic or Tertiary." He merely gives a list of ill-defined generic names of no value whatever, except as an index to certain special memoirs which he happens to approve.

In the Mollusca Pelecypoda, Dr. Dall must have devoted great labour to his exhaustive revision ; but, from the student's point of view, it would have been much better if he had bestowed it on the correction of mistakes. In the description of *Pseudomonotis*, for example, "left valve" is copied from the original German, although even the accompanying figure must have shown the translator that it was a mistake for "right valve."

Finally, every student must know something of the common *Nautilus*. If he looks at Prof. Hyatt's description (p. 526), he will learn that it is a recent genus, and may perhaps range backwards to the Tertiary ; but if he turns to Figs. 1075 and 1076, he will read that species of the genus occur in the Middle Lias and the Tithonian. Which of these two contradictory statements does Prof. Hyatt intend the unfortunate student to accept ? We presume he intended to re-name the illustrations *Cenoceras*, and, like Dr. Dall, was too much occupied with the greater rearrangements to take note of the minute points on which the real value of a text-book depends. In fact, not only in this instance, but throughout Prof. Hyatt's section on Cephalopoda, the student will find hopeless confusion and receive practically no aid in plodding through the current literature of geology and palæontology. Nearly a hundred new generic names, introduced without definition, add in no small degree to the difficulties.

While, however, the elementary student, for whom the "Grundzüge" was written, will meet with disappointment when he attempts to use its English counterpart, the more advanced student engaged in original research will welcome the handsome volume which Dr. Eastman has produced. It is a valuable work of reference, which ought to find a place in every geological and biological library. We hope it will soon be followed by the second volume, containing the Vertebrata, which will make the English "Zittel" the most exhaustive and valuable treatise on palæontology in our language.

INADEQUACY OF THE CELL-THEORY.

Les Êtres Vivants. Organisation—Evolution. By Paul Busquet. Pp. 181 ; 141 figures. (Paris : Carré and Naud, 1899.)

WHAT the particular secret of this volume is, we have been unable to discover, except that it is intended as an argument for a franker recognition of the unity of the organism, and as an argument against the view which regards the multicellular creature as a "cell-state" or as a colony. To discuss these difficult matters profitably requires great competence, and we do not think that this is shown by the author, who, for instance, cites the old report that the ectoderm of a Hydra turned inside out becomes endoderm, and so on, and uses this as an argument against the original distinctiveness of the two germinal layers. Furthermore, while an attack on a position often means progress, one must master the previous moves, and we see no evidence that Dr. Busquet has done so. Has he seriously considered, for instance, Whitman's notable essay on "The Inadequacy of the Cell-Theory of Development"?

A pleasing feature of the book is the author's grateful tribute to his master, Prof. Kunstler, whose views he expounds and elaborates. Thus he begins with a defence of Kunstler's conclusion that protoplasm is composed of series of minute elements, more or less globular, either placed in apposition or separated by fluid. This alveolar or "spherular" structure of protoplasm was described by Kunstler in 1881, and has been familiarised by the researches of Bütschli (not Butschli, as the author persistently calls him, just as he calls Kölliker—Kolliker, which is absurd). We do not notice any mention of Flemming, though his lifelong observations on reticular structure, and his criticism of the demonstrations of alveolar structure, must be taken account of if one wishes to be treated seriously in discussing such matters.

The author points out that just as Dutrochet (1824) and Turpin (1826) may be said to have priority over Schwann and Schleiden in formulating the "Cell-Theory," so Kunstler must be credited with priority over Sedgwick, Whitman and Delage in demonstrating its inadequacy. For Kunstler maintained long ago that the cell is no primitive morphological unit, but an acquired mode of organisation, and that the cellular structure of the Metazoa is a secondary result adaptive to functional convenience. The frequent vagueness of cell-limits, the abundant illustrations of inter-cellular bridges, and the occurrence of indisputable syncytia are forcibly indicated by the author.

It is argued that to think of a Metazoon as derivable from a colony of Protozoa is misleading ; and that although there are some true colonies among Metazoa, *e.g.* in Cœlenterates and Tunicates, the colonial or polyzoic hypothesis, especially elaborated by Perrier, is a specious fallacy. We are asked to choose between two alternatives—the Metazoa are colonies of individualities of a lower order, or they are individualised irreducible unities. But it is not made plain why we may not suppose that the ancestral forms of various stocks passed through an imperfectly integrated colonial or polyzoic stage.

The author takes a survey of the animal kingdom, and seeks to substantiate a number of general conclusions, which we shall try to summarise. Living matter shows "a general and universal tendency to proliferation or repetition of similar parts." "These phenomena of repetition appear at first in the adult, where they constitute an acquired character ; in the embryo they are but the reproduction more or less modified, by coenogeny, of what exists in the perfect individual." But in certain circumstances the repeated parts may coalesce, exhibiting a secondary and acquired simplification, and bringing about a recondensation of the organism, preparatory to a recommencement of the evolutionary process on some new line. Types do not arise by a slow and direct transformation of pre-existing forms, but each is a new genesis. "The law of the formation of new types is a fragmentation of the tissue of more primitive organisms, and the arrangement of these new formations in new groups." "Neither selection nor adaptation can explain the specific peculiarities (particularités) of the structure of organisms, which are due to new spontaneous productions."

Thus the reader is insidiously led from harmless admissions as to the structure of protoplasm to grave heresies in regard to the efficacy of natural selection; but if he is convinced, we confess our inability to understand how the trick is done. We think that the sound part of the book may be summed up in a sentence of E.B. Wilson's: "Broadly viewed, therefore, the life of the multicellular organism is to be conceived as a whole; and the apparent composite character, which it may exhibit, is owing to a secondary distribution of its energies among local centres of action." J. A. T.

OUR BOOK SHELF.

Notions de Minéralogie. Par A. F. Renard et F. Stöber. Ier. fascicule. Pp. iv + 189; 398 figures. (Ghent: Ad. Hoste, 1900.)

A TEXT-BOOK of mineralogy, written by the Abbé Renard, with the co-operation of his assistant, F. Stöber, who has published important mineralogical papers, excites high expectations; and, in spite of its modest title, this work is really a text-book. The present volume contains only the introductory portion, dealing with the geometrical, physical and chemical properties of minerals. A second part is promised, which will contain the description of various species and a notice of those found in Belgium.

The excellent historical survey with which the book opens is modelled upon Fletcher's well-known "Introduction to the Study of Minerals"; it is only brought down to the year 1833. In the following section (geometrical crystallography) some of the principal types of crystals, and their planes of symmetry, are indicated by projections of the "elementary spaces" (the systematic triangles of Maskelyne) similar to those used by Liebisch in his "Grundriss der Krystallographie"; axes of symmetry are not employed, but the familiar conception of hemihedrism is retained; and the facts are stated in a manner which involves no special mathematical knowledge. Indices are used throughout. The subject of twinning is briefly treated, and only by reference to twin planes. In the optical section use is made of the wave-surface and the ellipsoid of optical elasticity.

Since out of 189 pages eighty-eight are devoted to the geometry, and fifty-seven to the physics, of crystals, the chemical section is very brief, but considerable attention is, as might be expected, devoted to microchemical analysis, and also to crystal etching.

The reader will not expect to find much that is novel; neither will this book give him an insight into modern theoretical aspects of the subject; but he will find, what is more important, a very lucid statement of the essential facts, and a clear description of the practical methods in use by mineralogists; to illustrate this, special attention may be called to the paragraph on the angle of minimum deviation on p. 116, and to the interpretation of interference figures by the diagrams on pp. 138–9.

It must not be imagined from what has been said that the book ignores new advances in the science; there is, for example, a paragraph on the use of X-rays.

The figures are adequate, but not very well printed.

When the second part appears, we shall expect to find that it completes a very readable and useful student's handbook. H. A. M.

Muret-Sander's Encyclopaedic English-German and German-English Dictionary. Pp. xlviii + 1733. (London: H. Grevel and Co., 1900.)

BEFORE buying a dictionary of words of a foreign language the purchaser has to make up his or her mind as to what *kind* of a dictionary is required. There are, for instance, dictionaries which can easily be placed in the waistcoat pocket: these necessarily contain a very restricted number of words. From this they gradually increase in size, weight, and quantity of information given, until they assume such proportions that they are best kept in one place and referred to there, as their bulk renders them somewhat inconvenient to move.

The volume before us, which is described as an abridged edition, may be said to be verging on the larger size of dictionaries, as its dimensions are 11 × 8 × 3 inches, and it contains nearly 1800 pages.

The plan and arrangement of the work are uniform with the well-known French-German dictionary of Sachs-Villatte, and the pronunciation adopted is based on the phonetic system employed in the method of Toussaint-Langenscheidt.

The volume should find special favour with students of science, for, although it is in no sense technical, there is a sufficient sprinkling of scientific terms throughout its pages which should render it most useful to this large class of readers. To find out the extent of the insertion of technical terms, we have chosen at random some chemical terms such as ozone, hydroxide, vanadium, fractionation, nitrate, and find that all except one are included. Repeating the same for physical terms, we find ampere, watt, electrolysis (absent, but electrolyse inserted), galvanism, achromatic, all but one mentioned.

Some readers may dislike the use of the German type when German words are printed, since most of the German scientific publications are now printed in Roman type; any one, on the other hand, familiar with the German language, will probably prefer the usual German letters. In addition to being clearly printed, the volume is strongly bound, and is issued at the moderate price of fourteen shillings.

Die Elemente der Entwickelungslehre des Menschen und der Wirbelthiere. By O. Hertwig. Pp. vi + 406; 332 figures. (Jena: Gustav Fischer, 1900.)

THIS work is a condensation of the sixth edition of Hertwig's well-known "Lehrbuch," brought out in a form more suited to the needs of beginners and students, especially of medicine. It is intended "to serve as an introduction to the field of embryological science, and to put forward only its leading facts in a shorter form." Hence the discussion of controversial problems is omitted, as well as historical reviews or references to literature, for which the more advanced student must consult the larger work. Each chapter concludes with a "repetitorium," by which is meant a numbered series of categorical statements, summing up briefly the results obtained in the foregoing chapter. There are numerous illustrations, the pick of those in the "Lehrbuch." The book is doubtless one which will be very useful to the German student, but unless it is translated, it may be doubted if it will have a very large sale in this country, since the English student of the class for which it is intended is not able, as a rule, to read easily books in a foreign tongue, while those who take their science enough in earnest to acquire this faculty, will probably purchase the larger work. For the teacher, however, the book offers a brief and convenient summary, very handy for reference. E. A. M.

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.*]

Recent Exploration in the Upper Air and its Bearing on the Theory of Cyclones.

ABOUT ten years ago there was an interesting discussion in regard to the theory of cyclones, by such leaders in meteorology as Ferrel, Blanford, Hann and Davis (see NATURE, vol. xliii. p. 82 and p. 470). Since then, considerable new material has been accumulated by research in the free air with kites and balloons, and it seems appropriate to consider its bearing on current theories.

In America the work with kites, by Mr. Rotch, has resulted in the discovery of the following facts:—

(1) The atmosphere is separated by sharply marked inverted vertical gradients of temperature into superposed strata, each stratum potentially warmer than the one beneath. By potentially warmer is meant that if any stratum were brought down, it would be heated by compression and become warmer than the stratum it replaced. There are usually two, and sometimes three, strata between the ground and the altitude of 3000 metres. The boundaries between these strata are regions of sharp contrast in a vertical direction of temperature, of humidity (both absolute and relative), and sometimes of wind direction. These boundaries are also regions of maxima in wind velocity, and the regions where clouds are chiefly found.

(2) In the changes of condition of the atmosphere from day to day, the minima of temperature and humidity occur simultaneously at all levels, except that in a superficial stratum within about 300 metres of the ground, the minimum sometimes occurs later as a result of surface cooling.

(3) The air column up to 3000 metres above barometric minima at sea-level averages about 10° F. warmer than the air column up to 3000 metres above barometric maxima at sea-level.

(4) All the conditions which characterise the surface cyclone and anticyclone, such as the circulation of the wind around a central area, the clouds and the rainfall, usually do not exceed the height of 3000 metres. Above that height there is an entirely different distribution of pressure and wind circulation from that observed at the earth's surface.

(5) In the areas of low pressure in the upper atmosphere the air is cold, extremely dry and clear. In the areas of high pressure in the upper atmosphere the air is warm and frequently moist.

In kite-flights made on November 24 and 25, 1898, at Blue Hill, there were evidences of three distinct wind circulations. The surface cyclone did not exceed 800 metres (or half a mile) in thickness, and above this was a warm-centre cyclone with dense clouds and precipitation about 2000 metres in thickness. At the height of 3000 metres (or about two miles) the wind, on November 24, was found blowing from the south and circulating around an area of low pressure with a cold, dry central area; while at the same time at the surface of the earth the wind was from the north and circulating around a warm-centre surface cyclone. (See *Bulletins* No. 1, 1899, and No. 1, 1900, of the Blue Hill Meteorological Observatory).

In France, M. Teisserenc de Bort has made a study of the air by means of *ballons sondes* launched at frequent intervals from Trappes. His results show that the annual period in the temperature of the air is well marked up to and exceeding ten kilometres. They show further that during the irregular warm and cold periods in the atmosphere the isotherms rise and fall simultaneously at all heights up to at least ten kilometres. In other words, the warm and cold waves aloft occur simultaneously with those near the surface (see *Comptes rendus*, August 21, 1899).

Dr. Hergesell, of Strassburg, has discussed the records of the international balloon ascents, and derived a number of important conclusions. Among these are: (1) In the highest strata of the atmosphere attainable by balloons the temperature change from day to day, and the temperature gradients in a horizontal direction, are very marked. Within distances of only a few hundred kilometres are sometimes temperatures at the same level which differ as much from each other as 30°–40° C. (2) Such temperature distributions as that which brought frosts in Europe on May 13, 1897, are not local and confined to the earth's surface, but meteorological phenomena of great extent and importance which embrace the entire atmosphere above Europe. (3) By computing and plotting the air-pressure for the heights of 5000 and 10,000 metres, it was found that the areas of low pressure at these heights coincide approximately with the areas of low temperature, and in most cases are many hundreds of kilometres from the surface cyclone. Thus, on March 24, 1899, the surface cyclone or area of low pressure was along the north coast of the Mediterranean, near Italy, while the minimum pressure at 5000 and 10,000 metres was in Finland, or even further north (*Meteorologische Zeitschrift*, January 1900).

To compare these facts with theory, I have looked up the views expressed in modern text-books and recent literature. I find a number of different opinions in regard to the causes of cyclones, and have classified them as follows:—

(1) Instability produced by a rapid decrease of temperature with increase of height; that is, by a vertical gradient equalling or exceeding the adiabatic rate. This may be called *the theory of vertical instability*.

(2) Instability produced by differences of temperature in a horizontal direction. In such a case, in consequence of the the difference in density, there is established a convectional interchange of air between areas of different temperatures, and there result differences of pressure, and consequently cyclones and anticyclones. This theory I call *the convection theory*.

(3) If a current of damp air is deflected upward by any means, mechanical or otherwise, it cools by expansion, and its moisture begins to condense. This condensation retards further cooling, so that the air in rising may cool at a rate less rapid than that ordinarily existing in the atmosphere. In such a case, the air would continue to rise, and the conditions would be favourable for storm formation, as long as the supply of moisture lasted. This has been called *the condensation theory*.

(4) When bodies of water, moving in different directions or with different velocities in the same direction, come in contact, whirls and eddies are set up between them. It is therefore conceivable that the large masses of air moving between the equator and the pole, may, at their places of meeting, produce similar large eddies, such as the cyclones of the weather map. These have been called *dynamic cyclones* and also *driven cyclones*.

Probably no meteorologist believes that any one of these causes acts entirely alone in cyclone formation. But a difference of opinion arises as to which is the principal cause, and to what extent the others are subsidiary causes. All theories agree in ascribing the primary cause to differences of temperature, either local or between equator and pole.

Vertical instability can scarcely be considered the primary cause of cyclones, because, as stated above, the atmosphere is found normally separated into strata, each one potentially warmer than the one beneath. The fatal objection to the condensation theory, as pointed out by Dr. Hann, is that cyclones in temperate latitudes are more violent in winter than in summer. Latent heat is not so effective an aid to storm action in winter as in summer, and yet it is in winter that our cyclones possess their greatest violence. According to the theory of driven cyclones, "The masses of air set in motion polewards by the upper gradients are resolved, in part, into great whirls, the principal progressive motion of which is controlled by the prevailing west component of the former. The influence of the inequalities of the earth's surface, the different heating and cooling of the land and ocean, and the bringing in of aqueous vapour and its condensation, come thus into account, as matters of secondary importance," (NATURE, vol xliii. p. 470). "If . . . cyclonic and anticyclonic disturbances are produced by the irregular flow of the general winds, it is probable that these disturbances would originate in the higher regions of the atmosphere, where the winds blow much faster than near the earth's surface. The differences of pressure produced at high altitudes would be felt down to sea-level; and, as the lower winds move with comparative slowness, they would be governed by the gradients thus imposed on them by the irregular movements of the upper winds. According to this theory, an area of high pressure would be perceived at sea-level beneath a district where the upper currents crowd together; and an area of low pressure, or a cyclonic storm, would be developed beneath a region where the upper currents are somewhat divergent." (Davis's "Elementary Meteorology," 1894, p. 219.)

As stated above, observation does not show areas of minimum pressure in the upper air above areas of minimum pressure at sea-level. Furthermore, according to the theory of driven cyclones, the progressive motion of the cyclone is supposed to be determined by the "prevailing west component" of the upper currents. At Blue Hill the mean westerly component of the upper current is 35 metres per second at 9000 metres, about 17 metres per second at 4000 metres, and 1 metre per second at 200 metres (*Harvard Observatory Annals*, 1890, vol. xl. p. 447). It is natural to suppose that a driven whirl, in such conditions, would be rapidly toppled over and destroyed. Yet storms persist for days. If, however, a driven whirl did persist in such conditions, its axis if tilted at all would, according to all analogy, be tilted in the direction of progressive motion. Yet the direct observations with kites at Blue Hill, and the observations of clouds by Ley in England, prove that the axis of the cyclone is tilted backward. Moreover, it is reasonable to suppose that the air in the rear of a driven whirl would partake of the progressive motion of the whirl, and this, added to the indraught, would make the wind velocity in the rear of the whirl very much greater than that of the winds in front, yet such is not generally found to be the case. For these reasons I think the observations do not favour the theory of driven cyclones.

The theory of cyclones with which the observations in temperate latitudes seem best to agree, is the theory which supposes the cyclone to result from contrast of temperature in a horizontal direction. This I have called the *convection theory*. In this theory there are two types of cyclone. The warm-centre cyclone of the lower atmosphere, and the cold-centre cyclone of the upper atmosphere. The best type of the cold-centre cyclone is the polar cyclone; but there also exist in the upper air in temperate latitudes small travelling cyclones or *hemi*-cyclones of the same nature. Horizontal contrasts of temperature are most marked in winter, hence the theory explains why cyclones are most violent in winter. The origin of the horizontal contrasts of temperature is not shown by observation. They probably arise by the interchange of air between higher and lower latitudes. A body of air moving from the equator toward high latitudes would come into a region where it would be nearly surrounded by colder air, and the conditions would favour the production of a warm-centre cyclone. A body of air moving toward the equator would produce conditions favourable to a cold-centre cyclone. H. H. CLAYTON.

Blue Hill Meteorological Observatory, March 30.

Rock-structures in the Isle of Man and in South Tyrol.

IF the intercrossing of two separate systems of folding be the essential condition in the complicated rock-structures so ably worked out by Mrs. M. M. Ogilvie Gordon in South Tyrol, I scarcely think the parallelism with the conditions in the Manx *Carboniferous* rocks can be so close as Mrs. Gordon suggests in her recent letter (NATURE, March 22, p. 490).

So far as I have been able to judge, the disturbances in the Carboniferous volcanic rocks of the Isle of Man were the result of a movement which was single both as regards direction and time. It is true that this conclusion was reached in 1897, before Mrs. Gordon had taught us the importance of torsion-structure in areas of disturbance; but I re-examined the sections last autumn, after having studied Mrs. Gordon's paper, without finding any reason to alter my former opinion on this point. The interpretation given in my recent paper (*Q.J.G.S.* vol. lvi. p. 11) is therefore in all respects the same as that published in brief in the official Summary of Progress of the Geological Survey for 1897 (pp. 110-112).

It seems necessary, also, to call attention to the small scale of the structures in question in the Manx Carboniferous rocks. Their most striking feature is their sudden local development in a limited tract where the strata are rendered by diverse lithological composition peculiarly susceptible to differential displacement. Under such conditions, it appears that even a small degree of lateral movement may be so focussed as to cause great disturbance at certain places without much disturbance of adjacent tracts. The post-Carboniferous movement in the Isle of Man can scarcely have been even approximately of the magnitude of the disturbances in South Tyrol described by Mrs. Gordon.

It was in pre-Carboniferous times that the Manx region underwent earth-movements of really grand intensity; and Mrs. Gordon may have had this fact in mind in referring to the subject. In the Older Palæozoic (probably Cambrian) slate-rocks of the island, "crush-conglomerate" has been developed on a very extensive scale by differential shearing, as described by Prof. W. W. Watts and myself five years ago (*Q.J.G.S.* vol. li. p. 563). These rocks, moreover, show evidence of successive epochs of disturbance, varying slightly in direction but apparently all pre-Carboniferous. The production of the "crush-conglomerate" appears to have occurred during only one of these stages. It is not improbable that an observer acquainted with the "torsion-structures" of the Dolomites might be able to find parallel phenomena among the highly complicated pressure-structures in the Manx Slates; but I think that a sharp distinction should be drawn between these structures and those of the Carboniferous rocks of the island. G. W. LAMPLUGH.

Tonbridge, April 8.

Electric Light Wires and Dust.

I BELIEVE that the collection of dust upon electric light wires and fittings is generally attributed to air currents, due to thermal causes, the same thing occurring, to some extent, with hot-water pipes. Recent experience has, however, convinced me that in the case of electric light conductors, electrostatic attraction is really the chief factor, particularly where the supply is at 200 volts from the street mains. In my office here I have several electric light cords strung across the ceiling. They are all exactly similar and under the same conditions, except that some of them have the switch in the negative and some in the positive conductor. The former gather dust to an extraordinary degree, and now, after a few months' use, have become quite an eyesore. The latter are practically as clean as when first put up. As is well known, the negative conductor of a street supply tends always to earth itself, and, as a matter of fact, in my case I find that the negative of my supply from the Westminster Co. is almost at earth potential. The positive, on the other hand, is nearly 200 volts above the potential of the earth. In this lies obviously the cause of the phenomenon. The wires which have the switch in the negative are nearly at 200 volts potential above the earth whenever the switch is off, while those which have the switch in the positive are at zero potential in these circumstances. Of course, when the switches are on, all the cords are under similar conditions, one conductor in each being nearly at 200 volts above earth, and the other at about earth potential. No doubt it is when the switch is off, in the case where it is in the negative conductor, that the accumulation of dust takes place. Having regard to the comparative lowness of the 200 volts potential, from an electrostatic point of view, the rate at which the dust accumulates on the cords is most surprising, and this is my reason for thinking it worth while bringing the matter to notice. A. A. C. SWINTON.

66 Victoria Street, Westminster, April 23.

ON THE SIZE AT WHICH HEAT MOVEMENTS ARE MANIFESTED IN MATTER.

IN the molecular theory of heat it is assumed that the motions of atoms and molecules are the motions upon which the phenomena of temperature depend. These motions are assumed to be very irregular, and the apparent uniformity of structure of a gas, for example, is attributed to the very small size and irregularity of the motions, which within any region of sensible size are the same, *on the average*, as within any neighbouring region. Within regions of molecular dimensions the distribution of motion is extremely irregular; neighbouring molecules are not in general moving at the same speed or possibly vibrating in the same way. Hence in this view the size at which heat movements are manifested in matter are of molecular sizes, *i.e.* from 10^{-7} to 10^{-8} cm.

In addition, however, to all this matter, motion and vibration, there are present ether motions of an irregular kind. Within any closed envelope at constant temperature the ether motions must be in statistical equilibrium with the motions in the envelope. The energy per c.c. of these ether motions will be considerable at high temperatures, and small at low ones. Many years ago I called attention to the energy per c.c. required in order to, in this sense, warm up ether, and showed that it was quite comparable with that required to warm up a rare gas. Now the size at which these motions are developed are comparable with the wave-length of the ether disturbances of the period of the motion. In the case of irregular disturbances, such as cause temperature phenomena in solids and liquids, one cannot define precisely the size of the ether disturbances, because they are of all sorts of sizes, being irregular in the same way as the matter motions are irregular ; but it is known that at each temperature there is a particular wave-length, round which the ether vibrations may be grouped, and that this average wave-length is shorter the higher the temperature. The wave-lengths of these vibrations, so far as they have been observed, vary from $2 \cdot 4 \times 10^{-3}$ to 10^{-5} cm.

It is at once evident that the average size of the ether motions is *very* much greater—quite a thousand times greater—than the size of the molecular motions. In the molecular motions we could not expect to find any irregularity of distribution within distances such as we can see with a microscope, because within a visible volume there will be millions of molecules, and the average motion will be all that we can expect to see. Is it necessarily so as regards the ether motions which exist on so much a greater scale? Is there any way in which these very much larger scale phenomena may be expected to affect matter on a scale comparable with their own size, and which consequently we might expect to be able to see, and which might produce effects on masses of matter consisting of millions of molecules?

We may consider in this connection an analogy from sound. In sound we can have small solid objects, such as masses supported by springs, which give out waves in air very much longer than the sounding object. A tuning-fork, for example, may be only a few centimetres long, and may give out waves a metre long. The balance wheel in a watch vibrating quarter seconds would generate waves—feeble ones no doubt, but still waves—80 metres long, or some 8000 times the linear dimensions of the vibrating object. Similarly the vibrations of molecules generate ether waves many thousands of times as long as the linear dimensions of the molecules. On the other hand, solid bodies may be much longer than the air waves they produce. A bar of steel vibrating longitudinally would be fifteen times as long as some of the air waves it would generate. A pipe full of air would be of about the same length as the air waves to which it would resonate, not less than about a quarter as long. If, then, we had a large number of sounding bodies, some small ones like small tuning-forks, balance wheels, and such like, and others like pipes of a size comparable with the air waves, we would expect that when the small ones were all sounding, the larger ones would resonate to their corresponding waves, and thus be set in vibration by the waves originated in the smaller bodies.

In the case of electromagnetic waves we should expect the same result. If there are bodies comparable in size with the heat waves in the ether which can have electromagnetic vibrations produced in them of the same periods as those emitted by the molecules, these bodies should resonate to these heat waves. Now, by utilising the ordinary process of conduction in metals, we know that it is possible for electromagnetic vibrations to exist in conductors of a small size, down to a few millimetres in diameter; and there is no reason to doubt that by means of conduction very much smaller bodies can have electromagnetic vibrations in them. Dr. Lodge, indeed, has suggested that the structures in the retina are of about the right size to resonate electromagnetically to waves of the frequency of the light waves that affect our eyes. Larger objects would resonate to the electromagnetic vibrations corresponding to the ordinary air temperatures. A sphere 10^{-3} cm. in diameter would, for instance, resonate to waves of about the greatest length that have been measured by Rübens and Nicholls, and a much larger one could have a harmonic of its fundamental tone excited in it by these waves. In addition to these vibrations in conductors, non-conductors of one specific induction capacity immersed in a medium of a different specific inductive capacity could also have syntonic vibrations excited in them. From all this it seems quite certain that in small particles of matter there must exist, at all temperatures, electromagnetic vibrations of a size comparable with the wave-lengths existing in the surrounding ether.

What sort of effects might we expect to be produced by these electromagnetic vibrations? Is there any prospect of our being able to detect them? What amount of energy may there be in this form of vibration on each particle? These are questions to which I am afraid I can only give very vague answers. To the first question, as to what effects may be expected to be produced by these vibrations, I can only suggest in the first place an unequal heating of the particle. The parts of the particle which are the electric nodes, where the electric current alternates and where there are no electric charges, these parts should be kept at a slightly higher temperature than the electric loops. If the particle were not perfectly symmetrical, this would lead to an unequal heating of the particle as a whole, and this may be a cause of those so-called Brownian motions of small particles immersed in a liquid which are so very difficult to explain. In the second place, it may lead to a grouping together of molecules into masses of a size depending on the temperature of the liquid, and to a going about of these groups of molecules and a similarity of the vibrations of the component molecules which complicates the theory of temperature in a way that may ultimately, as I have before now pointed out, explain to some extent the difficulties at present surrounding this theory. In the third place, this may be connected with the conditions for the breaking down of simple viscous motion and the production of vortices in a liquid, though I hardly think an explanation on these lines is required ; and, finally, it may be connected with crystalline forces, the structures in the eye, vital actions in small cells and on a small scale, as in the patterns on diatoms, and possibly with the temperature at which vital actions of certain kinds, such, for example, as consciousness, are possible. These are the merest guesses of a wild kind as to the possible results of what seems to be a *vera causa* for structures and actions in matter of a size comparable with the wave-lengths of light, and must be taken as merely wild guesses.

As to the second question, of the prospect of detecting these electromagnetic vibrations in particles of matter, its answer depends so entirely upon the first that I can only leave it to the investigators of the future to try and detect them. That such electromagnetic vibrations exist, I think, can hardly admit of doubt, any more than that the strings of a piano are kept in vibration when loud and irregular noises are produced in its neighbourhood.

As to the energy of the vibrations upon each particle, I cannot give any satisfactory answer. If the particle were in a region through which a series of plane waves of a constant type were being transmitted, it would no doubt be possible to solve the problem of determining the amplitude of its vibrations in particular cases of assumed shapes of particles. In the actual case of irregular disturbances I do not see, at present, any direct way of attacking the problem. It would apparently require to be attacked statistically, but I doubt whether this would lead to a true result, because there seems some reason to think that trains of uniform waves of considerable length do exist in the ether, and if there is any regularity of this kind in the ether motions, a purely statistical treatment, in which the vibrations were assumed to be quite irregular, would fail to lead to a true result. If the energy of these electromagnetic vibrations of its fundamental period on a particle is no greater than corresponds to its one degree of freedom on Boltzmann's theory of partition of energy, I am afraid the amount of energy of this kind on each particle is hardly sufficient to account for any observable phenomenon. That it may, however, be much greater seems justified by the failure of this theory, so far as is known, in other cases, and this must be my excuse for calling attention to what seems certainly a *vera causa* for structures and actions in matter of a size comparable with the heat vibrations in the ether, even though the amount of this cause may, when fully investigated, turn out to be so small as to be insufficient to produce observable effects.

GEO. FRAS. FITZGERALD.

REPORT OF THE MALARIA EXPEDITION TO SIERRA LEONE.

FOLLOWING close on the "Instructions for the Prevention of Malaria," the Liverpool School of Tropical Medicine have issued the report of the malaria expedition sent out to Sierra Leone by that body in August last. Their objects, as stated in the report, were :—

(1) To find one or more species of insects hospitable to the human Hæmamœbidæ on the West Coast of Africa.

(2) To study the bionomics of these insects, with a view to suggesting better modes of prevention of malarial fever than those hitherto known to us.

The terminology adopted is that used by Major Ross in consultation with Prof. Herdman, already noticed in NATURE (August 3, 1899). It is proposed to abolish the word mosquito, and use the old English equivalent, gnat, as there is no difference between the two, and because the terms malaria and malarial fever no longer hold—they propose the term hæmamœbiasis, or gnat fever.

The genus Anopheles was chiefly looked for, because these had been shown to be concerned in the transference of the parasite. In the barracks at Wilberforce, Sierra Leone, 25 per cent. of the soldiers suffered from all three forms of malaria or gnat fever. All the gnats caught in the barracks were *Anopheles costalis* except one, and out of 109 of those examined, parasites were found in 27.

Some experiments on feeding Anopheles on a patient with *H. malariae* gave positive results, several young zygotes being found in the gnat. These gnats were caught in a building where there were no fever patients, and numbers of them had been examined and found free from parasites. When, however, Anopheles bred from the larvæ and kept in test tubes were applied to the skin of a patient, they were found not to feed copiously, and negative results, as regards zygotes, were obtained on dissecting them. It is suggested that the explanation of the failure was the non-fertilisation of the females ; it seems that the female gnat requires blood for the nutrition of the eggs. If the ova are not fertilised, the blood is possibly evacuated without some digestive process being performed which may be necessary to the vitality of the zygotes.

Measures of precaution against the bites of gnats, and measures for reducing their numbers, are discussed in the chapter on prevention. It is remarked that neither Europeans nor natives made any effort to keep down the numbers of gnats, which constitute a very serious pest in Sierra Leone, as they do in all tropical towns. Both this report and the "Instructions for the Prevention of Malaria" should be invaluable to residents abroad, as indicating how they may protect themselves from the annoyance from gnats, and from the evil results that may arise from their "bites."

Experiments were instituted with a view to destroying the adults or larvæ, and to prevent the insects from breeding. It was not always possible to discover the breeding pools of the Anopheles infecting a particular spot ; for instance, none could be found at Wilberforce, the nearest pools where larvæ were found being nearly a mile away. Dr. Fielding Ould tried experiments with tar, and found the film on the surface of the pool lasted longer than a film of kerosene oil ; while both killed the larvæ and prevented them from hatching so long as the film lasted.

In the addenda are some good micro-photographs of both zygotes and blasts from the gnat.

JOSEPH BERTRAND.

AMONG the heavy losses which science has suffered during the past few months, few will be the subject of such universal regret as the death, on April 3, of M. Joseph Bertrand. The loss will be felt, not only by mathematicians, but also by the great body of scientific men with whom Bertrand was brought into contact in his capacity of life-secretary of the Paris Academy of Sciences.

Joseph Bertrand was born at Paris in 1823, and at an early age commenced his mathematical studies under the guidance of his father, who had been a pupil of the École Polytechnique. Subsequently Bertrand entered the Collège de St. Louis, and at the age of eleven he succeeded in passing the examination for entrance into the École Polytechnique, although it was not till six years later that he actually entered the college, when he headed the list of candidates. As a boy, Bertrand would nowadays be styled an "infant prodigy," by analogy with the youthful musicians who created such a *furore* at London concerts a few years ago ; and it is interesting to learn from M. Maurice Lévy that this title (*enfant prodige*) was actually bestowed on him by the scientific men who welcomed Joseph as a young colleague at an early stage of his existence. The analogy between music and mathematics seems, moreover, to have suggested itself to M. Jules Lemaitre, Director of the French Academy, who remarks that such precocity of genius is sometimes found in mathematics and in music, but is never seen in literature. We find Bertrand publishing a paper on the theory of electricity in 1839, when he must have been about sixteen years old, and it is hardly surprising in view of this to learn that his precocity amazed his masters. In 1841 he wrote papers on indeterminate forms, Jacobi's theorem and differential equations, and from that time onward he was fairly launched on his career as a writer of mathematical papers, his output being five papers in 1842 and seven in 1843. But whereas most of the young musical *débutants*, to whom reference has just been made, have enjoyed only ephemeral reputations, and have exhausted their energies in their premature efforts to an extent which must have prejudiced their future careers, Bertrand succeeded in achieving all that was predicted of him ; he showed no diminution of energy in advancing years, and, moreover, to judge from all accounts, he developed into a good man of business, a quality which is commonly regarded by "the general public" as incompatible with being a genius.

In 1842 he had a narrow escape from being killed in a railway accident near Meudon. In company with his brother, Alexandre Bertrand, now distinguished as an archæologist, he had gone to Versailles to see the fountains, and on the return journey the accident occurred in which Admiral Dumont d'Erville was killed. Both of the Bertrand brothers suffered, Joseph losing the bridge of his nose—a misfortune which disfigured him for life—while Alexandre's leg was fractured. Joseph rescued his brother by dragging him through "the skylight," the carriage doors being locked. A few months later he married the sister of one of the injured, a Mademoiselle Acloque. At the Polytechnique, Bertrand acquired a knowledge of mining, and on leaving he became an inspector of mines. He was subsequently appointed professor at the Lycée St. Louis.

In March 1844 he became teacher of analysis (*répétiteur d'analyse*) in the École Polytechnique; from 1847 to 1851 he was examiner for admission to the same institution, which raised him to the rank of professor of analysis in 1856, a post which he held till 1895, just after he had completed his jubilee as a member of the teaching staff, an event which was commemorated on May 27, 1894, by a committee of his old students, who presented him with a medal engraved by Chaplain. In 1847 he was appointed deputy professor to Biot in the department of physics and mathematics at the Collège de France, and on the death of Biot, in 1862, he was appointed to the chair. From then up till 1890 he lectured regularly, with the exceptions that his work was taken by Darboux in 1867, by Maurice Lévy in 1874-76 and 1878-85, by Laguerre in 1885-86; since 1890 Marcel Deprez has acted as his deputy. We have it on the authority of M. Gaston Paris, that his first course of lectures was on a comparative study of the theories according to which geometers had attempted to account for capillary phenomena, his latest lectures being on electricity, thermodynamics and theory of errors. From 1858 to 1862 he was professor of higher mathematics at the École Normale Supérieure, and he also is stated to have held a professorship of special mathematics in the Lycée Napoléon. In 1856 Bertrand was elected a member of the Académie des Sciences at the early age of thirty-four, in place of Sturm; and on the death of Élie de Beaumont, in 1874, he was elected permanent secretary, in which office he had Berthelot as a colleague. He was made officer of the Légion d'Honneur in August 1867, and commander in December 1881. In 1884 he succeeded Jean Batiste Dumas in the French Academy.

Bertrand's larger works—namely, his "Traité d'Arithmetique," published in 1849; his "Traité d'Algèbre," published in 1856; and his "Traité du Calcul differentiel et integral," brought out during the years 1864-70—are accepted as standard treatises by mathematicians in all countries, the last named of the three being perhaps the most widely read of all. His treatise on Arithmetic contains, for the first time, a clear definition of incommensurable quantity. His treatise on the Calculus contains a large number of geometrical applications embodied in his divers memoirs; and special mention may also be made of his exposition of the theory of functional determinants and the close and useful relation which he established between these determinants and the simple derived function of one variable. It is greatly to be regretted that the manuscript of the third volume of this work was destroyed in a fire. A similar misfortune befel the manuscript of his original treatise on Thermodynamics, completed in 1870. In this case, however, the loss has been repaired by the publication of a book on the same subject at a later date, based on a course of lectures given at the Collège de France. Those who have grappled with such a subject as thermodynamics will appreciate his naïve observation that he has not attempted to make a complete treatise, and that he has only expounded what he has understood. But, as M. Lévy justly goes on to remark, on those points which he pretends not to have understood, notably on irreversible phenomena and the application of the Second Law to bodies of non-uniform temperature, he has made a series of critical remarks of great importance, which have already borne fruit. This treatise, moreover, is remarkably rich in illustrative examples all more or less original, those dealing with saturated vapours coming well within the range of *practical* applications. Other works emanating from his pen are an edition of Lagrange's "Mécanique analytique," with copious notes, and a small volume of lectures on electricity, in which Bertrand gives the true origin and reason of Faraday's notion of "electric flux," although, being a mathematician, he naturally favoured the rigorous methods of Ampère, for whom he expressed great admiration.

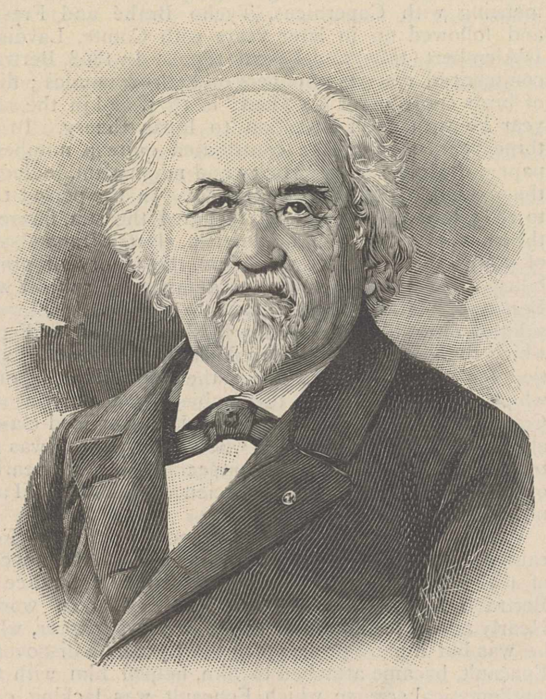
Passing from these standard treatises to the numerous papers published in scientific journals, a glance down the list of these shows that, from the outset, Bertrand devoted his attention largely to applied mathematics, and to those portions of pure mathematics required in the solution of problems in applied mathematics. His early papers deal chiefly with the differential and integral calculus, differential equations, the calculus of variations, analytical mechanics, and in particular the integration of the equations of dynamics. His papers on the theory of surfaces, dating from 1843, on the principle of similitude in mechanics, on the propagation of sound and on capillary phenomena, are among the best known of his minor writings. After 1864, we find him writing biographical memoirs, commencing with Copernicus, Tycho Brahé and Fresnel, and followed up in later years with Comte, Lavoisier, D'Alembert (1889) and Pascal (1890). In 1868, Bertrand commenced a series of papers on hydrodynamics; flight of birds came under his "ken" in 1871, and in the same year he turned his attention to lunar theory. In the three years 1871-73, he contributed quite a number of papers dealing with electricity and magnetism, including the mutual action of currents, &c. In the period 1874 to 1883, the subjects treated included the sun, figure of the earth, electricity and magnetism, electric transmission of power, the Foucault pendulum, the theory of probability. Probability was always a favourite subject with Bertrand. The numerous pitfalls connected with the solution of problems, the remarkable power of prediction which the theory appears to afford, had a great fascination for him, and many were the courses of lectures which he delivered on this subject, not only at the Collège de France, but even in the less advanced classes at the École Polytechnique, where the subject was introduced by him chiefly in connection with its bearing on astronomy and the applied sciences, such as civil and military engineering.

We have spoken, too, of Bertrand's papers on Foucault's pendulum. How far Foucault owed the success of this and his other discoveries to the influence of Bertrand may be judged from M. Lévy's own words. Nearly at the beginning of his (Bertrand's) career, when he was but a mere professor at the Lycée, he discovered Foucault, became attached to him, helped him with the mathematical science which Foucault was lacking, contributed thus to his discoveries without in any way thrusting himself forward; and afterwards, hardly had he been elected into the Academy of Sciences, before he pressed forward the candidature of the great physicist, then little known or unappreciated, against the opposition of many of the highest authorities of that time—a contest which has remained famous. The struggle was not without its risks, nor the success without its honour. One vote turned the scale. But the Institut de France added one more man of genius to its scientific roll.

By the end of 1883 Bertrand had written about 121 papers. Many of these were published in the *Comptes rendus*; others, mostly written in a lighter style and oftentimes with a vein of irony running through them, appeared in the *Revue des deux Mondes*, and included criticisms on "pseudo-mathematicians," as well as numerous biographies of genuine men of science.

Of late years Bertrand communicated but few papers to the Paris Academy. He appears to have devoted himself chiefly to the administrative work of the Academy. In connection with the annual awards of prizes, we find his name almost invariably appearing on the lists of judges, and he appears to have been no less energetic in drawing up biographical notices of deceased members. Nevertheless, we find him in 1895 writing on a geometrical theorem, and in 1896 breaking a lance with Boltzmann on that ever-fascinating and never-satisfying theory, the Kinetic Theory of Gases. This is the last time that we have been able to find Bertrand's name in the *Comptes rendus* as the writer of a paper, though it repeatedly figures in other connections.

Bertrand's countenance and carriage are described as "characteristic." He was "short, thick-set, lively, vigorous, and very kind-looking. His face was covered with scars, and his nose had lost its bridge," as we have seen, as the result of the Meudon railway accident, but the imprint of misfortune would appear to have given a tender pathos to his appearance, which seemed to draw his friends nearer to him. As a relaxation from work, he is said to have never tired of reading the novels of Sir Walter Scott, whom he described as "the greatest



Joseph Bertrand.
(From *La Nature*.)

novelist that ever lived." He leaves several sons, one of whom, M. Marcel Bertrand, a mining engineer, is himself a member of the Academy of Sciences, and rather well known.

If Bertrand's mathematical work earned for him the respect and admiration of men of science far and wide, his philanthropy endeared him to the smaller circle with whom he was more intimately known. The enjoyment he derived from his own studies was fully equalled by his delight at reading the works of others. He constantly sought to bring to light fresh workers, and the few words of kind reassurance and appreciation, not to mention the passing on of an idea or the lending a helping hand over a difficulty, so much valued by the budding mathematician, were never wanting at the critical moment. In endeavouring to help those less favoured by fortune than himself, Bertrand would give much time and thought as to the best way of rendering them assistance. In 1857 Baron Thénard founded the "Société des Amis des Sciences," an institution the object of which is to assist scientific men and their families when in need. Bertrand was one of the first to support the Society, and his signature figures along with those of Boussingault, Quatrefages, Becquerel, Sénarmont, Balard, Daubrée, Frémy, Deville, Berthelot and Pasteur in all its early records. In 1864 Bertrand was elected on the council, in May 1895 he was nominated vice-president, and in November of the same year he succeeded Pasteur as president. The Pasteur Institute also owes much to his energetic support.

Mathematical investigation is essentially a search for truth; but with Bertrand the love of truth and hatred of all that is false, was not confined to the mathematical side of his character; this trait was indeed deeply engrained into his whole existence. While there was nothing he would not do for those he knew to be deserving, he seems to have possessed a happy knack of effectually disposing of his enemies by a few strokes of sarcasm, which must have been the more withering because they so completely placed his adversaries in the wrong.

Had Joseph Bertrand's life and health been spared a little longer, there can be no doubt that he would have taken a foremost part in the liberal programme of congresses with which Paris hopes to attract a distinguished assembly of *savants* from all quarters of the globe, and we are sure that many English readers of his "Differential and Integral Calculus" would gladly have availed themselves of the opportunity of coming into personal contact with the well-known French mathematician. The loss of so prominent a figure in the Parisian world of science would at any time be deeply deplored, and his absence from the brilliant gatherings that are to be, only adds to our regret at losing one who has done much to simplify and popularise the study of mathematics.

At the funeral, discourses were delivered by M. Jules Lemaitre, director of the Académie Française; by M. Maurice Lévy, president of the Académie; by M. Berthelot, his fellow secretary of the Académie des Sciences; by M. Gaston Darboux, representing the Société des Amis des Sciences; by M. A. Cornu, representing the École Polytechnique; by M. Duclaux, director of the Institut Pasteur; by M. Gaston Paris, administrator of the Collège de France; and by M. Georges Perrot, director of the École Normale. In endeavouring to portray the life of a man of many and varied parts like Bertrand, we have largely drawn on the information contained in these orations, which are published in the *Comptes rendus*; but while it has thus been possible to enter into many of the details of Bertrand's life, his character as an individual can only be appreciated by reading separately the thoughts expressed by those who have known him intimately in his many capacities. Of these expressions, we can do no better than conclude with the words of M. Georges Perrot:—

"Il n'a pas été moins grand par le cœur que par l'esprit."

G. H. Bryan.

NOTES.

We notice with regret the announcement that the Duke of Argyll died on Tuesday morning, at the age of seventy-seven years. No definite arrangement has yet been made with regard to the funeral, but it is believed the interment will take place next week.

The international conference for the protection of wild animals in Africa, announced last week, was opened at the Foreign Office on April 24, and was attended by plenipotentiaries of France, Germany, Great Britain, Congo Independent States, Italy, Portugal and Spain. Readers of Nature hardly need to be reminded that such a conference is of deep importance, and it is sincerely to be hoped that a definite plan of action will be decided upon as a result of its deliberations. A leader in Tuesday's *Times* directs attention to the necessity of an international agreement to restrain the extermination of many of the mammals, birds and fishes in Africa. It is useless to preserve wild animals in one part of Africa while they are killed off without restriction in neighbouring districts by people accredited as citizens of another European State. This is why an international agreement is sought for. It is needless to dwell upon the unnecessary slaughter of elephants, rhinoceroses, hippopotami, and the larger kinds of antelopes, elands, koodoos, sables and others since the Cape Colony, the Boer States, and the Rhodesian territories have been opened up to colonisation. Half a century ago, as the *Times* points out, the whole of South Africa below the Zambesi swarmed with antelopes and other game, including lions and leopards. Now, except in a few rare districts, there is nothing more of the kind to be found than in Hampshire or Devonshire. To remedy this state of things, the *Times* advocates the establishment of large reserves, like the Yellowstone Park in the United States, where wild animals can be allowed to live their natural life. It is easier to bring this to pass in Central Africa, where so much land is practically waste, than in countries where civilisation has made its way. The experiment has been tried, on a small scale, in many places, and with considerable success. In a narrow strip of forest country on the South Coast the Government of the Cape Colony preserves some herds of elephants. Mr. Rhodes has done much for the preservation of antelopes both on his property near Cape Town and in Rhodesia. There appears to be no reason why very large areas in Central Africa should not be set apart as refuges in which all the rich animal life of the continent might be permitted to propagate and develop under something approaching to natural conditions. Ten or twelve of these great reserves would keep alive, for a time at least, the striking types of animal life in which Africa is so extraordinarily fertile.

In connection with the subject of the foregoing note, some remarks made by Prof. S. P. Langley in the latest report of the Smithsonian Institution are of interest. It is pointed out that the National Zoological Park at Washington was established with the object of preserving the fast vanishing species of American animals. The changes which were noticed in the western part of America some years ago are now occurring in Alaska. With the advent of the settler and the railroad in the West, the great herds of animals which ranged over the western territory of the United States were practically exterminated, though by strenuous efforts here and there small collections of the buffalo and other large interesting mammals, like those in the National Zoological Park, have been kept alive. Whether a race can be made to survive in this way is open to question, but the effort at least should be made, and the Smithsonian Institution is trying to promote this survival. The United States still possesses at Kadiak Island, on the south-east coast of Alaska, a few living specimens of the largest carnivorous animal now in the world—a monster bear—which has not at any time been brought into captivity. Prof. Langley has been trying for two years, through American companies on the island, to obtain live specimens of this and other great mammals of Alaska with the hope of preserving the species before the inevitable opening of all that distant territory of the United States to civilisation and settlement will have resulted in the extermination of its large fauna, but these efforts have hitherto been wholly unsuccessful.

The summer meeting of the Institution of Mechanical Engineers will be held in London during the last week in June.

The Bruce gold medal of the Astronomical Society of the Pacific has been awarded to Dr. David Gill, C.B., F.R.S.

The *Daily News* announces the death of Prof. A. Milne-Edwards, director of the Natural History Museum at Paris.

Sir J. Barry Tuke, well-known for his works on mental diseases, has consented to become a candidate for the vacancy in the parliamentary representation of the Universities of Edinburgh and St. Andrews, caused by the death of Sir William Priestley.

We learn from the *Chemical News* that an international banquet will be held by the Chemical Society of Paris in honour of those gentlemen who, by their presence at the Universal Exhibition, will represent pure and applied chemistry. The date fixed for the banquet is Thursday, July 19, when the chair will be taken by M. Berthelot, honorary president.

The economic position of the German Empire in 1900 forms the subject of a report by Mr. Gastrell, commercial attaché to Her Majesty's Embassy at Berlin, which has been issued by the Foreign Office. It is instructive to trace the steps in the progress of the German Empire towards the important position it holds to-day. Mr. Gastrell points out that, in industrial and commercial matters, the first twenty years of the existence of the German Empire—from 1871 to 1890—were devoted to the elementary education of its people; the following ten years—1891 to 1900—have been spent on their higher education; and the end of the century sees in them a body of men each an expert in his own trade or profession. The bases on which Germany's power stands are primarily its trade and, in a minor degree, its agricultural resources. The population of Germany to-day is probably larger than that of the United Kingdom by some 15,000,000, and greater than that of France by about 17,000,000.

The facilities which will be granted by the Portuguese Government to foreign astronomers visiting Portugal in May, for the purpose of viewing the total eclipse of the sun, have been made the subject of an official announcement by the Foreign Office. Astronomers from abroad will be exempt from payment of the usual Customs duties on production at the Custom House, on arrival, of a certificate drawn up by the astronomical society to which they may belong, setting forth their names, and describing the instruments and books which are to be imported. This certificate, however, should be legalised by the nearest Portuguese Consulate before starting. Further, it is announced that the Ministry of War has informed the Ministry of Education that all the military authorities of the districts of Vizen, Aveira, Guarda, Castello Branco and Coimbra will afford any possible assistance to astronomers during the observations, and that tents will be lent to observers, on a request being addressed to the Ministry of War in Lisbon to that effect. A Government notice has now been published in the *Official Gazette*, stating that the King has nominated a Royal Commission for the purpose of assisting in every way those who may come from abroad for scientific observations, and for superintending astronomical arrangements generally. This commission will sit either at the Royal Observatory, Lisbon, or at the Geographical Society, Lisbon; its president is his Excellency Senhor Marianno de Carvalho. If any British astronomers going to Portugal will communicate with her Majesty's Minister shortly before their arrival, he will be able to take steps to facilitate the object of their visit.

The annual meeting of the Iron and Steel Institute will be held on Wednesday and Thursday, May 9 and 10, under the presidency of Sir William Roberts-Austen, K.C.B., F.R.S.

On the first day, the Bessemer gold medal for 1900 will be presented to Mr. Henri de Wendel, president of the Comité des Forges de France. During the meeting, papers will be read and discussed on ingots for gun tubes and propeller shafts; the manufacture and application of water-gas; the equalisation of the temperature of hot blast; blowing-engines driven by crude blast-furnace gas; the solution theory of iron; the use of fluid metal in the open-hearth furnace; the manganese ores of Brazil; the utilisation of blast-furnace slag; iron and phosphorus; and the continuous working of the open-hearth furnace. The annual dinner of the Institute will be held at the Hotel Cecil on May 9.

IT may be remembered that in France, last year, the *Matin* organised a race of about 1400 miles, known as the "Tour de France," which effectually brought the powers of automobile vehicles to the notice of all sections of the population. In some of these contests very surprising results have been attained. The winning car in a recent race at Pau, says the *Times*, accomplished a distance of 208 miles without a stop, at an average speed of 44¾ miles an hour, covering the first 34½ miles in the remarkable time of 33½ minutes. Stimulated by the success of last year's "Tour de France," both in promoting the use of motor cars and in revealing the types of car best suited for the purposes in view, the Automobile Club of Great Britain and France has arranged a trial of over 1000 miles, to be carried out on a route passing through the following centres of population:—Bristol, Birmingham, Manchester, Edinburgh, Newcastle-on-Tyne, Leeds and Sheffield. The procession of cars started from Hyde Park Corner on Monday, and the survivors will return to London on Saturday, May 12. Eleven days will be devoted to covering the distance, and at each of the above-named places the vehicles will be on exhibition for one clear day. They will also be exhibited for a few hours at Cheltenham, Kendal, Carlisle, York, Lincoln and Nottingham, and at the conclusion of the trial there will be a week's exhibition at Prince's Club, Knightsbridge. Over eighty vehicles are taking part in the trial, of which fifty-three have been entered by manufacturers and agents, and the remainder by private owners.

THE death is announced of Prof. Silas W. Holman, emeritus professor of physics at the Massachusetts Institute of Technology.

AN appreciative notice of the life and scientific career of the late Mr. J. J. Walker, F.R.S., who died on February 15, is contributed to the *University College School Magazine* by Mr. R. Tucker. Mr. Walker was appointed lecturer in applied mathematics and physics at the school in 1865, and in the same year became a member of the London Mathematical Society. He was a member of the council of the society from November 1869 to November 1874, and then again from November 1876 to November 1894; he was vice-president for two periods of two years, and president from November 1888 to November 1890. He contributed some twenty-four papers to the *Proceedings*, the longest of which were a method in the analysis of plane curves and on the satellite of a line relatively to a cubic. His presidential address was "On the influence of applied on the progress of pure mathematics." This, as remarked by his successor in office, Prof. Greenhill, "showed us how many of the most abstruse theories of pure analysis owe their origin to ideas which arose in connection with concrete and even practical requirements." His range of mathematical reading was very extensive, and he contributed papers to the Royal Society and most of the mathematical journals. From 1868 to 1882 Mr. Walker was vice-principal of University Hall. He was a member of the Physical Society, and was elected F.R.S. in 1883.

THE death of M. Gustave Planchon has removed from our midst perhaps the most active scientific pharmacist of the present day. Although typically French, Planchon's works, so far as their matter is concerned, are cosmopolitan, his "Simple Drugs of Vegetable Origin," for instance, being known to all students of pharmacy. Planchon was a graduate of Montpellier, and the first part of his career was spent in teaching pharmacy in the Montpellier Faculty of Medicine. In 1866, however, he was called to Paris as Professor of the Natural History of Medicaments. He was appointed Director of the Paris School of Pharmacy in 1886, and continued to hold that position until his death a few days ago. Most prominent among his contributions to pharmacy are his, the work mentioned above, and, brochures upon quinine, ipecacuanha and jaborandi. He was also a great authority upon the history of pharmacy and medicinal plants lore. He was quite recently elected President of the International Congress of Pharmacy, which is to take place in Paris next August, and it will be a matter of most sincere regret that one who would have filled the duties of this position so ably has been so unexpectedly cut off. Besides those who admire his work, and him on account of it, he leaves behind a large circle of close friends who will all their lives miss his kindly personality.

THE Paris correspondent of the *Times* reports that a geologist, M. Neuburgher, has just been examining, on behalf of the French Government, the mineral oil country of Oran, Algeria. It is stated that there is a tract, of at least 120 miles in length, exceedingly rich in petroleum, resembling the rich districts of Baku and Galicia.

THE death of an aëronaut at Paris from poisoning by hydrogen arsenide shows the necessity of taking precautions to purify the gas used for filling balloons. From a note in *La Nature* it appears that upon the occasion on which the accident occurred the balloon was filled in the ordinary way, and nothing peculiar was noticed in the character of the gas; but some hours afterwards the persons who had assisted in the operation were taken seriously ill, and one of them did not recover. The accident directs attention to a danger frequently overlooked.

ANOTHER effort to discover some clue to the fate of Andrée will be made this summer. The *National Geographic Magazine* states that the Swedish-Russian Expedition, which will leave about June 1 for Spitzbergen to relieve the party that is at present engaged in the work of measuring an arc of the meridian in that latitude, plans to make a detour to King Charles Land and carefully search the entire neighbourhood. It will be remembered that in September of last year a buoy was picked up on the north coast of King Charles Land, at 80° north latitude and 25° east longitude, marked "Andrée's Polar Expedition." When taken to Stockholm and opened, it proved to be what Andrée had called "the North Pole Buoy," and in which he was to place a message when he passed the North Pole. However, a microscopical examination of the interior could discover no message. As the buoy could not have drifted to King Charles Land from the neighbourhood of the Pole, the only conclusion possible is that it was a part of the wreckage of the expedition, and that possibly more wreckage may be found near by.

SWISS engineers, though so successful in the manufacture of various classes of machinery, labour under the disability that practically the whole of the iron employed, valued at over two million pounds annually, has to be imported from Germany and elsewhere. This is due, not so much to the absence of iron ores within their boundaries as to the want of coal wherewith to smelt it. We learn from the *Electrician* that recent researches in electro-metallurgy promise a means of overcoming the defect, and a scheme for the application of the electric furnace to the smelting of iron on the large scale is being developed by Herr Müller Landsmann in the Bernese Oberland, near Meiringen. A concession has been obtained from the State for the working of an outcrop of hæmatite. The vein has a thickness of 7 feet, and is visible for a length of two miles along the mountain face. Thence the ore will be transported by an aërial ropeway to Innertkirchen below. The concession obtained for the water power available from the Aar in the immediate neighbourhood, amounting to 60,000 h.p., will be used to drive the machinery required, and to supply the power for the electric smelting furnaces.

AGRICULTURAL experiment promises to become an important branch of technical education in rural districts. Prof. W. Somerville's eighth annual report on experiments with crops and stock in the counties of Cumberland, Durham and Northumberland is an instance in point. It contains the results of well-arranged experiments of direct value to the farmers of the districts in which they were made; and by encouraging work of this kind the councils of the counties mentioned are doing a service both to technical education and the agricultural community. Many of the investigations described deal with the values of natural and artificial manures for different crops. A note on the eradication of charlock amongst corn crops by spraying with solutions of sulphates of copper and iron is of wide interest. The corn crop was in no case permanently injured by the treatment, though in some cases it was temporarily harmed. In no case was clover at all injured. On the whole, a 4 per cent. solution of copper sulphate is recommended for application at the rate of 25 to 40 gallons per acre, the dressing being repeated after the interval of a week if necessary.

AT a meeting of the Academy of Science of St. Louis, on April 2, Dr. W. H. Warren read a paper giving an outline of recent progress in the chemistry of perfumes. For the most part, these substances are high boiling oils. Formerly these oils, which are complex mixtures of several compounds, were obtained exclusively from flowers, but recently some of the essential principles have been produced by chemical means, whereas other artificial perfumes are mere imitations. With a few exceptions, the essential principles which give the perfumes their value belong to the complex class of organic compounds known as the terpenes. Nearly every substance having the properties of a perfume has in its molecule certain atomic groups the presence of which exerts a marked influence on the odour. Among the more important of these may be mentioned the aldehyde, ketone, ester, ether and alcohol groups. Wonderful progress has been made in the knowledge of the terpenes and of their derivatives during the past ten or fifteen years, among the chemists who have taken a prominent part in the labour being Wallach, Baeyer and Tiemann.

PARTICULARS concerning the establishment of the Hamburg Institute for the study of nautical and tropical hygiene are given in the *Board of Trade Journal*. The Institute, like those of Liverpool and London, is a natural outgrowth of new conditions. The rapid transition from sails to steam, as a means of propulsion, the almost universal substitution of steel for wood in the construction of sea-going vessels, and the improvement in the food provided for seamen, have brought about a marked change alike in the ailments and the nature of the accidents occurring to members of the crews. Scurvy, night blindness, the so-called ship anæmia, chronic ailments of the digestive organs and canals, as well as lead-poisoning, even if not yet absolutely extinct, have become rare in a very marked degree. In their place, however, a series of new diseases has demanded the closest attention of the medical faculty. To deal with these diseases, and cases of malaria, beri-beri, black water fever, and other tropical disorders, special hospitals or institutes at large ports are needed. The Hamburg Institute is to comprise a division for patients, provided with sixty beds and a laboratory, which will be fitted for bacteriological as well as for chemical research, space being provided for twelve investigators. Five tables for research will be reserved for qualified military medical aspirants for service with the German Colonial troops or under the German Colonial Department. Their course of study of the etiology, symptoms and treatment of malaria and other grave tropical diseases, of tropical physiology and tropical hygiene, will extend over several months. Attention will also be given to the more general methods of hygienic investigation, so that the students in question, when opportunity should be forthcoming, may possess the requisite training for extended research abroad, combined with the ability to report technically thereon. The additional tables in the laboratory will be placed at the disposal of the naval and mercantile services, as well as of medical men, who, having returned from the tropics, are desirous of pursuing special branches of research. The participation of Prof. Koch in the investigation of tropical diseases has greatly assisted the decision of the German authorities in establishing the Hamburg Institute.

THE complete history of the great Japanese earthquake of 1891 is still unwritten; but Prof. Omori has contributed an interesting note upon it to the last volume of the *Publications* of the Earthquake Investigation Committee. The total disturbed area is estimated at about 900,000 sq. km. The maximum acceleration at various places was calculated from a large number of overturned bodies; that at Nagoya being 2600, and at two other places more than 4300 km., per second. The range of the motion at Nagoya must have been about 233 km. Many observations were also made on the direction of overturned bodies, from which it appears that in and near the Mino-Owari plain, the principal direction of the earthquake motion was approximately normal to, and directed towards, the meizoseismal zone.

FOR several years Prof. Omori has studied the subject of earthquake measurement in a brick building. One of Prof. Ewing's horizontal pendulum seismographs was fixed near the top of an external wall of the Engineering College at Tokyo, whilst another was erected on the ground below. During the years 1894-98, ten moderate earthquakes were recorded, and it was found that if the earthquake consisted of comparatively slow vibrations (say, above half a second in duration), the motion was practically the same in both places; but if of quick-period vibrations, the motion of the top of the wall was about twice as great as that of the ground. Prof. Omori notices that, with destructive earthquakes, the damage of two-storied buildings is generally confined to the upper storey.

WE have received a reprint, from the *Transactions* of the Royal Society of Canada, of a note, by Mr. W. Bell Dawson, on some remarkable secondary tidal undulations registered at Halifax, N.S., Yarmouth, St. Paul Island, and St. John, N.B., on January 1 and 2 of this year. The secondary movements ranged from 10 per cent. of the whole amplitude of the tide at St. Paul Island, to no less than 45 per cent. at Yarmouth. The pilot chart of the North Atlantic shows that at least three storms, two of which developed hurricane force, passed over or near the region between December 26 and January 2. Mr. Dawson does not attack the general problem of the causes of secondary undulations, which are of very frequent occurrence off the eastern seaboard of Canada, but he draws attention to the favourable conditions which exist there for observing them. The most important feature as yet determined is that the secondary undulations do not become magnified in range in the same ratio as the main tidal undulation does, under the influence of the general form of the coast.

The sudden rise of temperature over the British Islands towards the close of last week, when the temperature in the neighbourhood of London reached 78°, owing to the presence of a large area of high barometric pressure, was a very welcome change from the recent exceptionally cold period to which the latenesss of the spring in all parts of the country was due. This reading has only been once exceeded in April during the last twenty-five years. For the greater part of the month the mean of all the highest day readings was about 1° below the average, and it was not until the 19th that the temperature at Greenwich exceeded 64°; in many recent years a higher temperature has occurred in March. The returns published by the Meteorological Office show that the rainfall over England since February had been much below the average, and that the amount of bright sunshine had been deficient in most parts

To the March number of the *Agricultural Gazette* of New South Wales, Mr. W. W. Froggart, the Government Entomologist, communicates an important paper on the "plague" of locusts to which the country has lately been subjected. Although Australia has been visited by swarms of locusts from a very early period, it does not appear that these did much damage till the seventies, when farms had begun to occupy much of the open plains of Victoria and other districts. Between that period and 1891 New South Wales was devastated by swarms of the species known as *Pachytylus australis*; but in the serious visitation of 1899 the place of that kind was taken by *Epacromia terminalis*, which is believed to have moved into the colony from South Australia. Not only did the swarms destroy all the sheep-feed in the districts visited, but they likewise ruined some 20,000 acres of young wheat. Mr. Froggart concludes that an effectual remedy would be either to destroy the eggs, or to expose them in such a manner that they would be readily accessible to the attacks of birds. But he has also hopes that inoculation of the immature insects with the so-called African locust-fungus would have good results.

The March number of the *American Naturalist* contains some interesting remarks on the habits of the American gilled and blind salamander described some time ago by Dr. Stejneger under the name of *Typhlomolge*. A number of living specimens were obtained from subterranean waters at a depth of 181 feet below the surface, but only one of these survived for any length of time above ground. Unless disturbed, these salamanders spend their time in resting or in walking very slowly; when walking, they move a few steps at a time, pause awhile, and then once more advance. From the extreme slenderness of their limbs, Dr. Stejneger came to the conclusion that these were employed solely as feelers, and that progression was effected by means of the tail; but this conjecture is now shown to be incorrect.

From Mr. J. C. Thompson we have received a copy of his paper on tropical and northerly "plankton," published in the *Transactions* of the Liverpool Biological Society.

We have to thank Messrs. Eigenmann and Schafer for a copy of their paper on the mosaic of single and twin cones in the retina of fishes, published in the February number of the *American Naturalist*.

The *Irish Naturalist* for April contains an interesting account by Dr. R. F. Scharff upon all the species of whales and dolphins known to have visited the Irish coast, illustrated by good figures of their skulls, with the outline of the heads.

In a paper on some abnormally-coloured Australian birds, in the *Victorian Naturalist*, Mr. R. Hall calls attention to the fact that while in New Zealand and South Australia birds display a tendency to albinism, in North Australia, as in India, the variation tends to the development of melanism.

Hitherto the genus of vampire bats known as *Monophyllus* has been represented only by a single species from Jamaica. In a recent issue of the *Proceedings* of the Washington Academy of Sciences, Mr. G. S. Miller describes three new representatives of the genus, at least one of which is from the mainland.

The *Journal* of the South-Eastern Agricultural College, Wye, Kent—issued under the joint auspices of the Kent and Surrey County Councils—contains much valuable information in regard to pests and diseases which infect or afflict cattle and crops; the one of most local interest being an essay on "red mould" in hops.

Monsieur C. Janet, President of the Zoological Society of France, has favoured us with a copy of his "Essai sur la constitution morphologique de la Tête de l'Insecte," Paris, 1899. In this brochure, which is admirably illustrated, the author adopts the view that the true head of all insects is primarily composed of five segments.

We have received from the Trustees of the British Museum the portion of vol. ii. of the "Catalogue of the Lepidoptera Phalænæ" containing the plates, by Sir George Hampson. The execution of the coloured illustrations of these "Microlepidoptera" is all that can be desired; but we notice that the author has departed from recognised usage in calling the family *Arctiadae* instead of *Arctiidae*.

The "Psychological Index," published annually by the *Psychological Review*, is well-known to be a comprehensive and orderly bibliography of original publications in all languages, on psychology taken in its widest sense. The "Index" for 1899 has just been published, and it occupies no less than 174 pages of the *Psychological Review*.

Engler's *Botanisches Jahrbuch für Systematik, Pflanzengeschichte, und Pflanzengeographie* continues to be characterised by the value and excellence of its papers in the domain of systematic botany. The parts most recently received (vol. xxvii. Heft 5 and vol. xxviii. Heft 2) contain, among other contributions, the conclusion of the Editor's series of papers on the flora of Africa; a paper on experiments on variation in plants, by Krasan; an exhaustive paper on the genus *Thea*, and the anatomical and morphological characters of the teas of commerce, by J. Kochs; a monograph of the genus *Mollinedia* (Monimiaceæ), by Janet R. Perkins.

The report of the Epsom College Natural History Society reminds us that the study of natural objects and phenomena which the Board of Education is endeavouring to develop in rural schools, is already carried on in an admirable way by the boys in many of our public schools and colleges. We find in the present report abstracts of lectures, descriptions of work done in the astronomical, botanical, entomological, geological, photographic and zoological sections, a summary of meteorological observations, and tables of anthropological measurements of boys in the college. The lists of plants observed and dates of first blooms, of insect captures, and of the dates when various birds were seen, or their nest, eggs and young, are particularly interesting from the point of view of phenology. The evidence given by the report of interest in natural things and characteristics is gratifying to every lover of natural history, and a credit to Epsom College.

The *Athenæum* makes the following announcement:—The "Diary of White of Selborne" is to be published. He kept it, as is well known, for more than twenty-five years, and used for the purpose a form "invented" by Daines Barrington, entitled "The Naturalists' Calendar," constructed for recording on each day, in proper columns, the readings of the thermometer and barometer; the direction of the wind; the measurement of the rainfall; the weather; the appearance of leaves and flowers of plants; the appearance or disappearance of birds and insects; observations with regard to fish and other animals; and miscellaneous observations. But Gilbert White enriched his "Calendar" with much other matter. There are not only numerous disquisitions on points of natural history, but notes of events of public interest and of personal or domestic concern. These are written on interleaves, or such spaces as may happen to be available. It is proposed to arrange for the publication of the diary in the manner of the original in every substantial particular. There will be no editorial notes, except in elucidation of a few points of real obscurity. It will fill two large quartos of about 700 pages each, and Messrs. Constable and Co. are to be the publishers.

IN the current number of the *Bulletin de la Classe des Sciences* of the Royal Belgian Academy is a paper by M. Henry, on some new reactions of formaldehyde. Phosphorus pentachloride and pentabromide give methylene dichloride and dibromide respectively, the latter in so good a yield as to be an advantageous method of preparation. Formaldehyde also reacts readily with acetyl chloride to give chlormethyl acetate, acetyl bromide giving the corresponding bromine compound. The yields are better than those given by the interaction of the halogen and methyl acetate.

THE same number of the *Bulletin* contains an exhaustive study, by M. Gillot, of the hydrolysis of raffinose by *Penicillium glaucum*. In solutions containing a mineral acid the mould is able to secrete a zymase capable of inverting raffinose, and this ferment is still produced, although more slowly, when the solution is neutral. In alkaline solutions the germination of the spores is retarded, the solution losing its alkalinity as the development of the mould proceeded, finally becoming acid. The zymase from a pure culture of the *Penicillium* was isolated, and raffinose inverted by its aid.

THE additions to the Zoological Society's Gardens during the past week include a —— Baboon (*Cynocephalus*, sp. inc.) from Zanzibar, a Suricate (*Suricata tetradactyla*) from South Africa, a Common Boa (*Boa constrictor*), an Anaconda (*Eunectes murinus*) from South America, a Pin-tailed Sand-Grouse (*Pterocles alchata*), South European, deposited; a Panolia Deer (*Cervus eldi*, ♀) from Burmah, five Common Wigeon (*Mareca penelope*), three Pochards (*Fuligula ferina*), three Tufted Ducks (*Fuligula cristata*), four Goldeneyes (*Clangula glaucion*), European; a Common Boa (*Boa constrictor*) from South America, purchased; a Barbary Wild Sheep (*Ovis tragelaphus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN MAY.

May 1. 8h. 58m. to 9h. 48m. ι Tauri (mag. 4·7) occulted by the moon.

1-6. Epoch of the Aquarid meteoric shower (radiant 338°–2°).

2. 5h. Venus in conjunction with moon. Venus 4° 55′ N.

5. 11h. 48m. to 12h 42m. A^1 Cancri (mag. 5·6) occulted by the moon.

6. 11h. 1m. to 11h. 51m. ω Leonis (mag. 5·6) occulted by the moon.

7. 10h. 43m. to 11h. 49m. 19 Sextantis (mag. 6·0) occulted by the moon.

15. Venus. Illuminated portion of disc, 0·402; Mars, 0·975.

22. 10h. 8·7m. Jupiter's Sat. IV. in conjunction N. of the planet.

27. 7h. Jupiter in opposition to the sun.

28. Total eclipse of the sun, partially visible at Greenwich.

Times of Occurrence and Magnitude for places in the British Isles.

Place.	Eclipse begins. h. m.	Middle of eclipse. h. m.	Eclipse Ends. h. m.	Magnitude.
Greenwich ...	2 47·0 ...	3 54·9 ...	4 57·5 ...	0·681
Cambridge ...	2 46·7 ...	3 53·9 ...	4 56·0 ...	0·664
Oxford	2 45·3 ...	3 53·6 ...	4 56·7 ...	0·683
Liverpool ...	2 42·1 ...	3 49·9 ...	4 52·9 ...	0·655
Edinburgh ...	2 40·8 ...	3 46·1 ...	4 47·4 ...	0·599
Dublin	2 37·9 ...	3 47·4 ...	4 52·0 ...	0·676

This is the largest solar eclipse visible in England since that of 1870 December 22, when about eight-tenths of the sun were obscured.

31. 18h. Venus at her greatest brilliancy.

PHOTOGRAPHS OF THE AURORA SPECTRUM.—M. Paulsen describes in *Comptes rendus*, cxxx. pp. 655-656, 1900, his successful attempts to obtain a photographic record of the spectrum of the aurora borealis. His station was in Iceland, where he states the displays were very vivid during the period December 31, 1899, to January 25, 1900, and photographs were obtained with two spectrographs, one having a quartz train for recording especially the ultra-violet, the second with glass components. In all twenty-two lines have been recorded, of which sixteen are new. Their wave-lengths have been provisionally determined by means of comparison photographs of the spectra of air and metals, and are as follows:—

Strong lines: 337, 358, 391, 420.
Faint lines: 353, 371, 376, 381, 393, 397, 402, 406, 412, 417, 422, 432, 436, 443, 449, 456, 463, 470.

The four strong lines were obtained from even feeble streamers, but for the others it was necessary to keep the spectroscope in the brightest regions. Besides the lines given, several others can be seen between λλ 357 and 250, but are too feeble for reduction.

NEW VARIABLE STAR IN TAURUS.—Dr. Anderson, of Edinburgh, announces in the *Astronomische Nachrichten* (Bd. 152, No. 3634), that he has detected variability in the star having the following position for 1855:—

R.A. = 5h. 44·1m.
Decl. = + 15° 45′.

This star is not in the B.D., and some years ago he found it about magnitude 9·25, while on 1899 November 8 it was invisible in a 3-inch refractor, which plainly showed a neighbouring star of 11 mag. On 1900 March 26 it was about 9·7 mag.

NEW VARIABLE IN CASSIOPEIA.—In the *Astronomische Nachrichten* (No. 3634), Dr. Anderson also announces the variability of a star in Cassiopeia, whose position for 1855 is

R.A. = 23h. 48·4m.
Decl. = + 52° 55′.

On 1900 February 10 the star was 9·6 mag.; but on March 17 and 25 it was less than 10·5 mag.

FORMULA FOR ATMOSPHERIC REFRACTION.—In the *Comptes rendus* (vol. cxxx. pp. 1060–1061, 1900), M. L. Cruls gives a simple formula for calculating the astronomical atmospheric refraction, which is found to give results very closely in agreement with those calculated from Laplace's formula.

The equation is

$$R = (60'' \tan z - 1'' \tan^2 z)\left(0{\cdot}00138B - 0{\cdot}00001\frac{Bt}{2}\right),$$

in which R is the refraction, z the zenith distance of the object, B the barometric pressure, and t the temperature in degrees Centigrade at the time of observation.

A table of comparisons is given, showing that the difference in the refraction, as obtained from the above formula and that of Laplace, is only 0″·2 at 10° zenith distance, the error gradually increasing as the horizon is approached; but even at 70° zenith distance the two formulæ give results differing only by 1″·6 of arc.

DETERMINATION OF AXIS AND COMPRESSION OF NEPTUNE.—The *Astronomical Journal*, No. 479 (vol. xx. pp. 181–185), contains an article by Prof. S. J. Brown, of the U.S. Naval Observatory, on the determination of the position of Neptune's axis, and the degree of its polar compression from an investigation of the perturbations of the orbit of its satellite. Eighteen determinations of the orbit of the satellite to this planet have been made during the period 1848–1898, but, owing to the position of the planet and the plane of the orbit, many of the earlier observations are very discordant, and it was only on publication of the results obtained with the 26-inch at Washington that the certainty of change in the position of the orbit plane was manifest (*Washington Observations*, 1873, 1881, Appendix i.). Marth first drew attention to the changes as being too great for systematic errors, but attempted no explanation as to their cause (*Monthly Notices*, vol. xlvi. p. 504), and finally Tisserand used his data to show that the phenomenon could be explained by the assumption of a moderate polar compression of the planet (*Comptes rendus*, vol. cvii. p. 804). In calculating the perturbation Prof. Brown neglects the action of the sun and other planets, as the chief effect is undoubtedly due to the equatorial protuberance on Neptune itself. He therefore analytically obtains the elements of the satellite's orbit with respect to the invariable plane of the planet's equator, along which the node of the former moves with a uniform *retrograde* motion, the *inclination* of the two planes remaining constant.

The variations of these elements at the various epochs then furnish data for computing the annual motion of the node of the orbit of the satellite on the equator of Neptune as seen from the earth. The elements finally obtained indicate a period of revolution of the node in 531 years. At the epoch 1900·0 the position angle of Neptune's polar axis will be 158°·4, and the plane of its equator will make an angle of −21°·6 to the line of sight.

Taking the value 1″·10 as the most probable radius of the planet from recent observations, and the mean distance of the satellite as 16″·308, the flattening of Neptune is found to be about 1/43. This would indicate a low mean density for the planet, the value given being 1·83 times that of water.

THE RELATIONS BETWEEN ELECTRICITY AND ENGINEERING.[1]

THE nineteenth century is distinguished in our profession chiefly by the knowledge we have obtained of the constitution of *matter* and of the qualities of the materials we utilise for the service of man, of the presence and the characteristics of that medium—*the aether*—which fills all space, and of the existence, indestructibility and protean character of that great natural source of force, motion, work and power which we call—*energy*.

Electricity is only one of many forms of this energy. It is measureable in well-defined and accurately-determined units. It is produced and sold, utilised and wasted. It is, therefore, something distinctly objective. It has even been defined by Act of Parliament. There are four great principles underlying the practical applications of electricity:—

(1) The establishment of a magnetic field.
(2) The establishment of an electric field.
(3) The disturbance or undulation of the æther.
(4) The work done by the generation and maintenance of electric currents in material systems.

Electricity as a science is fascinating to every one, but it is deeply fascinating to the engineer. The trustworthiness of its laws, the accuracy of its measurements, and the completeness and definiteness of the units to which its measurements are referred give him confidence in his estimates and a certainty of the performance of his preconcerted operations. It places in his hands the means of directing the energy out of sight in positions known only to himself, and of applying it with great efficiency at the exact spot desired. No magician or poet ever conceived so potent a power within the easy reach of man.

The Doing of Work.

The maintenance of an electric current through a conductor means the expenditure of work upon that conductor, and this expenditure of internal work means molecular motion. In solid conductors the result is *heat*. If the current be gradually increased, this motion is similarly increased. The result is successively incandescence, white heat, fusion and disruption.

In liquid conductors the motion probably becomes revolution. The result is decomposition by the activity of the centrifugal force overcoming chemical affinity. The atoms fly away in fixed determined lines, and collect at opposite poles.

In gases the transference of electric energy in the form of sparks means dissociation. Compound gases are broken up into their component elements under the same directing influences. Work is done upon the gas as in the previous instances.

The principle of work that lies at the very root of the profession of the engineer enables all these operations to be measured in definite mechanical units, reducible to the common English standard, the *foot-pound*, but which the electrical engineer, with greater precision, refers to the scientific unit of work—the *Joule*.

The Purification of Matter.

The elements and their useful compounds are rarely, if ever, found pure. Impurities have to be sifted away. Ores, raw produce, rocks and earths have to be subjected to various processes of refining and conversion to extract from them that which is wanted. The electric current by the above operations has proved to be a powerful agent to break up crude materials into their useful and useless constituents. The electro-chemical industries of the world are very extensive.

According to Prof. Borchers, the eminent electro-metallurgist, the world manufacture of calcium carbide for the production of acetylene gas is utilising a power equal to 180,000 HP.; that of the alkalies and the combinations of chlorine for bleaching, 56,000 HP.; of aluminium, 27,000 HP.; of copper, 11,000 HP.; of carborundum, 2600 HP.; and of gold, 455 HP. Electroplating is one of the staple manufactures of Sheffield and of Birmingham. There are nearly 200 firms working at the former place, and over 100 at the latter.

The decomposing bath and the arc furnace are revolutionising many industries. Phosphorus is now being produced in England in large quantities from corundum, and aluminium from bauxite is extending in use and being reduced in price. The Post Office is using aluminium for telephone circuits. I have recommended its use on a very large scale in the interior of Africa, where transport is so costly. We can get the same conductivity as with copper with half the weight, and at a less price, and we can put up a line telegraphically ten times better than of iron for less money.

The Annihilation of Space.

The elements of Volta and the battery of Galvani—zinc, copper and a solution of sulphuric acid—gave a convenient generator of electric currents which could be directed along wires to great distances, and thus, by establishing magnetic fields, could deflect needles in such a way as to form the alphabet and so transmit words and, therefore, thought. In wires of great length, while the initial speed is that of light, it takes time for the electric waves to rise and fall, so that the number of currents which can be sent per second is limited. Between London and Liverpool the speed of speaking is virtually unlimited, but between Ireland and America it is restricted by the so-called *capacity* of the cable submerged in the ocean. This capacity absorbs energy and retards the rate of rise and fall of currents. While a thousand currents per second can be sent in the former case, only six per second are available in the latter.

Nevertheless, sitting on the shore of the Atlantic in Ireland, one can manipulate a magnetic field in Newfoundland so as to record simultaneously on paper in conventional characters slowly written words. Thus we have bridged the ocean and annihilated space.

The regulation of the ever-growing traffic on our railways and the safety of passengers is secured by similar means. The telegraph not only places the manager of the line in communication with every station upon his system, but electric signals control the motion of every train. A railway signal-box is an electrical exhibition. Every line is protected by its own electric signal. Every distant outdoor mechanical signal is repeated back. The danger signal is locked, and cannot be lowered to "line clear" until it is unlocked by the train itself or by the distant signalman. Mr. F. W. Webb is not only working the outdoor signals themselves by electrical energy, but he is moving the points and switches by the same means. So far, the experience gained at Crewe during a period of about twelve months, from the working of a signal cabin containing about sixty levers, has been such as to justify confidence and the extension of the system, and some

[1] Abridged from the "James Forrest" Lecture delivered at the Institution of Civil Engineers, on April 23, by Sir William Henry Preece, K.C.B., F.R.S.

ten cabins containing about 1000 levers will be provided. The apparatus has been designed to work in with, as far as possible, the standard signalling apparatus of the London and North-Western Railway. The interlocking frame may be said to be the ordinary mechanical frame in miniature, occupying one-third of the space. The levers—about 6 inches in length—are placed in two tiers, and are manipulated in the same way as the levers of a mechanical frame; consequently the signalman accustomed to the old type has nothing to learn in the new. The levers are mechanically locked by means of tappet locking, and they control carbon switches by which the 110-volt electric current is transmitted to the motors.

The object of this electric working is primarily to reduce the manual labour of the signalman, and enable him to pay more attention to the movements outside his cabin; increased speed of working; the removal of obstructions on the ground caused by the numerous wire and rod connections necessitated by the present system; and, finally, a reduction in the number of signalmen employed. Thus electricity adds to the security of life. It supplies the railway man with a new sense, and the engineer with a new power.

The abridgment of time necessarily follows from the annihilation of space, but the chief element which saves our time so much is the fact that we can, by electricity, do so much more from one spot. Indeed, in the United States the railway companies complained that their revenue between New York and Chicago suffered through the introduction of the telephone. People remained at home and did their business by wire.

It is very curious when visiting the United States to find that their morning papers contain extracts from our London evening papers of the same day. One frequently receives messages in England that were sent off to-morrow. This is due to the difference of longitude.

Wireless telegraphy, or, as it is better termed, ætheric telegraphy, has made but small progress, owing to the simple fact that the demands for its services are so very few.

Transmission of Power.

The sun is the *fons et origo* of all the available energy upon the surface of the earth. Coal and oil are extracted from its crust; oxygen is found in its atmosphere. Grasses, corn, fruits and vegetables become food and fuel for beast and man. Waters are converted into vapour, forming clouds, rain, brooks, rivers, torrents and falls. The atmosphere is disturbed by wind, and the waters of the ocean by tides. Energy is thus found available for useful work in many different forms. The problem before the engineer is how to select the best form of energy for his purpose, and how to utilise these waste energies of Nature so as to secure the best economical result. Falling water can, by a turbine or impulse wheel, convert the energy it possesses in virtue of its fall into the form of electricity. By the aid of transformers it can be raised to very high voltages; 40,000 volts is employed in California, 11,000 in Niagara. We use 10,000 between Deptford and Trafalgar Square. It can thus be transmitted to any reasonable distance, and there it can be utilised to do useful work. The waste forces of Nature are thus within our reach. The waterfalls of the Highlands may work the tramways of Glasgow; Niagara already works those of Baltimore.

The economy of this system for large industries is a question of the relative cost of the generation of energy by other means. Energy on the coal-fields can be produced cheaper by burning coal than by any water scheme that I have yet examined in this country. The price and abundance of coal renders the transmission of energy to great distances at present a very limited question indeed. Where coal is scarce and dear and water abundant, as in Switzerland, water-power is very much utilised. Where coal is abundant and cheap, as in England, it is uneconomical to adopt it. The transmission of power within limited areas by electricity in our cities is now within the range of practice. In Edinburgh it is supplied at the rate $1\frac{1}{4}d.$ per unit; this is 0·83*d.* per HP.-hour. It is invaluable for small industries. It is there ready to be used when it is wanted; it wastes nothing while idle.

The economy and efficiency of distributing power over mills, factories and workshops by electricity instead of by shafting, gearing and belts, is so pronounced that the change is being effected in every country with great rapidity. If it were a question of the mere efficiency of the two systems, the advantage of the change would not be so obvious; but it is shown by the HP.-hours expended, which means the coal bill. The efficiency of an electrical system is rarely less than 75 per cent., while that of shafting is frequently as low as 25 per cent.; but the economy is the continuous waste of the latter that tells on the coal bill, while in the electrical system there is no such waste. The motor runs when it is wanted, and expends only what energy is wanted for the particular work to be done. Electrical measurements are so exact and so easily applied that automatic records can be obtained of the work done by each machine.

Every up-to-date shop should have its electric plant for healthy light, cheap power and handy distribution of material. Its economy is demonstrable in the smallest, but in the largest shops it is at once most marked. It is always available, and it costs little. Ignorance or timidity restricts its use very much. The number of works that are run by electric motors in different parts of the country is very large indeed. The efficiency, handiness and economy of doing so is so marked that the practice is extending with great rapidity. Motors themselves are being daily improved.

On the Clyde and the Tyne, and indeed wherever shipbuilding is flourishing, there we find electrical energy driving machine tools, holding up plates, and assisting in various processes. In many large machine works, cranes and travellers are worked by it.

At Boston, U.S.A., crossing the Charles River and uniting Charlestown, the scene of the famous battle of Bunker's Hill, with its head-quarters, is a new bridge 100 feet wide and 1920 feet long, having a draw of 240 feet span, weighing 1200 tons. This draw is opened and closed by electric motors.

In the Post Office we have introduced electric motors very largely. At Leeds they are used for driving pneumatic pressure and vacuum pumps, employed there to work the pneumatic tube system. They are also used for working automatic stokers, ventilating fans and lifts.

Traction.

It is for traction purposes that electricity is making such gigantic strides. In the United States tramway working by its means has become practically universal. In the United Kingdom it is making rapid way, and in connection with electric lighting it is giving great economical results.

Electric railways are also growing apace. A bold attempt is being made by the Metropolitan Railway to work the existing line in such a way as not to interfere with the existing traffic or even with the permanent way. A new train of six coaches weighing 180 tons, having a motor car at each end weighing 54 tons, is about to run between Earl's Court and High Street, Kensington. Electric traction has an immense advantage over steam traction in impressing a continuous and uniform torque or turning moment on the shaft, and consequently a continuous and uniform effort on the trend of the wheel. The action of the steam locomotive is intermittent and the bite not continuous. Hence such frequent slipping on greasy rails. Again, the maximum torque can at once be applied by the current, and in combination with the constant effort it increases the acceleration so that a train acquires its maximum speed much more quickly. We shall increase the mean speed of the Metropolitan trains from 11 miles per hour to 15, and thereby increase the capacity of the line over 30 per cent. The stoppages on the underground railways are so frequent that the trains are always either accelerating or stopping. They never reach their top speed as they do on main lines. Electric traction enables them to start quicker and stop more promptly. On the Metropolitan the 180-ton train acquired 20 miles an hour in 200 feet, and, when going at the same speed, it was stopped in 130 feet—half its length. Smart work on such a railway depends on the rate at which trains can be emptied and filled. The English system of compartments and side doors facilitates this. It would be still further expedited if we could have one platform for entry and one for exit, and one class only.

The Liverpool and Manchester Lightning Express Railway, promoted by a very powerful representative syndicate of those two great commercial centres to carry out the scheme of Mr. Behr, is a very bold and promising venture. The line is to be monorail, 34 miles long, direct between the two cities, without any intermediate station and with no crossing. There are to be cars every 10 minutes. The speed is to be 100 miles per hour, and the time of transit 20 minutes. I know of no reason why this should not be done with safety and comfort.

The automobile car of the future has not yet seen the light. It will be electrical. Immense progress has been made in motors and in batteries. Lundell has shown how to store up the energy now wasted in descending hills, and to recover some of that absorbed by the inertia of the car. Although a battery has already been able to drive a car 100 miles with one charge, we are waiting patiently for the real automotor storage cell.

Electricity in War.

A strong contingent of electrical engineers, under the command of Major Crompton, has volunteered for service in South Africa. They are all scientifically-trained practical young engineers. Bicycles, field telegraphs, telephones, arc and glow-lamps, cables, search-lights, traction-engines and generating plant will be under their care. It is strongly hoped that we may soon hear good accounts of their performances at the front.

Electricity has been extensively applied to the development and utilisation of explosives in both the civil and military divisions of our profession. Charges are safely fired under water and blasted in mining and demolition operations by small exploding dynamos, magnetic-electric machines or induction coils acting upon high tension fuses. Sir Frederick Abel has especially distinguished himself in this direction. His fuse, composed of phosphoride and subsulphide of copper, is universally used by our War Department. Time guns are thus fired at stated hours at different sea-ports by currents originating in Greenwich Observatory. Broadsides in battleships and guns in turrets are similarly discharged. Torpedoes are even directed by currents from the shore. The defence of our coasts by submarine mines and their explosion by currents when the enemy's ships are properly located by position-finders is the last development of the application of electricity to war.

Electrical blasting has revolutionised the operations of tunnelling and driving galleries. It is much used in quarrying with great security to the men. The deepening of harbours and channels, and the removal of obstructions such as wrecks and rocks, are facilitated. On September 23, 1876, 63,135 cubic yards of solid rock were completely demolished by one discharge at Hell Gate in East River, New York. The preparation for this great blast took four years and four months. There were 4427 charged holes, each containing its mercury fulminate fuse and charges of dynamite. There were 49,914 explosions used in that one blast. Batteries were used to generate the currents, and they were arranged in large groups. Each battery exploded 160 charges. This was the record blast,

The battleship is the home of electricity. It controls the rudder, it ventilates the interior and the living space of the ship, it forces the draught and assists the raising of steam, it revolves the turrets, it trains and controls the fans, it handles the ammunition, it purifies the drinking water, it lights up the ship internally, it enables the captain to sweep the horizon with the brilliant rays of the search-light, and to communicate with his tender or with his commanding officer across space independent of weather, night, season, fog or rain.

Sanitation.

No branch of our profession fulfils the true function of the engineer more efficiently than that which deals with sanitation. Pure air, pure water, pure food, pure soil, pure dwellings, and pure bodies are the panacea for health and comfort. Electricity helps us very much in attaining some of these qualities An electric glow-lamp does not vitiate the air. It does not throw into circulation in the air any product of combustion. The question of ventilation is very much reduced in importance and rendered more simple to effect. Much less air need pass through our sitting-rooms and meeting-places. The air vitiated by our lungs can be easily withdrawn and fresh air can be forced in by fans worked by electric motors. Even the air during its entrance can be warmed, and impurities floating in it can be sifted out of it by the attraction of electrification. Heating by Dowsing's luminous electric radiators is very much on the increase; they consume 250 watts, which cost about a halfpenny per hour. In many post-offices sealing-wax is melted and kept in a liquid state by currents. Water can be sterilised by ozone, a product of electrification, and even by the nascent oxygen, when broken up into its constituent elements by electric currents. Sea-water thus electrolysed supplies us with chlorine, and converts the water into a powerful antiseptic, disinfectant and deodoriser.

Weaving.

The applications of electricity to other industrial processes are innumerable. I have time to mention only one. Mr. T. A. B. Carver has brought out a new Jacquard loom for weaving; 600 hooks are controlled electrically. The twill as well as the pattern is under complete management. It has been warmly taken up in Glasgow, and a factory has been started there.

The pattern on this cloth is woven directly from a photo-print of the artist's design, mounted on a metallic sheet; the threads of the warp being picked up by electromagnetic action, owing to the figure of the pattern being cut away, and thus allowing the circuit to be completed by the metallic sheet.

Distinction between Physicists and Engineers.

There is now a distinct line of demarcation separating the physicist from the engineer. The former dives into the unknown to discover new truths; the latter applies the known to the service of man. Research is the function of the one; utility that of the other. In the past the engineer had to rely on himself for his facts, but the advance of modern science, the growth of technical education, the formation of laboratories, and the endowment of chairs have changed all that.

We can scarcely hope for new sources of energy to be discovered, but there are some existing ones we have not touched yet. When the evil day arrives for our coal supplies to give out we may perhaps be able by the aid of electricity to utilise the heat of the sun and the tides of the ocean. There is, however, a vast illimitable store of energy not only in the rotation of the earth upon its axis, but in the internal heat of this globe itself. As we descend, the temperature gets higher and higher. It ought not to be difficult to reach such temperatures that by thermo-electric appliances we might convert the lost energy of the earth's interior into some useful electric form.

THE SIGNIFICANCE OF THE INCREASED SIZE OF THE CEREBRUM IN RECENT AS COMPARED WITH EXTINCT MAMMALIA.[1]

It has occurred to me that in order, at short notice, to take part in the celebration of the Biological Society of Paris—however briefly—I might place before my colleagues a biological problem and suggest a solution of it which, though not decisive, has, I think, much in its favour, and raises many interesting points for observation and discussion. It is well established that the extinct Mammalia of the Middle and Lower Tertiaries had—as compared with their nearest living congeners—an extremely small cerebrum. The exact figures are not important, but Titanotherium—a true Rhinoceros—had certainly not more than one-fifth of the cerebral nervous substance which is possessed by living Rhinoceros. Dinoceras representing a distinct group of Ungulata had even a smaller brain. Yet in bulk these animals were as large as, or larger than, the largest living Rhinoceros. Further, it appears from the examination of the cranial cavities of extinct and recent Reptiles, that the increase in the size of cerebrum is not peculiar to Mammalia, but that we may assert as a general proposition that recent forms have a greatly increased bulk of cerebrum as compared with their early Tertiary or mesozoic fore-bears.

It appears also that the relative size of the cerebrum in man and the anthrapoid apes may be cited here as a similar phenomenon; the more recent genus Homo having an immensely increased mass of cerebral nerve-tissue as compared with the more ancient pithecoid genera.

The significance of this striking fact—viz. that recent forms have a cerebral mass greatly larger than that of extinct forms (probably in every class of the animal kingdom)—has not been discussed or considered as it deserves. We cannot suppose that the extinct Rhinoceros, Titanotherium, was really defective in the essential control of its organisation by the cerebral nerve-centres. Probably could we see the two creatures alive side by side, we should not detect any defect in the manifestations of the nervous system in Titanotherium as compared with Rhinoceros; just as we do not remark any such obvious inferiority when we compare a lizard and (let us say) a mouse. The organism with the lesser cerebrum is in each case, in spite of the smaller mass of cerebral nerve-tissue, an efficient and adequate piece of living mechanism.

In what then does the advantage of a larger cerebral mass consist? What is it that the more recent Mammalia have

[1] By Prof. E. Ray Lankester, F.R.S. Reprinted from the "Jubilee Volume of the Société de Biologie of Paris, 1899."

gained by their larger brains? Why has there been this selection in all lines of animal descent of increased cerebral tissue?

I think we gain a key to the answer to this question by a consideration of the differences of cerebral quality between man and apes. Man is born with fewer ready-made tricks of the nerve centres—those performances of an inherited nervous mechanism so often called by the ill-defined term "instincts"—than are the monkeys or any other animal. Correlated with this absence of inherited ready-made mechanism, man has a greater capacity for developing *in the course of his individual growth* similar nervous mechanisms (similar to but not identical with those of "instinct") than any other animal. He has a greater capacity for "learning" and storing his *individual* experience, so as to take the place of the more *general* inherited brain-mechanisms of lower mammals. Obviously such brain-mechanisms as the individual thus develops (habits, judgments, &c.) are of greater value in the struggle for existence than are the less specially-fitted instinctive in-born mechanisms of a race, species or genus. The power of being educated—"educability" as we may term it—is what man possesses in excess as compared with the apes. I think we are justified in forming the hypothesis that it is this "educability" which is the correlative of the increased size of the cerebrum. If this hypothesis be correct—then we may conclude that in all classes of Vertebrata and even in many Invertebrata—there is and has been a continual tendency to substitute "educability" for mere inherited brain-mechanisms or instincts, and that this requires increased volume of cerebral substance. A mere spoonful of cerebral tissue is sufficient to carry abundant and highly efficient *instinctive* mechanisms from generation to generation; but for the more valuable capacity of elaborating *new* brain-mechanisms in the individual as the result of the individual's experience of surrounding conditions, a very much larger volume of cerebral tissue is needed.

Thus it seems probable that "educability" has increased in those Mammalia which have survived. The ancient forms with small brains though excellent "automata" had to give place, by natural selection in the struggle for existence, to the gradually increasing brains with their greater power of mental adaptation to the changing and varied conditions of life: until in man an organism has been developed which, though differing but little in bodily structure from the monkey, has an amount of cerebral tissue and a capacity for education which indicates an enormous period of gradual development during which, not the general structure, but the organ of "educability," the cerebrum, was almost solely the objective of selection.

Two lines of speculation and inquiry are strongly affected by the hypothesis thus sketched.

Firstly, as to the general laws of progressive development of bodily structure by the operation of natural selection—is it not probable that in various groups of animals, just as in the case of man among the Primates, the operation of natural selection on bodily structure (limbs, teeth, hair, horns, &c.) must have been checked, or even altogether suspended, by the transference of selection to the all-important organ of educability, the cerebrum or corresponding nerve-centres? Adaptation by means of the mental powers must take the place of adaptation of bodily structures. The educable animal leaves the ground and learns to climb trees in order to gain its food, whilst in another race the slower process of alteration of bodily form is evolving a long neck to reach the green twigs, or a ponderous strength of limb which can pull trees to the ground. Many similar cases will suggest themselves to the reader in which, even in lower animals, the capacity of learning by experience must (as it were) defeat and turn from its route the otherwise triumphant transformation of bodily structure.

Secondly, the question of the transmission of acquired characters is largely touched by these speculations. The character which we describe as "educability" can be transmitted, it is a congenital character. But the *results* of education can *not* be transmitted. In each generation they have to be acquired a-fresh, and with increased "educability" they are more readily acquired and a larger variety of them. On the other hand, the nerve-mechanisms of instincts are transmitted, and owe their inferiority as compared with the results of education to the very fact that they are *not* acquired by the individual in relation to his particular needs, but have arisen by selection of congenital variation in a long series of preceding generations.

To a large extent the two series of brain-mechanisms, the "instinctive" and the "individually acquired," are in opposition to one another. Congenital brain-mechanisms may prevent the education of the brain and the development of new mechanisms specially fitted to the special conditions of life. To the educable animal—the less there is of specialised mechanism transmitted by heredity, the better. The loss of instinct is what permits and necessitates the education of the receptive brain.

We are thus led to view that it is hardly possible for a theory to be further from the truth than that espoused by George H. Lewes and adopted by George Romanes, namely that instincts are due to "lapsed" intelligence. The fact is that there is no community between the mechanisms of instinct and the mechanisms of intelligence, and that the latter are later in the history of the development of the brain than the former, and can only develop in proportion as the former become feeble and defective.

These few lines—for the abruptness of which I apologise—will, I trust, serve to show the interesting nature of the speculations connected with the significance of the size of the cerebrum in various Mammalia and other animals. Some of the suggestions obtained from a consideration of the subject will, if carried out in detail, be found of first-rate importance in building up the science of comparative psychology.

ZONES IN THE CHALK.

THE philosophical observations on the genus *Micraster*, which were communicated by Dr. A. W. Rowe to the Geological Society in 1899, have been followed by the publication of his special researches on the zones of the white chalk on the coasts of Kent and Sussex. This second most valuable essay has been communicated to the Geologists' Association (*Proceedings*, vol. xvi. March 1900), who are to be congratulated on having such an addition to their published works. The paper follows along the lines so ably sketched out more than twenty years ago by Dr. Barrois; and Dr. Rowe, in nearly all cases, confirms the previous zonal distinctions and largely increases our knowledge. He shows how invaluable it is to collect stage by stage, and to pay the closest attention to the minute changes which the fossils, and particularly the Micrasters, undergo. The paper is essentially a zoological one, invaluable in indicating the succession of life, and as a contribution towards the genesis of species.

The ordinary subdivisions of lower, middle and upper chalk, which are important when we deal with purely geological problems, are not here dealt with; but the author, who apparently takes little interest in stratigraphy apart from fossils, admits that "we can generally recognise the zones from the appearance of the chalk alone, and that the fossils act as confirmatory evidence." This, indeed, is the experience of those who have worked at zones, and it is only by utilising properly all the evidence that satisfactory results can be obtained. Lithological evidence, often invaluable, is essentially local; the palæontological evidence, so ably and exhaustively dealt with by Dr. Rowe, is clear and uniform throughout the areas with which he deals The fossils, as he remarks, "never fail us,"—that is to say, when you find them, their testimony is safe after the experience he has gained. He has been fortunate in having such an excellent series of sections to work at, and these are well depicted in two folding plates, drawn by Mr. C. Davies Sherborn. Inland, of course, the observer has only a pit-section or road-cutting here and there to act as a guide to the zonal divisions, but no doubt with the aid of the clear descriptions given by Dr. Rowe, and of the ascertained thicknesses of the several zones, it might be possible and even desirable to trace inland their approximate boundaries, if any useful purpose were thereby gained. In any case, Dr. Rowe's work will be appreciated alike by field-geologists and palæontologists. Prof. J. W. Gregory describes a new Echinoderm, and Dr. F. L. Kitchin describes a new species of *Terebratulina* from the chalk.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. R. H. Yapp has been appointed assistant curator of the Herbarium under Prof. Marshall Ward.

Prof. Clifford Allbutt was on April 23 appointed physician to Addenbrooke's Hospital, in accordance with the recent agreement between the University and the governors.

Dr. Adami and Mr. de Soyres have been appointed delegates to represent the University at the approaching Centennial of the University of New Brunswick.

The honorary degree of D.Sc. is to be conferred on Mr. Charles Hose, of Sarawak, to-day (April 26).

AT the spring graduation ceremony of Edinburgh University, the honorary degree of LL.D. was conferred upon Miss E. O. Ormerod, Dr. C. D. F. Phillips, and (*in absentia*) Dr. A. Stuart, professor of physiology in the University of Sydney.

IT is hoped (says the *Athenæum*) that the Prince of Wales will preside at the next Presentation ceremony of London University, which will be held in the new home of the University at South Kensington on May 9.

THE governors of the Goldsmiths' Company Technical and Recreative Institute, New Cross, again report a decline in the number of students, owing to the establishment of free evening continuation classes close to the Institute by the London School Board. It will be remembered that the extension of the work of the School Board to technical education has been called into question, and that the official auditor has disallowed items in the Board's accounts referring to such expenditure. The School Board has appealed against his decision, and the whole matter will shortly be argued in the Queen's Bench Division. The engineering department of the Goldsmiths' Institute shows an increase of members, in spite of the competition of free continuation classes. It is satisfactory to notice that the governors are taking steps to encourage students to undertake systematic courses of study, extending over three or more years, and propose to periodically test the efficiency of such courses by appointing independent examiners in grouped subjects, and to award special certificates for such examinations. Mr. J. Carrington having given 100 guineas towards the encouragement of systematic study, a portion of that sum will, during the current year, be devoted to prizes in connection with these special courses. The governors report that the quality of the work done in the advanced classes in chemistry is excellent, and some useful research work is being carried on by the students.

THE annual income of the Technical Education Committee of the Derbyshire County Council is at present about 11,000*l*., exclusive of Science and Art Department's grants. This income is used to supplement local effort, and not to supersede it. Promising students of elementary schools in the county are assisted to proceed to secondary schools, and really able students of secondary schools are enabled to proceed to University or Technical Colleges, or Universities. In addition to awarding these scholarships the Council assists the development of the work of secondary schools, by means of building and equipment grants, supply of apparatus, &c. Agricultural experiments are carried on in connection with the Agricultural Department of the Nottingham University College, and the Midland Dairy Institute, Kingston, Notts. All the work of these institutions is placed under the inspection of the Board of Agriculture, which aids the work by a grant of 700*l*. a year. An experiment commenced in 1897 at Egginton for the purpose of demonstrating the influence on the quantity and quality of the herbage of permanent grass land by the use of different kinds of natural and artificial fertilisers has been continued. Each year the grass upon the different plots is cut and weighed, and the proportions of the various grasses and plants constituting the herbage is estimated. A member of the University College staff experienced in such work superintends the laying out of the plots, the sowing of the manures, and the cutting and weighing of the grass. The area under experiment is two and three-quarter acres, and the size of the plots one-eighth of an acre. The results of the experiment have been published for use by the agriculturists of the counties which promoted it.

THE report of the Advisory Committee appointed to inquire into the best manner of providing for scientific and commercial training respectively in connection with the new University of Birmingham has just been issued. It will be remembered that Mr. Andrew Carnegie and an anonymous donor each promised a gift of 50,000*l*. towards the establishment of these two departments. The committee have made inquiries as to facilities for the teaching of science in its application to industries, and they report that, in their opinion, no such teaching, complete as they contemplate it, and as it must be if it is to be successful, exists in any college in Great Britain. In making their recommendations, the committee have had in view the object of the teaching of science in its application to industry, coupled with such technical instruction in handicrafts as will enable the students to complete their course in the University itself. It is proposed that the facilities already provided in Mason University College should be supplemented by chairs of mining, metallurgy, engineering, and applied chemistry. The scheme submitted contemplates the introduction of a complete equipment for the treatment of metals by heat and a small plant for treatment by electricity, as well as the necessary outfit for testing metals. Shops would be provided for manual training, and it is recommended that the machines used should be of the best and most modern type of English, American, and foreign manufacture. The committee further recommend the acquisition of 25 acres of land in the outskirts of Birmingham on which to build the University, their estimate of the total cost being 155,000*l*.

SCIENTIFIC SERIALS.

American Journal of Science, April.—Skull, pelvis, and probable relationship of the huge turtles of the genus Archelon from the Fort Pierre Cretaceous of South Dakota, by G. R. Wieland. The marine turtles of the Fort Pierre Cretaceous of South Dakota not only represent the most gigantic species known, but also are of much importance as including undoubted descendants of Protostega from the underlying Niobrara Cretaceous, in common with which they may be regarded as ancient relatives of Dermochelys.—Application of the radio-micrometer to the measurement of short electric waves, by G. W. Pierce. A long loop of fine copper wire is suspended by a quartz fibre in a strong magnetic field. The lower ends are twisted together for some distance down, and carry at the bottom a mica vane on which is mounted a small resonator consisting of two vertical copper cylinders, joined by a constantan and a manganine wire which cross in the centre between the cylinders, and are attached to the ends of the copper wire. The impact of electric waves produces surgings between the two cylinders, which heat the junction and produce a thermo-electric current in the copper loop. The latter turns in the magnetic field, and thus indicates the waves. The author confirms Righi's observations of the different transparency of wood along and across the grain.—A large slab of Uintacrinus from Kansas, by C. E. Beecher. This paper contains photographs of a slab of limestone preserving on its surface a number of fine specimens of *Uintacrinus socialis*, Grinnell. It has 27 square feet of surface, and contains 220 crinoids.—Granodiorite and other intermediate rocks, by W. Lindgren. Granodiorite, a member of the great family of rocks with predominating soda-lime felspars, is distinguished by a granular texture, greyish colour, and a mineral composition of quartz, oligoclase or andesine, orthoclase or microcline, hornblende or biotite. The family represents an important and widespread type of rocks, especially common along the Pacific slopes of the Cordilleran ranges.—Two new American meteorites, by H. L. Preston. Describes the Luis Lopez siderite, characterised by the length of its bands of kamacite, and the Central Missouri meteorite, which is distinguished by the absence of etching figures, its beautiful pitting and prominent ridges of a lustrous dark steel-grey colour resembling graphite, and containing small quantities of carbon.

Annalen der Physik, No. 3.—Wave current generators, by C. Heinke. The author discusses variable currents from two different aspects. Some are generated as such, whereas others are generated by continuous currents broken up into variable currents by mechanical, liquid, or gaseous gaps in the circuit. The latter require a certain "saturation current" which is independent of the E.M.F.—Absorption of light in electrically-glowing gases, by M. Cantor. Kirchhoff's law does not hold for electrically glowing gases, though it may hold for flames. The author sent a strong beam of light through a vacuum tube from end to end and back, and compared its intensity with a beam passing through the open air. The beam of light suffered no absorption by the glowing gas. This result could only be made to agree with Kirchhoff's law of radiation by supposing the gas to possess an extremely high temperature. This, as we know, it does not possess. Hence we have a case of emission without absorption, which indicates that the light-producing mechanism is quite different from what it is in flames.—Analysis of oscillating jar discharges by means of the Braun tube, by F. Richarz and W. Ziegler. The authors note a curious appearance produced in a Braun kathode-ray tube when the fluorescent screen is moved in a direction at right angles to the oscillation of the beam influenced by the discharge. It is a kind of herring-bone structure, in which the slanting ribs are produced by the apparent coalescence of the points of reversal, where the track is brightest and the motion slowest.—A mixture of three powders for producing electric dust figures, by K. Bürker. A mixture far superior to the ordinary minium-sulphur combination may be obtained by mixing five volumes of flowers of sulphur with one volume of powdered carmine and three volumes of lycopodium seed. The colours are reversed with respect to the ordinary mixture.—Effect of ultra-violet light upon gaseous bodies, by P. Lenard. The author proves that not only kathode and Becquerel rays are able to make air electrically conducting, produce nuclei of condensation in it, and convert part of it into ozone, but the same effects are produced, though only to a slight extent, by the extreme ultra-violet rays. The source of light used was the electric spark, but the arc light, and even sunlight, contain some rays effective in this respect.—Quincke's rotations in the electric field, by L. Graetz. Instead of suspending spheres of the dielectrics by threads, the author mounts them in the electrolyte on points, so that they have freedom of rotation. The speed of rotation, when it becomes constant, gives a measure of the conductivity of the dielectric. This mode of measurement may be applied to measuring the conductivity of air ionised by Röntgen rays.—Electrolytic interruptor for feeble currents, by A. von Rzewuski. If the pressure of the acid upon the anode is increased, the current is interrupted at feebler E.M.F.'s. This is done by either making a current of acid flow against the anode, or by suspending the reservoir of the acid some distance above the anode and connecting it by a tube.

IN *Symons's Monthly Meteorological Magazine* for April, Mr. A. B. MacDowall draws attention to a curious fact about London summers. Since 1841, the mean temperature of the summer months (June-August) at Greenwich has fluctuated between the extremes $57^{\circ}\cdot 4$ and $65^{\circ}\cdot 1$. If we select all the summers reaching or exceeding 63°, and all those reaching or falling below 60°, it will be observed that the hottest summers are nearly all in years ending with the figures 5 to 9, and that the coolest summers are mostly in years ending with 0 to 4. It would appear, therefore, that the earlier summers in a decade tend to be cooler, and the later summers hotter. The data previous to 1841 are not so trustworthy, but if we take Dr. Buchan's figures as the most dependable, it might be shown that as far back as 1810, at least, the same contrast is indicated. The author of the paper would be glad of any explanation of the cause of this feature in our summer weather.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, March 29.—Annual General Meeting.—Prof. Thorpe, President, in the chair.—After the delivery of the presidential address, a ballot was held for the election of officers and council for the ensuing year.—At an extra meeting held in the evening, Sir H. E. Roscoe, Vice-President, delivered the Bunsen Memorial Lecture.—April 5.—Prof. J. M. Thomson, Vice-President, in the chair.—The following papers were read:—The liquefaction of a gas by "self-cooling" (a lecture experiment), by G. S. Newth. The author exhibits the liquefaction of nitrous oxide by rapidly passing the gas from the slightly-warmed storage cylinder through a fine copper tube spiral inserted in a vacuum-jacketed test-tube.—Note on partially miscible aqueous inorganic solutions, by G. S. Newth.—The decomposition of chlorates. Part ii. Lead chlorate, by W. H. Sodeau. The slow decomposition of lead chlorate by heat consists of the two independent reactions: (1) $Pb(ClO_3)_2 = PbCl_2 + 3O_2$, and (2) $Pb(ClO_3)_2 = PbO_2 + Cl_2 + 2O_2$. The reaction $PbO_2 + Cl_2 = PbCl_2 + O_2$ simultaneously proceeds to a greater or less extent.—The bromination of benzeneazophenol, by J. T. Hewitt and W. G. Aston.—A new glucoside from willow-bark, by H. A. D. Jowett. The author has isolated, from the bark of a species of *Salix*, the glucoside of metahydroxybenzaldehyde and gives to it the name salinigrin.—Alkylation by means of dry silver oxide and alkyl iodides, by G. D. Lander. Dry silver oxide and ethyl iodide react with acetanilide yielding ethyl *i*-acetanilide, $C_6H_5N:C(OEt)Me$.—The interaction of mesityl oxide and ethyl sodiomethylmalonate, by A. W. Crossley. By the condensation of mesityl oxide with ethyl sodiomethylmalonate, ethyl trimethyldihydroresorcylate, $C_{12}H_{18}O_4$, is obtained; on hydrolysis it yields trimethyldihydroresorcinol,

$$CMe_2 \begin{matrix} \diagup CHMe.CO \diagdown \\ \diagdown CH_2 — CO \diagup \end{matrix} CH_2.$$

—The products of the action of fused potash on dihydroxystearic acid, by H. R. Le Sueur.

Entomological Society, April 4.—Mr. G. H. Verrall, President, in the chair.—Mr. M. Jacoby exhibited specimens of the genus *Sagra* from Eastern Asia.—Mr. M. Burr exhibited three species of *Pseudophyllidae*, two new species of *Capnoptera* (females), and *Capnoptera quadrimaculata*, Westw. (female), collected in the Siamese Malay States by Mr. N. Annandale. The specimens illustrated the peculiar methods of protection adopted by the insect when alarmed.—Mr. H. J. Elwes communicated a paper on "Bulgarian Lepidoptera," and made some remarks on the more notable species which he had taken in the Balkan Peninsula during the months of June and July 1899. The number of species of *Rhopalocera* captured was 120, which, with a further 20 recorded by Haberhauer and Lederer, brings up the total to 140. The mountains visited were an extension of the Rhodope range where the climate was particularly rainy, a great number of ferns flourishing everywhere, in contrast to the drier Balkans, where the number of species of *Rhopalocera* is not less than 200. Some interesting forms but no new species were encountered. A variety of *Colias myrmidone* occurred much larger and brighter than the Austrian, and more nearly agreeing with the Ural, form. The form of *Coenonympha davus* met with showed an affinity with the Asiatic and not the European form. The form of *Argynnis pales* was intermediate between that found in Greece and the central European Alps, while a form of *Erebia*, var. *gorgone*, was taken similar to that in the Pyrenees—a curious instance of interrupted distribution.

Linnean Society, April 5.—Mr. C. B. Clarke, F.R.S., Vice-President, in the chair.—Mr. W. B. Hemsley, F.R.S., exhibited and made remarks on a selection of plants collected by Dr. A. Henry and Mr. W. Hancock in the neighbourhood of Mengtze and Szemao in Western China.—Dr. D. H. Scott, F.R.S., read a paper "on *Sphenophyllum* and its allies, an extinct division of the vascular cryptograms." The author explained that his purpose was not to communicate any new observations, but to give a summary of our present knowledge of the group and to discuss its affinities. He pointed out that the study of the Palæozoic Flora not only greatly widens our conception of the three existing classes of Pteridophyta, but adds a fourth—that of the Sphenophyllales—to their number. The various views which have been held as to affinities of the Sphenophyllales were discussed in the light of the results recently attained. The supposed relation to Hydropteridæ, though supported by some ingenious arguments, was rejected as baseless, and as inconsistent with the manifest Filicinean affinities of that family. The author came to the conclusion that the Sphenophyllales were most naturally regarded as the derivatives of a synthetic group, combining the characters of Lycopods and Equisetales, and indicating the common origin of these two classes.

PARIS.

Academy of Sciences, April 17.—M. Maurice Lévy in the chair.—On the heat of combustion of some very volatile liquids, by MM. Berthelot and Delépine. The method for burning volatile liquids in the calorimetric bomb previously described by the authors involves the use of collodion films, and as collodion is not infrequently dissolved by the vapours of the liquid under examination, a new method has now been devised. The liquid is sealed up in a thin glass bulb, which it completely fills, and this bulb is burst in the bomb by a small piece of camphor, the weight and heat of combustion of which are exactly known. Determinations are given for aldehyde, methylal, methyl formate, ethyl formate, propaldehyde and isopropaldehyde.—A rotating contact breaker, and some arrangements for producing powerful high frequency currents, by M. d'Arsonval. A description of the apparatus used in the decoration of the front of the electricity section at the Paris Exhibition. The condenser was of a special type, micanite plate immersed in petroleum being used; glass, ebonite, celluloid and paraffined paper were all found to be rapidly destroyed by the currents in use. A new device for breaking the circuit by blowing out an arc is also described.—On the *Stigmaria*, by M. Grand' Eury. The observations of the author are opposed to the view that the *Stigmaria* are the roots of *Sigillaria*, a study of over one hundred specimens showing distinct differences between the two kinds of roots. The true *Stigmaria*, although frequently found together with the roots of *Sigillaria*, appear to have lived generally in much deeper waters.—Influence of periodic perturbations of semi-major axis upon the value of the mean motion deduced from the observations of a planet, and on the corresponding correction of the value originally adopted for the semi-major axis, by M. A. Gaillot.—On a simplified formula for calculating astronomical refractions, by M. L. Cruls.—On series of rational fractions, by M. Émile Borel.—On the characteristics of partial differential equations and the principle of Huygens, by M. J. Coulon.—Vortex motions with cellular structure. Optical study of the free surface, by M. Henri Bénard.—The increases of resistance in radio-conductors, by M. Édouard Branly. The usual effect observed in receivers for the Hertzian waves is a decrease of resistance. In certain cases, however, the opposite is the case, and the experimental results for a tube containing lead peroxide are given.—Induction and electrostatic oscillations, by M. P. de Heen.—Remarks on a recent note of M. G. le Bon, by M. P. Curie. The property of losing its luminosity possessed by a radiferous barium chloride, recently made the subject of a communication by M. le Bon, has been previously published by several authors.—A new microchemical reaction of palladium, by MM. M. E. Pozzi-Escot and H. C. Conquet. Potassium nitrite and excess of a caustic alkali give characteristic crystals with a solution of a palladium salt.—Experimental researches on the physiological phenomena accompanying chlorosis in the vine, by M. Georges Curtel. Chlorosis is accompanied in the diseased leaf with a marked decrease in the respiratory activity and diminution of the ratio $CO_2 : O_2$, by a diminution or cessation of assimilation, and by a great decrease in the transpiratory function.—On a Selaginella from the coal-measures of Blanzy, by M. R. Zeiller.—Sub-divisions of the Senonian in Portugal, by M. Paul Choffat.—On the production of calcium carbide, by M. L. K. Böhn.

DIARY OF SOCIETIES.

THURSDAY, APRIL 26.

ROYAL INSTITUTION, at 3.—A Century of Chemistry in the Royal Institution: Prof. J. Dewar, F.R.S.
INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Electric Transmission of Power: Prof. George Forbes, F.R.S.
INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Road Locomotion: Prof. Hele-Shaw, F.R.S.

FRIDAY, APRIL 27.

ROYAL INSTITUTION, at 9.—Nineteenth Century Clouds over the Dynamical Theory of Heat and Light: Lord Kelvin, G.C.V.O., F.R.S.
PHYSICAL SOCIETY (Solar Physics Observatory, Exhibition Road, South Kensington), at 8.—A short account of the Physical Problems now being investigated at the Solar Physics Observatory, and their Astronomical Applications: Sir Norman Lockyer, K.C.B., F.R.S.—Weather permitting, the 36-inch, 10-inch, and 9-inch telescopes will be used for the observation and photography of celestial objects and their spectra. The Apps-Spottiswoode coil and 21-ft. Rowland grating will also be in operation.

SATURDAY, APRIL 28.

ROYAL INSTITUTION, at 3.—Egypt in the Middle Ages: Prof. Stanley Lane-Poole.

MONDAY, APRIL 30.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Through Africa from the Cape to Cairo: Ewart S. Grogan.
INSTITUTE OF ACTUARIES, at 5.30.—Census-Taking: Dr. Reginald Dudfield.

TUESDAY, MAY 1.

ROYAL INSTITUTION, at 3.—Studies in British Geography: Dr. H. R. Mill.

WEDNESDAY, MAY 2.

ENTOMOLOGICAL SOCIETY, at 8.
SOCIETY OF PUBLIC ANALYSTS, at 8.

THURSDAY, MAY 3.

ROYAL INSTITUTION, at 3.—A Century of Chemistry at the Royal Institution: Prof. J. Dewar, F.R.S.
LINNEAN SOCIETY, at 8.—Note on the Movements in Fishes: Prof. R. J. Anderson.—On New Species of *Halimeda*, from Funafuti: Miss E. S. Barton.—On West Indian Fungi: Miss A. L. Smith.
CHEMICAL SOCIETY, at 8.—Brazilin, Part IV.: A. W. Gilbody, W. H. Perkin, jun., and J. Yates.—Hæmatoxylin, Part V.: W. H. Perkin, jun., and J. Yates.—The Substituted Nitrogen Chlorides and Bromides derived from *o*- and *p*-acet-toluide and their Relation to the Substitution of Halogens in Toluides and Toluidines: F. D. Chattaway and K. R. P. Orton.
RÖNTGEN SOCIETY, at 8.—Demonstration and Exhibition of New Methods and Results.
INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—If the discussion on Prof. Forbes's Paper, read on April 26, is concluded, the following Paper will be read:—The Calculations of Distributing Systems of Electric Traction under British Conditions: H. M. Sayers.

FRIDAY, MAY 4.

ROYAL INSTITUTION, at 9.—Pottery and Plumbism: Prof. T. E. Thorpe, F.R.S.
COLD STORAGE AND ICE ASSOCIATION (Examination Hall, Victoria Embankment), at 11.30.—Recent Researches in Refrigeration: G. Halliday.—Insulation and Insulators: W. D. A. Bost.——At 3.—Electric Lighting of Cold Stores: W. B. Esson.—The Design and Construction of Buildings for Ice Factories and Cold Storage: P. Gaskell.

SATURDAY, MAY 5.

ROYAL INSTITUTION, at 3.—Egypt in the Middle Ages: Prof. Stanley Lane-Poole.

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