Nature

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

Vol. 44
May to Nov. 1891

Supplement to Nature,
November 26, 1891

Nature

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

VOLUME XLIV

MAY 1891 to OCTOBER 1891

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH

London and New York
MACMILLAN AND CO.
1891

[Supplement to Nature,
November 26, 1891

RICHARD CLAY AND SONS, LIMITED,
LONDON AND BUNGAY

INDEX

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

THURSDAY, MAY 7, 1891.

FOSSIL INSECTS.

The Fossil Insects of North America, with Notes on some European Species. By Samuel H. Scudder. 2 Vols. 4to, Illustrated. (New York: Macmillan and Co., 1890.)

THE name of Mr. S. H. Scudder is familiar to students of every branch of zoology through his invaluable "Nomenclator Zoologicus." Though that work alone would be sufficient to earn the gratitude of zoologists, yet the author's claims to especial distinction really rest on the results of his investigations into the structure and distribution of fossil insects, and more particularly those of North America.

The magnificent work before us, containing considerably more than a thousand pages of letterpress, and illustrated by no less than sixty-two beautifully-executed plates, as well as by numerous figures in the text, contains, in a collective form, practically the whole of the author's contributions to the history of North American fossil insects, together with much important information relating to those of Europe. In reality, however, it treats of more than is revealed by its title, since the author includes under the head of insects not only the animals usually thus designated (which he distinguishes as Hexapods), but likewise the Myriopods and Arachnids. Since the issue of the work is limited to 100 copies (each separately numbered), it is probable that it will soon acquire an adventitious value above that which it possesses from its intrinsic merits. Apart from the author's admirable account of fossil insects (in the larger sense of the term) contributed to Prof. von Zittel's "Palæontologie," the work is the only one giving an exhaustive history of the subject, and is therefore invaluable to all interested in this branch of study. And the excellent manner in which the volumes are turned out demands a meed of praise alike to author, artists, and printers. Indeed, the only serious fault in the book is that in the first volume no explanation of the plates is given otherwise than in the text, at the close of the articles they severally illustrate.

The first of the two volumes treats exclusively of the pre-Tertiary insects, and consists of a reprint of upwards of twenty articles and essays published in various serials, dating from December 1866 to September 1890. The second volume, which is a replica of the one recently issued by the U.S. Geological Survey of the Territories, formerly under the charge of the late Dr. F. W. Hayden, contains practically the whole of what has been written concerning the Tertiary fossil insects of North America, in which field the author, with one small exception, is the sole worker.

In the first volume, as we are informed in the introduction, the whole series of essays shows the manner in which the author's views have been gradually modified in certain respects with increasing knowledge; and we think he has exercised a very wise discretion in allowing the articles to stand as they were written, and thus permitting the gradual evolution of his later views to be traced.

The earliest known true insect is *Palæoblattina* of the lower part of the Upper Silurian of France, regarded by its describer as a cockroach, although considered by our author as probably one of the Neuropteroid Palæodictyoptera (p. 286); but with this exception the insects from the Upper Devonian of the United States claim the earliest position. It is, however, only (as the author tells us elsewhere) when we reach the coal-measures that we find insect-faunas of any considerable extent, such as those of France and Illinois. The Permian, if, with the author, we refer the coal of Saarbrück to the Carboniferous, is, however, poor in insects; and the Trias, with the exception of that of parts of Colorado, almost barren. The later Secondary beds of America are likewise very barren of insect-remains, so that we have to turn to Europe to gain any definite knowledge of the fauna of that date. In the Tertiaries abundant insect-faunas occur in several river and lake-basins of both hemispheres; two of the most celebrated being the Florissant basin of Colorado, and that of Œningen on the Rhine.

The wings of the Palæozoic insects being those parts of the body which are most commonly preserved in a satisfactory condition, Mr. Scudder, at the commencement of his studies, devoted particular attention to this subject; and the first volume commences with an inquiry into the relationship of the Neuropteroid insects of the North American Carboniferous to the existing Neuroptera, as exemplified by the structure of their wings. It would be out of place here to allude to the variations in the structure of the veins of the wings presented by different groups of insects, and their derivation from a common plan of structure; and we may accordingly proceed to notice the most interesting chapter in the whole volume. This is the essay on Palæodictyoptera, commencing on p. 283. Here we have a detailed account of the reasons which induced the author to separate the whole of the Palæozoic insects from the existing orders under the name of Palæodictyoptera—a term first proposed by Goldenberg in lieu of Dohrn's preoccupied Dictyoptera, which had been suggested for an order typified by the Permian *Eugereon*. This order is defined more by the generalized characters of its various members, and the lack of those special characteristics which are the property of existing orders, than by any definite peculiarities of its own. One of its most important features is, however, that the two pairs of wings are always closely similar to one another, being equally membranous, and with the six principal veins always developed. With the exception of a few cockroach-like insects found in the American Trias, the Palæodictyoptera not only includes all the insects of the Palæozoic, but is restricted to that period, and is, therefore, extremely convenient to the geologist. The order is divided into various sections, which are severally regarded as the ancestors of the existing orders whose names they bear. Thus, the Palæozoic cockroaches constitute the Orthopteroid Palæodictyoptera; while we have a Neuropteroid section represented by *Platephemera*, *Miamia*, &c.; and an Hemipteroid one by the above-mentioned *Eugereon*. The presence in wood of Carboniferous age of borings similar to those made by modern Coleoptera, further suggests the existence of a Coleopteroid section of the order. The author (p. 320) considers that such Coleopteroids "at first showed no greater distinction between the front and hind wings than existed in other Palæodictyoptera; but afterwards those races were preserved in which the thickening of the membrane of the upper wings the better protected the insects in their burrows for the marriage flight in open air."

The author gives a still fuller account of the reasons for adopting the order Palæodictyoptera, in the essay on "Winged Insects from a Palæontological Point of View" (p. 317), from which the preceding extract is taken. Great stress is there laid on the fact that the differentiation of wing-structure characteristic of modern insects did not exist in those of Palæozoic times; all of them having a common type of neuration barely admitting of division into families. The differences in the organs of the mouth, as exemplified by the biting *Progonoblattina* (a Palæozoic cockroach) and the suctorial *Eugereon*, are considered merely as physiological adaptations of no morphological value (pp. 284, 285).

The facts and arguments detailed by the author leave, then, no doubt as to the close affinities and undifferentiated characters of all the Palæozoic insects; and also that the group Palæodictyoptera includes the ancestors of a considerable number of the existing orders of insects. Since, however, all the latter are clearly divergent branches from one or more common stocks, and are in no sense ancestral to one another, the suggestion arises whether it might not be advisable to group all the existing orders together—say, under the name of the Neodictyopterine "series"; and to rank the Palæodictyoptera as a "series" of equal value, in which the various members were not sufficiently differentiated from one another to constitute "orders." It is a very significant fact that, while the Palæozoic insects show ancestral forms of those recent orders grouped together by Packard as the Heterometabola, they include no ancestral types of the more specialized orders—Lepidoptera, Hymenoptera, and Diptera—constituting the Metabola. We have, therefore, proof that these specialized types are of later date; and it thus appears that palæontological evidence is in favour of Packard's classification.[1] Of the existing orders of insects it appears, indeed, that while the Neuroptera, Orthoptera, and Coleoptera are more or less fully represented in the Trias, it is not till the Lias that we meet with Hemiptera (Rhynchota), although *Eugereon* may be taken as sufficient evidence that a Triassic member of that order must have existed. None of the Metabola are known before the Lias, the Diptera and Hymenoptera dating from that epoch, while the Lepidoptera are unknown till the Middle Jurassic.

Though space does not permit of much further reference to the true insects of the pre-Tertiary epochs, we cannot pass over the interesting essay (p. 323) on the oldest known insect larvæ. These larvæ, which appear to be very abundant in the Trias of the Connecticut River, are known as *Mormolucoides* (*Palephemera*), and there has been much discussion as to whether they indicate Coleopteroid or Neuropteroid insects. Mr. Scudder's mode of treating this difficult question is a model of palæontological induction. After carefully reviewing all the evidence, he concludes that the fossils come nearer to the larvæ of the Neuropterous families *Perlidæ*, *Ephemeridæ*, and *Sialidæ*, and that the relationship is nearest to the latter family, which belongs to the true Neuroptera. Another exceedingly interesting article (p. 433) refers to the cockroaches of the Fairplay beds, Colorado. Several of the species from these beds belong to the Palæodictyoptera, showing the complete interdependence of two of the veins of the fore-wing characteristic of the Palæozoic types. Others, however, are true Orthopteroid cockroaches, and we thus seem to have presented to our view the very period when the Palæodictyoptera were passing into the Orthoptera. From the mingled Palæozoic and Mesozoic facies presented by their insect fauna, the author is disposed to refer the Fairplay beds to the Trias; although, as is so frequently the case, the plant-evidence does not accord with that presented by the animals.

Passing to the Palæozoic Myriopods, we notice that while all the forms described in the earlier essays are clearly referable to extinct ordinal groups, the progress of discovery has recently shown (p. 393) that side by side with these lost types there existed in the Coal-measures of Illinois Centipedes closely allied to existing forms, and

[1] Many authorities, attaching more importance to the nature of the metamorphosis, transfer the Coleoptera to the higher group (Holometabola), in which some also include the true Neuroptera, placing the Pseudoneuroptera with the Orthoptera.

belonging to the same ordinal group (Chilopoda). The essays respectively commencing on pp. 195 and 247 of the first volume give the full history of the specimens on which the author founded the orders Protosyngnatha and Archipolypoda. The former group is represented only by a single specimen from the Carboniferous of Illinois, described as *Palæocampa;* this curious creature being of small size, and in its short body, with pencils of bristles on the back, presenting a superficial resemblance to the well-known larva of the tiger-moth. Of more interest are the Archipolypoda, confined in America to the Carboniferous and Permian, although represented in the "Old Red" of Scotland. A restoration in Plate vii. A, of one of the largest of these creatures (*Acantherpestes*) gives an excellent idea of their extraordinary appearance; the animal being represented as emerging from the water and ascending the stem of a *Lepidodendron.* The figured species attained a length of about one foot; its amphibious habits being inferred from the presence of lateral apertures presumed to be branchial. The Archipolypoda agree with the Diplopoda, or Millepedes (and thereby differ from the Chilopoda), in having two ventral plates, each carrying a pair of limbs, to every dorsal plate, but differ in that each dorsal plate occupies at most only two-thirds, instead of nearly the whole of the circumference of the body. The larger species, like the figured one, were further distinguished by carrying rows of long spines on the dorsal plates. The smaller forms originally discovered by Sir J. W. Dawson in the Sigillarian stems of Nova Scotia, which were doubtless of purely terrestrial habits, and have been described as *Xylobius* and *Archiiilus,* appear to indicate a distinct group of this order approximating to the modern Millepedes.

As an instance of the danger of drawing inferences in palæontology from negative evidence, we may quote a sentence from p. 196 of the first volume, where the author states that "The Diplopoda are universally considered the lower of the two in their organization, and it is therefore not surprising to find that no Chilopoda have been found in rocks older than the Tertiary series, while Myriopods with two pairs of legs corresponding to each dorsal plate range back through the entire series of rocks to the Coal-measures." This inference is, of course, completely traversed by the above-mentioned discovery of Carboniferous Chilopoda; and it may be suggested whether the presumed coalescence of two dorsal segments in the Diplopoda and Archipolypoda is not a character in advance of the Chilopoda.

The only essay devoted to Arachnids in the first volume is the one commencing on p. 419, which was originally published for the first time in September 1890. This essay treats of the Palæozoic order Anthracomarti, and of that division of the Pedipalpi known as the Phrynidea; the Scorpions being reserved for a future occasion. The Arachnids differ from both the insects and Myriopods in being represented by an existing order (Scorpions) as far back as the Silurian. Indeed, the only extinct order of the class is the Anthracomarti, which is confined to the Carboniferous, and is regarded as having some points of connection with the Adelarthrosomata, as represented by the *Phalangidæ* ("Harvestmen"), and others with the Pedipalpi, the relationship being on the whole nearer to the latter. They are characterized by their somewhat depressed bodies, in which the abdomen is distinct from the cephalothorax, and consists of a single mass composed of from four to nine distinct joints; while the palpi are short, and do not terminate in pincers or claws. With the possible exception of the Scorpions, these appear to have been the most abundant of the Carboniferous Arachnids, and were represented by a number of genera; those described in the essay before us being arranged in two families and six genera. In the Phrynidean section of the Pedipalpi, containing the Spider-Scorpions, Mr. Scudder describes a new Carboniferous genus, *Græophonus,* besides giving further characters of a previously-described species of *Geralinura,* whose nearest living ally is *Thelyphonus,* of the tropical regions of Asia, America, and Australia.

Passing to the second volume, on the Tertiary insects, of which only a very brief notice can be given, we may touch upon a few points mentioned by the author in the introduction. One of the most noteworthy circumstances to which he refers is the extraordinary profusion in which insect remains have been preserved in some of the Tertiary lake-basins of North America, this being especially the case with the Florissant basin of Colorado, belonging to the Oligocene epoch. Not less remarkable is the fact that in "hardly a single instance has the same species been found at two distinct localities"; and this not only when the localities are separated by hundreds of miles, but even when they are comparatively near. The author considers that this peculiarity may be explained by the absence of exact synchronism between any of the insectiferous beds, and he is thus led to infer that insects will probably afford very valuable aid in determining geological horizons, the modification of species having progressed much more rapidly than is the case with plants.

Another point to which attention is directed relates to the extraordinary number of forms known only by a single specimen; the author stating that, in beds whence thousands of insects have been obtained, every third or fourth specimen will prove to be a new form. The interest of these investigations is enhanced by the discovery that a considerable proportion of the Tertiary insects must be referred to extinct genera; the author considering that a large number of the species he has placed in existing genera will eventually have to be removed to new ones. We trust, however, that Mr. Scudder will not burden the science with more new terms than are absolutely essential; more especially since, if he favours us with a new edition of his "Nomenclator," he will have the additional labour of recording them a second time.

Following the introduction there is a chapter devoted to the American localities where fossil Tertiary insects are most abundantly found. In addition to the Florissant basin of Colorado, there are deposits of approximately the same age on the White River in Colorado and Utah, as well as on the Green River in Wyoming. Less productive spots include a town in Wyoming, rejoicing in the appropriate name of "Fossil," as well as various places in British Columbia, Ontario, and Pennsylvania. There are also a certain number of insects—mostly Coleoptera—from Pleistocene or recent bone-caves and other superficial deposits.

By far the greater bulk of the enormous collection with which the author has had to deal was obtained from the Florissant basin; and it is to these alone that our few remaining observations will refer. The mass of material from these deposits is, however, so vast that in the present volume (large as it is) the author has found it possible to deal only with the Arachnids, Myriopods, and the Neuroptera, Hemiptera, and Orthoptera among the true insects. Some introductory remarks are, however, given as to the relative proportions in which the Lepidoptera, Hymenoptera, Diptera, and Coleoptera, are represented in these beds.

The total number of specimens of insects obtained from Florissant during the labours of a single summer is estimated to be more than double that obtained during thirty years at the celebrated European locality, Œningen.[1] A remarkable difference occurs between the relative number of species of the different orders of insects found at the two places. Thus, while at Œningen the Diptera are less than 7 and the Hymenoptera less than 14 per cent. of the whole; at Florissant they reach respectively 30 and 40 per cent. On the other hand, while the Œningen Coleoptera form nearly half of the whole number, at Florissant they fall to 13 per cent. The great percentage of Hymenoptera is due to the prodigious number of ants; in which respect, as also in the small proportion of beetles, the fauna agrees better with that of Radaboj, in Croatia, to which it likewise approximates more closely in age. It would take too much space to enter into the details of the proportions in which the various families of the different orders are represented in these beds; but it appears that, with the exception of the Lepidoptera, nearly every prevalent family may be demonstrated to have been in existence at that epoch. Among the beetles, about three-fifths belong to the normal series, and the remaining two-fifths to the weevils; water-beetles being unexpectedly scarce. Lepidoptera are rare, only eight species of butterflies, all referable to different and extinct genera, and about the same number of moths being at present known. It is of especial interest to note that, while seven of the eight butterflies belong to the *Nymphalidæ*, no less than two of these are referable to the sub-family *Libytheinæ*, the members of which, although found in every quarter of the globe, are fewer in number than many other groups, consisting only of ten species, referable to the single genus *Libythea*. It is, therefore, a legitimate inference that the *Libytheinæ* have been on the wane since the Oligocene or some later Tertiary epoch. Some writers, it may be mentioned, regard *Libythea* as the representative of a family rather than a sub-family.

In taking leave of the author, we congratulate him on the patience and perseverance which have carried him thus far through a task of unusual magnitude and difficulty, and hope ere long to have the pleasure of welcoming its completion. With the widely-scattered literature of palæontology ever increasing, the importance and value of monographs like the present, where the whole subject is collectively treated by a master-hand, cannot be too highly estimated.

R. Lydekker.

[1] Œningen is situated on the right bank of the Rhine, between Shaffhausen and Constance, and is in Baden, and not, as the author states on p. 26, in Bavaria.

STATISTICS OF POPULATION AND DISEASE.

Studies in Statistics. By George Blundell Longstaff. (London: Edward Stanford, 1891.)

"STUDIES" is a title appropriate to these somewhat detached investigations concerning at least three different classes of subject. The first few chapters, relating to vital statistics, are described by the author as "of an introductory and elementary character"; though the discussion which is contained in one of them, on the fluctuation of death-rates, varying according to the cause of death, does not appear to us so very rudimentary.

A great part of the book is occupied with the "growth of population": whether by "natural increase" or immigration. England and Wales alone add 1000 a day to the population of the world. "Over and above reserve men who fill up the gaps caused by death, a fresh regiment at full war strength daily marches to the front." To what quarters are they marching? The answer involves a consideration of intra-migration, as Mr. Longstaff terms the migration between the several divisions of the same kingdom. The inquiry brings into view the relatively slow increase of rural as compared with urban districts—a contrast not peculiar to the United Kingdom.

These and other facts, extracted from records accessible to all, are not absolutely new to the student of Statistics. Yet they excite gratitude, almost as much as if they were wholly due to the author; enhanced as they are by the wealth of his inferences and the luxury of his illustrations.

The statistics of the growth of America are less familiar to the English reader. By a careful analysis of the American census, Mr. Longstaff estimates that nearly one-third of the whole population (almost 28 per cent.) is "foreign"; considering as foreign not only those born of foreign parents (whether in America or elsewhere), but also *half* of those who, though native-born, have *one* foreign parent. This heterogeneity of population constitutes a grave social and political danger; particularly in the case of the rapidly-growing coloured population. In more than one sense, says the author, a black cloud may be said to hang over the future of the Republic.

Canada is not equally threatened by the dangers arising from a mixed population. Yet, even in Canada, the fact that the persons of French race form about a third part of the population, and increase more rapidly than any other known people, "cannot but be a source of anxiety and possible trouble in the future." The solidity of our Australian colonies is more perfectly satisfactory.

Surveying the British Empire, the writer exhibits the growth of the colonies relatively to the mother country during the last half-century. Whereas the ratio between the populations of the colonies and the United Kingdom was 7 : 100 in 1841, it had become 21 : 100 in 1881. Entertaining the idea of an Imperial Federation, our statistician thus estimates the balance of power in the imagined Federal Parliament. If every 100,000 of white population are entitled to one representative, then 61 per cent. of the Imperial Parliament would be English; the proportions for Scotland and Ireland would be 9 and 12 per cent. respectively.

But the political interest of these estimates must not detain us from what is perhaps the most severely scientific part of the work before us—namely, the investigation of the causes of disease. This medical portion of the volume may, as the author fears, "prove too technical for many readers"; and, perhaps we should add, critics. The student of such statistics must bring much knowledge in order to carry away much. The need of this requisite may be illustrated by one of Mr. Longstaff's examples. Certain of the curves which he traces show a remarkable correspondence between the outbursts of diphtheria and a group of other diseases, amongst which are croup and cynanche maligna. And yet between the two latter diseases and diphtheria the correspondence at some dates is not so close as the suggested theory desiderates. Diphtheria in 1859 rose enormously, while the other diseases did not rise simultaneously, or even fell. But, as we understand the matter, the theory is saved by the surmise that many cases previously ascribed to croup and cynanche maligna, were put down to diphtheria in 1859 and afterwards, when the stir created by letters in the newspapers had excited the attention of observers to the "new disease." This is one of those explanations of figures which an outsider would probably not even have thought of, and the importance of which he is little qualified to estimate.

The "ætiology" of the subject must be left to the expert. The general reader, if he cannot penetrate to the laws of causation, may at least admire the uniformity of results which the author's diagrams exhibit. The nature of some of his observations, and the labour and care which they required, are indicated in the following quotation:—

"The object of my investigation was . . . [principally] to see whether any, and if so what, relations subsist between diseases believed to be distinct. . . . I accordingly traced eighty-nine curves representing the death-rates per million in England and Wales from as many 'alleged causes.' . . . By a simple application of the law of combinations, it will be found that to compare all these eighty-nine curves two and two together, would involve 3916 operations. Of these I have as yet actually made only 1425."

This comparison of curves representing the fluctuation of death-rates for different diseases forms some of the most beautiful pieces of statistics which we have ever seen. We may allude in particular to the comparison of erysipelas, scarlatina, rheumatism of the heart, and certain other diseases with each other and the variations in the rainfall (Plate xix.). The death-rates are shown to be parallel to each other, not only for different times, but also, in the case of three of the diseases, for different places in all the eleven registration counties of England and Wales. The splendid diagram which exhibits this manifold comparison (Plate xxi.) affords, as the author points out, a good illustration of the value of large numbers in statistical inquiries.

"The curves for England and Wales exhibit smaller fluctuations than those for sections of the country, and the correspondences between them [between the rise and fall of death-rates for three specified diseases] are in nearly all cases much closer."

Among investigations of which the interest appeals to the mere statistician as distinguished from the medical expert, we may mention the calculation of the frequency with which coincidences between the deaths of both husband and wife from phthisis "might be expected to occur *as a pure matter of chance*, on the hypothesis that phthisis is *not* a communicable disease." By a beautiful application of the calculus of probabilities, the following conclusion is reached:—

"It is plain, therefore, that, to show any substantial argument for the existence of infection, it would require a much larger collection of cases than has yet been published."

Another inquiry which the general reader will follow with peculiar interest relates to hydrophobia. The statistics suggest laws very different from popular beliefs. The paucity of the observations, however, necessitates caution; which Mr. Longstaff does not fail to inculcate. It is not his least merit that he instils what may be called the logic of statistics by occasional precept, as well as by repeated examples.

OUR BOOK SHELF.

The Best Books: A Contribution towards Systematic Bibliography. By William Swan Sonnenschein. Second Edition. (London: Swan Sonnenschein and Co., 1891.)

THE idea of this "contribution towards systematic bibliography" is excellent, and has been excellently carried out. When interest in a subject has been excited, the first question of the student, of course, is, Who are the best and most recent authorities on the matter? The question is by no means always easily answered, for as yet there are few good subject-indexes, and the most valuable of them are not within the reach of everyone. The present volume may almost be said, for ordinary practical purposes, to have solved the problem. Mr. Sonnenschein has not attempted anything so ambitious as a philosophic classification of the sciences. He has worked out his scheme on what he properly calls "a common-sense plan," grouping books first into large classes, then breaking them up into sections, sub-sections, and paragraphs—"with the result of obtaining all the literature of one subject in one list, and that of outlying subjects close at hand." He begins with theology, next takes mythology and folk-lore, then philosophy, society (including many different branches), geography, history, archæology, and so on, until all important departments of knowledge have been included. No one who has occasion to use the book will have the slightest difficulty in understanding the principle, or in finding the particular subdivision presenting the facts of which he is in search. The new edition contains the titles of twice as many books as the first edition (50,000 as against 25,000); and, so far as we have been able to examine them, they seem to have been admirably selected. Here we have to do only with the scientific part of the work; and, considering how vast is the material from which Mr. Sonnenschein had to choose his lists of scientific treatises, he may be congratulated on the manner in which his task has been accomplished. For the most part, he refers only to books that are in print, and easily obtainable. The very best books he has "asterisked," and in every case he gives the dates of the first and last editions, with the price, size, and publisher's name. Two separate indexes—one, a list of authors, with the titles of their works; the other, a list of subjects—add greatly to the value of the compilation.

The Fairyland Tales of Science. By the Rev. J. G. McPherson. Second Edition. (London: Simpkin, Marshall, and Co., 1891.)

THIS volume consists of a number of papers which appeared originally in various periodicals. The author does not profess to embody in them the results of independent research. His object is to give to readers who may not have access to recent scientific authorities "an accurate and at the same time interesting account of the remarkable discoveries in science during the last decade." This object he attains. His style is clear and straightforward, and, without being "sensational," he knows how to present facts and principles in a way that is likely to arrest attention and awaken curiosity. Among the subjects dealt with are the formation of dew, the colour of water, dust and fogs, lightning, sun-spots, after-glows, the enumeration of organisms in air, micro-organisms in water, and characteristics of deep-sea fishes. The first edition was issued about two years ago. In the present edition the author has added a few notes to bring the facts up to date.

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.*]

County Councils and Technical Education.

YOUR article of April 30 (vol. xliii. p. 602) is scarcely fair to the London County Council.

When you allege that the Council "*have 'grabbed' a fund, ear-marked for educational purposes*," you assume the question at issue. The only way in which the fund in question is "earmarked" for educational purposes is by a clause in the Act which gives each Council a discretionary power to apply the fund either to those purposes or to other purposes, as they choose.

London, which, as proved by Mr. Goschen, is exceptionally rated, has come badly off in the general scramble for Imperial doles which are devoted to the alleviation of rates; and if the representatives of London ratepayers treat this additional dole out of the beer and spirit duties as a make-up for their comparatively small share of other doles, they are doing not only what the law allows, but what equity justifies.

I believe, however, that amongst those who voted against the plan proposed by the Committee of the Council there are many who would not be unwilling to see the money devoted to education, if any well-considered and reasonable plan were proposed for this purpose.

But there are several questions which have to be answered before this can be done properly.

What do the promoters of "technical education" mean by that term? It is not to be the teaching of the elementary school; it is not to be the training of the workshop; but between these two extremes all is uncertain. The counties say, "instruction in the elements of farming"; the London County Council Committee says, "Polytechnics"; the statute says, "whatever the authorities at South Kensington define it to be." Educational reformers generally, so far as I can judge, mean by it all or any forms of secondary education, *i.e.* of the education which carries forward the work of the elementary school, and brings the pupil nearer to the business of life. But we need to be a good deal more precise before we establish a precedent and a practice.

Then, again, is it wise for the London County Council, which has work enough on its hands in looking after the physical condition of this great City, to take upon itself a task for which it is in no way fitted, and which was not contemplated when it was elected? Is it wise to muddle administration by first intrusting one part of education to one elective body—viz. the School Board—and then intrusting another part of it to a different elective body chosen for a different purpose?

Whilst such questions as these remain unanswered, the London Council exercises a wise discretion in not committing itself to any scheme for appropriating this fund, the offspring of a legislative fluke, to any special and permanent object.

You speak, as persons in general speak, of the London County Council as one amongst other County Councils. The name County Council is a misnomer which leads to constant errors. The London County Council has little or nothing in common with the bodies which have taken the place of the old magistracy in most districts. It is really the chief Town Council of the largest city or aggregation of cities in the world, and the rules and reasoning which, under the ill-drawn and ill-digested Local Government Act, are applied to both, are often singularly inappropriate. Calling London a county is the parent of endless mistakes; and to abuse the London Council because it is not acting in the same way as the Councils of counties seem disposed to act is no less confused than unfair. T. H. FARRER.

May 5.

The Alpine Flora.

I HAD not intended to continue the discussion on this subject, but Prof. Henslow's last letter calls for a few remarks. My argument, summed up, is as follows:—

(1) Alpine plants as a class show certain characters, *e.g.* dwarfing and compact growth.

(2) These characters are advantageous to them, or are correlated with such as are advantageous.

(3) Although dwarfing, &c., may be produced as the direct result of environment (*e.g.* poor soil), there is normal variability in respect to size, time of maturing, &c.

(4) When in cultivation those plants are selected which show a natural tendency to dwarfing, &c., it is found that the character is inherited; and in this way, dwarfed, early-maturing, and other peculiar races can be produced.

(5) On the other hand, when plants have been dwarfed from growing in poor soil, or otherwise as the result of environment acting directly upon them, there *appears* to be no evidence to show that the peculiarity is inherited.

(6) Supposing natural selection to be the only factor, it is fully competent, working on the normal variability, to produce the results observed, *so far as they are hereditary*. At least, so it seems to me.

To illustrate the point, take *Mertensia* again. In Colorado, *M. sibirica* grows in ravines, &c., by creeks; it could not possibly grow in the same way above timber-line, with its tall stems and abundant foliage. Yet it gains much advantage in the creek-bottoms from its height and rank growth; if it were a dwarf, it would be almost or altogether smothered. Above timber-line, on the Sangre de Cristo Range, I found the dwarf species, *M. lanceolata*. Thus we have two species frequenting different situations in the same district: each is fitted for its station; either, removed to the station of the other, could not exist. In Arctic regions, *M. sibirica* has produced a dwarf variety called *drummondii*, which is, I suppose, a first step towards the establishment of a dwarf Arctic species.

Prof. Henslow asks why, if natural selection eliminates tall plants on Alpine summits, it does not also do so lower down? I am not at all clear that it does not, in some cases. For example, why is it that plants growing on exposed sea-shores have a tendency to lie upon the ground or otherwise to evade the violence of the winds? But when a plant is growing among others, it has to compete with them in raising itself into conspicuousness, and any slight disadvantage from exposure to the winds would be more than compensated by the advantage of being able to spread its flowers and foliage in the sunlight and attract insects.

The only plant of any size I found above timber-line on the Sangre de Cristo Range was *Cnicus eriocephalus*, a wonderful great thistle, with bright chrome-yellow flowers, which are visited by humble-bees. But this plant is very prickly and woolly, and its heads are nodding; it is, though it seems paradoxical to say so, a gigantic dwarf.

The splendid *Primula parryi* shows its crimson flowers by creeks at very high altitudes in Colorado; an allied but *very small* species lives above timber-line in the same districts, called *P. angustifolia*. These are true species; *angustifolia* is not starved or frozen *parryi*. Now *P. parryi* is coming into cultivation, it would be interesting to see whether it could be modified by environment in the direction of *angustifolia*, and how far such modification would be inherited.

There are other matters one might discuss, but I think I have already written enough. I merely ask, will Prof. Henslow give a case in which the direct effect of environment *has* produced inherited dwarfing? Will he also show that natural selection cannot produce a dwarfed variety, or that artificial selection has not? T. D. A. COCKERELL.

3 Fairfax Road, Bedford Park, Chiswick, W., April 27.

MR. THISELTON-DYER, in his interesting letter in NATURE (p. 581), does not mention one of the striking characteristics of the Alpine flora—the remarkable brilliancy of the flowers, as compared with those borne by the same or similar species in

England. A comparison of this kind made by the memory is no doubt not severely scientific, but those tourists in Switzerland who are in the habit of observing flowers will probably confirm the statement. Plants grown at high levels in the Alps are, as Mr. Dyer says, above a great screen of aqueous vapour, and I have in my own mind always put down the greater brilliance of Alpine flowers to their getting more sun than in our cloudier climate. It is not, however, solely any alteration in the actual effects of the solar rays, caused by this absence of aqueous vapour, that makes the colours of Swiss flowers so bright. The same, or, I should assert from memory, even greater, brilliancy, will be found in Arctic and sub-Arctic Norway by anyone who visits the Throndhjem district and the coast to Hammerfest in June. Western Norway notoriously is one of the moistest parts of Europe; but, on the other hand, it has, broadly speaking, no night at midsummer. It is thus apparently the quantity, and not the quality, of the sunlight that causes the peculiarly vivid colours of Swiss flowers, including those of the pastures from 2000 feet upwards. I have never been in Switzerland in spring, and I cannot therefore judge whether the colours of the flora in the lower districts are also more brilliant than ours; but it will be seen below that Swiss observers find that the high Alpine flora is much more brilliant than the same plants in the lowlands.

Our great national garden at Kew is peculiarly badly situated for the growth of Alpines. The situation is low and foggy, and mild muggy weather alternates with night frosts. Above all, the smoke pall of London is peculiarly destructive in connection with the other disadvantages of the site. Alpine plants, as Mr. Dyer shows, are, in their natural state, at rest under a cloak of snow during the winter. The least warmth, however, starts them into growth, and the marvellously rapid flowering of many kinds in the ooze on the melting of a snow-bed, is one of the most curious sights of the Alps. The Kew climate (and the general English one too, though to a lesser degree) keeps the plants in growth in winter. Then fogs, smoke, and damp collect on the young growth. These enemies are peculiarly liable to attach themselves to the numerous sorts with hairy or woolly leaves. Then follow night frosts, and the young growth perishes.

The application of these remarks is, that it does not follow that, because cold frames are necessities in the culture of Alpines at Kew, they should be used elsewhere in England. There has been a long discussion recently on this very point in the gardening papers, and the general belief appears to be, that given a fairly dry climate cold frames are *injurious*, because they excite and keep plants in growth when they should be at rest. A sheet of glass suspended over a plant in the open air, so as to shoot off our superfluous rain and to keep off some of our fog, appears to be much better, for premature growth is not stimulated. Alpines should so far as practicable be kept as dry as we can in winter, by drainage, light soil, &c. Then when growth commences, say in March, they should be well watered each day (unless it is raining), early in the morning. The plentiful moisture thus supplied to some degree takes the place of the melting snow, and it has dried off before the evening frosts seize upon the leaves. The plants thus can grow freely in the day because they are surrounded with a moist atmosphere, and they are kept "stocky" (in gardeners' phrase) by the cold at night, just as they are in fact on the Alps. This is the plan recommended by that great authority M. H. Correvon, of the Jardin Alpin d'Acclimatation, Geneva. In the drier climate of that city, M. Correvon replaces the snow blanket of the Alps by pine boughs fastened closely over his Alpines. In England this would, I fear, only make the plants rot. It does not follow that, because many plants in frames at Kew grow long and straggling and lose their natural habit, they do so in England generally in the open air. The changes in the habits of Alpines are largely due to changes in soil. For instance, the Edelweiss (*Gnaphalium leontopodium*) grows perfectly freely from seed anywhere about London, but the flowers lose their compactness. I am told, however, that if plenty of lime is added to the soil they become as compact and close as in Switzerland.

In "Les Plantes des Alpes" (Geneva, Jules-Carey) M. Correvon very fully explains his views, formed, after great practical experience, on the conditions of the Alpine flora. Your space will not allow me to make many quotations from a work of the utmost interest both theoretical and practical, but the following bears on my point as to the brilliant colours of Alpine flowers:—

"Ces végétaux sont 'reine Kinder des Lichtes,' comme les a appelés un poète allemand; on ne trouve pas de champignons dans les Alpes, ni aucune plante qui n'appartienne franchement au domaine de la lumière. Aussi les espèces de nos plaines qui se trouvent transportés là-haut sont-elles parées de couleur bien plus vives, bien plus pures qu'elles ne sont chez nous."

M. Correvon gives a number of instances in support of this, which I will not quote here. In conclusion, is Mr. Dyer correct in thinking that the soil in the high Alps is permanently frozen with the exception of a slight film on the top? I am aware that when you get to considerable elevations the subsoil is frozen. For instance, I was told that the reason for the well-known mortuary on the Great St. Bernard was that bodies could not be buried there. But a great many of the flowers generally called Alpines grow below the tree limit of 6000 or 6500 feet, and few are to be found above 8000 feet. If the subsoil on the higher Alps is frozen, it would not apparently be so where trees grow, and it would be interesting to know the line of subterranean frost, and at what depths below the surface it is permanent at various elevations. J. INNES ROGERS.

Chislehurst, April 27.

Co-adaptation.

I DO not propose to extend the discussion on this subject beyond the present communication, but I cannot refrain from calling attention to the remarkable discrepancy in the position taken by Dr. Romanes in his last letter (April 23, p. 582), and that in his former communication (March 26, p. 489), in which he says:—"I do not . . . hold myself responsible for enunciating Mr. Herbert Spencer's argument, which the quotation sets forth. I merely reproduced it from him as an argument which appeared to me valid on the side of 'use inheritance.' For not only did Darwin himself invoke the aid of such inheritance in regard to this identical case . . . &c." If words have any meaning, this implies that Dr. Romanes agrees with Darwin in regarding this case as one in which "use inheritance" played a part. Now, after I have endeavoured to show that this supposed case of co-adaptation can be explained without the aid of "use inheritance" at all, Dr. Romanes says that there is no difference of opinion on this point between us. I can only say that I am very glad to learn this admission on his part, but why did he quote the argument from Herbert Spencer as "valid on the side of 'use inheritance,'" if he did not believe it to be a case of true co-adaptation? R. MELDOLA.

High and Low Level Meteorological Observatories.

I HAVE read with much interest your article of the 11th inst. on the results obtained by simultaneous observations in the meteorological observatories at the base and at the summit of Ben Nevis. Ben Nevis rises to a height of only 4370 feet above the sea, and yet we find that the comparison of these observations gives results of a kind that could not be obtained from any number of stations all on the same level. Might we not hope for still more valuable results from similar observatories placed at the base and the summit of Etna and Teneriffe? Etna is 10,870 feet high, and Teneriffe 12,200. These would be better than any Alpine stations, because of their perfect isolation.

Belfast, April 25. JOSEPH JOHN MURPHY.

An "International Society."

AN institution with the grandiloquent title of "The International Society of Literature, Science, and Art," which appears now to be largely touting for subscriptions, publishes in its prospectus a list of the "Honorary Council," among whom appears "Professor Flower." As I am the only person in this country to whom such a description could be applicable, and as many of my friends have inquired of me whether I have really given my support to the institution, I wrote to the secretary to inquire by what authority the name appeared, and received the following reply, which needs no comment:—

"Sir,—We beg to acknowledge the receipt of your favour of Saturday. The gentleman to whom you refer is the well-known Professor Ogilby Flower, of New York. I am sorry the coincidence should have caused you any annoyance. In future printings of our prospectus the Christian name shall be inserted, so that no misunderstanding may exist."

Although this letter was dated March 9 last, I find that the prospectus continues to be issued unchanged, otherwise I should not have cared to trouble you with what may appear a small personal matter. I may mention that there are other names upon the list which present as great or even greater difficulties of identification. W. H. FLOWER.

British Museum (Natural History), May 2, 1891.

ON SOME POINTS IN THE EARLY HISTORY OF ASTRONOMY.[1]

II.

WE have next to deal with the astronomical relations of the horizon of any place, in connection with the worship of the sun and stars at the times of rising or setting, when of course they are on or near the horizon; and in order to bring this matter nearer to the ancient monuments, we will study this question for Thebes, where they exist in greatest number and have been most accurately described.

The French and Prussian Governments have vied with each other in the honourable rivalry of mapping and describing the monuments. The French went to Egypt at the end of the last century, while the Scientific Commission which accompanied the army, a Commission appointed by the Institute of France, published a series of volumes containing plans of all the chief temples in the valley of the Nile, as far as Philæ.

In the year 1844, after Champollion had led the way in deciphering the hieroglyphics, we became almost equally indebted to the Prussian Government, who also sent out a Commission to Egypt, under Lepsius, which equalled the French one in the importance of the results of the exploration; in the care with which the observations were made, and in the perfection with which they were recorded. Hence it is that in attempting to get information from ancient temples it is wise to study the region round Thebes, where the information is so abundant and is ready to our hand.

We have then to consider an observer on the Nile at Thebes, and to adjust things properly we must rectify the globe to the latitude of 25° 40′, or, in other words, incline the axis of the globe at that angle to the wooden horizon.

It will be at once seen that the inclination of the axis to the horizon is very much less than in the case of London. Since all the stars which pass between the North Pole and the horizon cannot set, all their apparent movement will take place above the horizon. All the stars between the horizon and the South Pole will never rise. Hence, stars within the distance of 25° from the North Pole will never set at Thebes, and those stars within 25° of the South Pole will never be visible there. At any place the latitude and the elevation of the pole are the same. It so happens that all these places with which archæologists have to do in studying the history of early peoples, Chaldæa, Egypt, Babylonia, China, Greece, &c., are all in middle latitudes, therefore we have to deal with bodies in the skies which do set and bodies which do not, and the elevation of the pole is neither very great nor very small. In each different latitude the inclination of the equator to the horizon as well as the elevation of the pole will vary, but there will be a strict relationship between the inclination of the equator at each point and the elevation of the pole. Except at the poles themselves the equator will cut the horizon due east and due west. Therefore everything to the north of the equator which rises or sets will cut the horizon between the east or west point and the north point; those bodies which do not set will of course not cut the horizon at all.

The sun and stars near the equator, in such a latitude as that of Thebes, will appear to rise or set at no very considerable angle from the vertical; but when we deal with stars rising or setting near to the north or south points of the horizon they will seem to skim along the horizon instead of rising directly.

Now it will at once be obvious that there must be a strict law connecting the position of the sun or a star with its place of rising or setting. Stars at the same distance from the celestial pole or equator will rise or set at the same point of the horizon, and if a star does not change its place in the heavens it will always rise or set in the same place. Here it will be convenient to introduce one or two technical terms: we generally define a star's place by giving, as one ordinate, its distance in degrees from the equator: this distance is called its declination. Further, we generally define points on the horizon by dividing its whole circumference into 360°, so that we can have *azimuths* of 90° from each pole to the east and west points. We also have *amplitudes* from the east and west points towards each pole. We can say then that a star of a certain declination will rise or set at such an azimuth; or at such an amplitude. This will apply to both north and south declinations.

The following table gives the amplitudes of rising or setting (north or south) of celestial bodies having declinations from 0° to 64°; bodies with higher declinations than 64° never set at Thebes if they are north, or never rise if they are south, as the latitude (and therefore the elevation of the pole) there is nearly 26°.

Amplitudes at Thebes.

Declination.	Amplitude at Thebes.		Declination.	Amplitude at Thebes.	
°	°	′	°	°	′
0	0	0	33	37	11
1	1	7	34	38	21
2	2	13	35	39	31
3	3	20	36	40	42
4	4	26	37	41	53
5	5	33	38	43	5
6	6	40	39	44	17
7	7	47	40	45	30
8	8	53	41	46	43
9	9	59	42	47	56
10	11	6	43	49	10
11	12	13	44	50	25
12	13	20	45	51	41
13	14	27	46	52	57
14	15	34	47	54	14
15	16	41	48	55	32
16	17	49	49	56	51
17	18	56	50	58	12
18	20	3	51	59	34
19	21	10	52	60	58
20	22	17	53	62	23
21	23	25	54	63	51
22	24	33	55	65	21
23	25	41	56	66	54
24	26	49	57	68	31
25	27	58	58	70	12
26	29	6	59	71	59
27	30	15	60	73	55
28	31	23	61	76	1
29	32	32	62	78	25
30	33	41	63	81	19
31	34	51	64	85	42
32	36	1			

This being premised, we now pass to the yearly path of the sun, with a view of studying the relation of the various points of the horizon occupied by the sun at different times in the year. In the very early observations that were made in Egypt, Chaldæa, and elsewhere, when the sun was considered to be a god who every morning got into his boat and floated across space, there was no particular reason for considering the amplitude at which the boat left, or came to, shore. But a few centuries showed that this rising or setting of the sun in widely varying amplitudes at different parts of the year

[1] From shorthand notes of a course of lectures to working men delivered at the Museum of Practical Geology, Jermyn Street, in November 1890. The notes were revised by me at Aswan during the month of January. I have found, since my return from Egypt in March, that part of the subject-matter of the lectures has been previously discussed by Herr Nissen, who has employed the same materials as myself. To him, therefore, so far as I at present know, belongs the credit of having first made the suggestion that ancient temples were oriented on an astronomical basis. His article is to be found in the *Rheinisches Museum für Philologie*, 1885. Continued from vol. xliii. p. 563.

depended upon a very definite law. We now, of course, more fortunate than the early Egyptians, know exactly what this law is. We saw in the last lecture that not many years ago Foucault gave us a means of demonstrating the fact that the earth rotates on its axis. We have also a perfect method of demonstrating that the earth not only rotates on its axis once a day, but that it moves round the sun once a year, an idea which was undreamt of by the ancients. As a pendulum shows us the rotation, so the determination of the aberration of light demonstrates for us the revolution of the earth round the sun.

We have, then, the earth endowed with these two movements—a rotation on its axis in a day, and a revolution round the sun in a year. To see the full bearing of this on our present inquiry, we must for a time return to the globe or model of the earth.

To determine the position of any place on the earth's surface we say that it is so many degrees distant from the equator, and also so many degrees distant from the longitude of Greenwich: we have two rectangular co-ordinates, latitude and longitude. When we conceive the earth's equator extended to the heavens, we have a means of determining the positions of stars in the heavens exactly similar to the means we have of determining the position of any place on the earth. We have already defined distance from the equator as north or south declination in the case of a star, as we have north latitude or south latitude in case of a place on the earth. With regard to the other co-ordinate, we can also say it is at a certain distance from our first point of measurement, whatever that may be, along the celestial equator; speaking of the stars we call this distance right ascension, as speaking of matters earthy we measure from the meridian of Greenwich and call this distance longitude.

The movement of the earth round the sun is in a plane which is called the plane of the ecliptic, and the axis of rotation of the earth is inclined to that plane at an angle of something like 23½°. We can if we choose use the plane of the ecliptic to define the positions of the stars as we use the plane of the earth's equator. In that case we talk of distance above the ecliptic as celestial latitude, and along the ecliptic as celestial longitude. The equator, then, cuts the ecliptic at two points: one of these is chosen for the start-point of measurement along either the equator or the ecliptic. It is called the first point of Aries.

We have, then, two systems of co-ordinates, by each of which we can define the position of a star in the heavens: equatorial co-ordinates dealing with the earth's equator, ecliptic co-ordinates dealing with the earth's orbit. Knowing that the earth moves round the sun once a year, the year to us moderns is defined with the most absolute accuracy. In fact, we have three years: we have a sidereal year—that is, the time taken by the earth to go through exactly 360° of longitude; we have what is called the tropical year, which indicates the time taken by the earth to go through not quite 360°, to go from the first point of Aries till she meets it again; and since the equinoctial point advances to meet the earth, we talk about the precession of the equinoxes; this year is the sidereal year minus twenty minutes; then there is also another year called the anomalistic year, which depends upon the movement of the point in the earth's orbit where the earth is nearest to the sun; this is running away, so to speak, from the first point of Aries, instead of advancing to meet it, so that in this case we get the sidereal year plus nearly five minutes.

The angle of the inclination of the earth's plane of rotation to the plane of its revolution round the sun, which, as I have said, is something like 23½°, is called *the obliquity of the ecliptic*. This obliquity is subject to a slight change; 6000 years ago it was over 24°.

In order to give a concrete idea of the most important points in the yearly path of the sun round the earth, I have here four globes representing the earth, with another globe in the middle representing the sun, showing the four practically opposite points of the earth's orbit, in which the north pole of the axis is most inclined to the sun; the north pole of the axis is most inclined away from the sun; and the two opposite and intermediate points where the axis is not inclined to or from the sun, but is at right angles to the line joining the earth in these two positions.

A diagram (Fig. 6) shows what will happen under these conditions. If we take the two points at which the axis, instead of being inclined towards the sun, is inclined at right angles to it, it is perfectly obvious that we shall get a condition of things in which the movement of the earth on its axis will cause the dark side of the earth

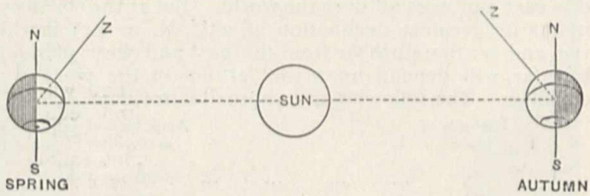

FIG. 6.—Diagram showing the equality of the sun's zenith distance at the two equinoxes. N, north pole of the earth; S, south pole; Z, zenith of Greenwich.

and also the light side represented by the side nearest to the sun both being of equal areas, to extend from pole to pole; so that any place on the earth rotating under those conditions will be brought for half a period of rotation into the sunlight, and be carried for half a period of the rotation out of the sunlight; the day, therefore, will be of the same length as the night, and the days and nights will therefore be equal all over the world.

We call that the period of the equinoxes; the nights are of the same length as the day in both these positions of the earth with regard to the sun.

But in Fig. 7 we have a very different condition. Here the north pole is inclined at the greatest angle of 23½° towards, and away from, the sun. If I take a point very near the north pole, that point will not, in summer, be carried by the earth's rotation out of the light,

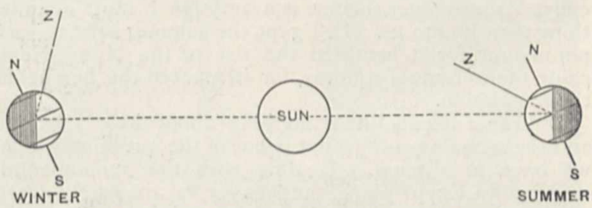

FIG. 7.—Diagram showing the variation of the sun's zenith distance from solstice to solstice. N, north pole of the earth; S, south pole; Z, zenith of Greenwich.

and a part equally near the south pole will not be able to get into it. These are the conditions at and near two other points called the solstices.

In each of these globes I have placed a wire to represent the overhead direction from Jermyn Street, London, and if I observe the angle between this direction of the zenith to the sun in winter I get a considerable one; but if I take the opposite six-monthly condition and take the same zenith point, I get a very small angle. In other words, under the first condition the sun will be far from the zenith of Jermyn Street, we shall have winter; and in the other condition the sun will be as near as it can be to the zenith of Jermyn Street, we shall have summer. These two points represent the two points in the earth's orbit at which the sun has the highest declination north or south. With the greatest north declination the sun will come up high, appear stationary for a day or two, as it does at our summer solstice, and then go down again; at the other point, when it has the greatest southern declination, it will go down to the lowest point, as it does in our winter, stop, and come up again—that is, the sun will stand still, and the Latin word solstice exactly expresses that idea. We have then two points in the annual revolution of the earth round the sun at which we have equal altitudes of the sun at noon, two others when the altitude is greatest and least. We get the equal altitudes at the equinoxes and the greatest and the least at the solstices. These altitudes depend upon the change of the sun's declination. The change of declination will affect the azimuth and amplitude of the sun's rising and setting, this is why the sun sets most to the north in summer and most to the south in winter. At the equinoxes the sun has always 0° Decl., so it rises and sets due east and west all over the world. But at the solstices it has its greatest declination of 23½° N. or S.; it will rise and set therefore far from the east and west points; how far, will depend upon the latitude of the place we consider. The following are approximate values:

Latitude of place.	Amplitude of sun at solstice.
°	° ′
25	26 5
30	27 24
35	29 8
40	31 21
45	34 40
50	38 20
55	44 0

At Thebes, representing Egypt, we find that the sun's azimuth at the summer solstice will be 26° N. of E. at rising, and it will be 26° N. of W. at setting.

These solstices and their accompaniments are among the striking things in the natural world. In the winter solstice we have the depth of winter, in the summer solstice we have the height of summer, while at the equinoxes we have but transitional changes; in other words, while the solstices point out for us the conditions of greatest heat and greatest cold, the equinoxes point out for us those two times of the year at which the temperature conditions are very nearly equal, although of course in the one case we are saying good-bye to summer and in the other to winter. To people who live in tropical or sub-tropical countries a summer solstice is a very much more definite thing than it is to us. In Egypt the summer solstice was paramount, for it heralded the rise of the Nile. Next came the autumnal equinox, for it marked the height of the inundation.

Did the ancients know anything about these solstices and these equinoxes? That is one of the questions which we have to discuss. Dealing with the monumental evidence in Egypt alone, the answer is absolutely overwhelming. The evidence I propose to bring before you consists of that afforded by some of the very oldest temples that we know of in Egypt. Among the most ancient and sacred fanes in Egypt was one at Abydos, which, the tradition runs, was built by the Shosou-Hor or servants of Horus (therefore sun-worshippers) before the time of Menes; Menes, as we have seen, having reigned at a date certainly not less than 4000, and possibly 5000 years B.C.

First a word as to the general plan of a temple such as we find it in Egypt. They may be arranged architecturally into two main groups. Edfou is the most perfect example of one of the first group, characterized by having a pylon consisting of two massive structures right and left of the entrance, which are somewhat like the two towers that one sometimes sees on the west front of some of our English cathedrals. The Temple of Ramses II. in the Memnonia at Thebes is another example (Fig. 8).

From the entrance-pylon the temple goes stretching along through various halls of different sizes and details until at last at the extreme end of the temple what is called the Sanctuary, Naos, or Holy of Holies, is reached. The end of the temple at which the pylons are situated is open, the other is closed. These lofty towers, and indeed the walls, are sometimes covered with the most wonderful drawings and hieroglyphic figures and records. Stretching in front of the pylons, extending sometimes very far in front, are rows of sphinxes. This prin-

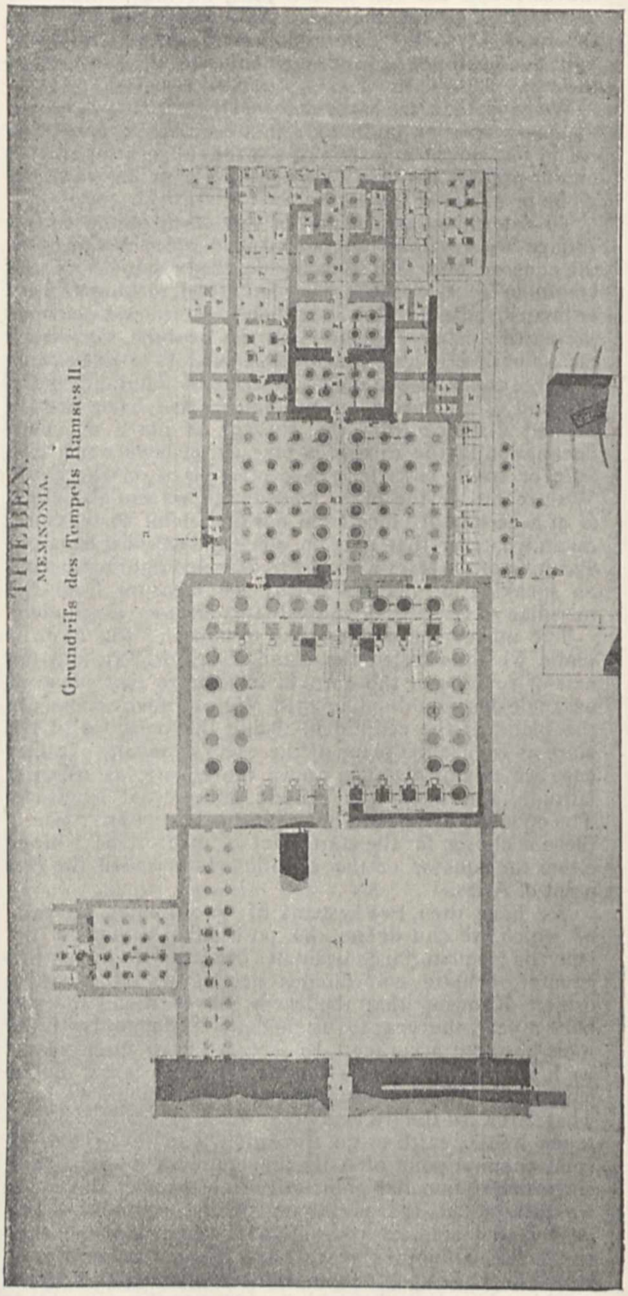

FIG. 8.—Plan of the Temple of Ramses II. in the Memnonia at Thebes (from Lepsius), showing the pylon at the open end, and the sanctuary at the closed one.

ciple is carried to such an extent that in some cases separate isolated gates have been built right in front and exactly in the alignment of the temple. At Karnak there really are two such temples back to back, and the distance which separates the outside entrances of both is greater than the distance from Pall Mall to Piccadilly; the great temple covers about twice the area covered by

St. Peter's at Rome, so that these were temples of a vastness absolutely unapproached in the modern world.

In Denderah we have an example of the second group, in which the massive pylon is omitted. In these the front is entirely changed; instead of the pylon we have now an open front to the temple with columns—the Greek form of temple is approached (Fig. 9).

I shall not have time to get to the astronomical side of the Greek temples in this course of lectures, but I am anxious to take this opportunity to refer to the transition from the Egyptian form of temple to the Greek one. The east front of the Parthenon at Athens very much more resembles the temple of Denderah than it does the early Egyptian temple—that is to say, the eastern front is open; it is not closed by pylons.

In many Egyptian temples, in the progress from one end to the other, one goes through various halls of different styles of architecture and different stages of magnificence. But in the Greek temple this is entirely changed; the approach to the temple was outside, the temple representing, so to speak, the core, almost the Holy of Holies, of the Egyptian temple, and any magnificent approach to it which could be given, was given from the outside. But although they were quite different in their aspects, they were quite similar in their objects. Some Egyptian temples took hundreds of years to build; the obelisks were all in single blocks like that on the Embankment, and all were brought for hundreds of miles down the Nile. A temple meant to the Egyptians a very serious thing indeed.

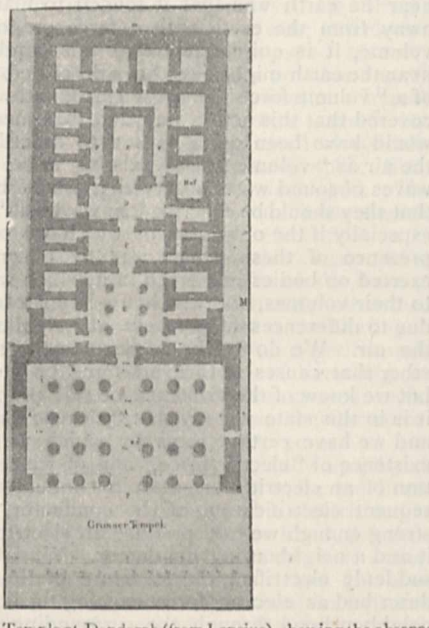

Fig. 9.—Plan of the Temple of Denderah (from Lepsius), showing the absence of a pylon.

So much, then, for a general idea of an ancient temple.

Another point is very striking in these temples, notably in the chief one at Karnak.

From one end of the temple to the other we find the axis marked out by narrow apertures in the various pylons, and many walls with doors crossing the axis. There are 17 or 18 of these limiting apertures, and in the other temple which is back to back to this one we have pylons in exactly the same way limiting the light which falls into the Holy of Holies or the Sanctuary. This construction gives one a very definite impression that every part of the temple was built to subserve a special object, viz. to limit the sunlight which fell on its front into a narrow beam, and to carry it to the other extremity of the temple—into the sanctuary—which extremity was always blocked. There is no case in which the beam of light can pass absolutely through the temple.

The idea is strengthened by considering the construction of the astronomical telescope. Although the Egyptians knew nothing about telescopes, it would seem that they had the same problem before them which we solve by a special arrangement in the modern telescope—they wanted to keep the light pure, and to lead it into their sanctuary, as we lead it to the eyepiece. To keep the light that passes into the eyepiece of a modern telescope pure, we have between the object-glass and the eyepiece a series of what are called diaphragms; that is a series of rings right along the tube, the inner diameters of the rings being greatest close to the object-glass, and smallest close to the eyepiece; these diaphragms must so be made, that all the light from the object-glass shall fall upon the eyepiece, without loss, or reflection by the tube.

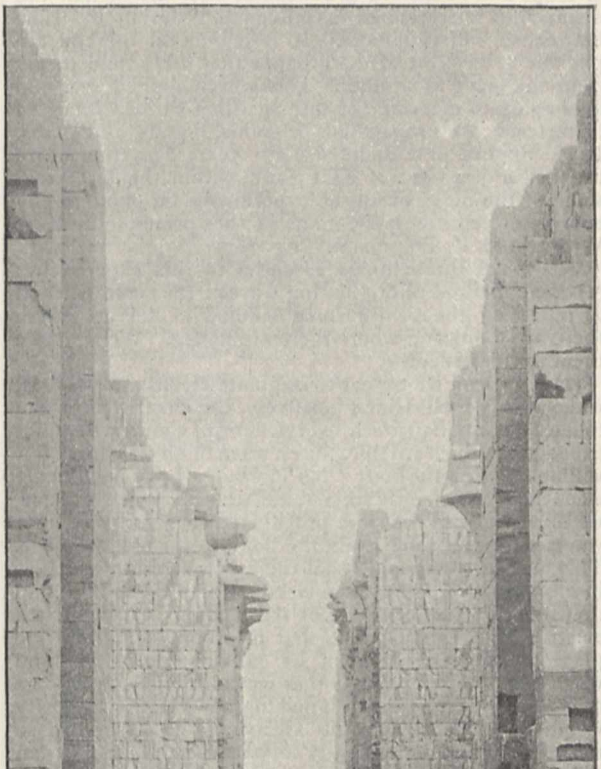

Fig. 10.—The axis of the Temple of Karnak, looking south east, from outside the north-west pylon (from a photograph by the author).

These apertures in the pylons and separating walls of Egyptian temples exactly represent the diaphragms in the modern telescope. J. Norman Lockyer.

(*To be continued.*)

HERTZ'S EXPERIMENTS.[1]

II.

In the last article, a general method of measuring the velocity at which a disturbance is propagated was described. It depended on being able to produce a regular succession of disturbances at equal intervals of time. These were made to measure their own velocity by reflecting them at an obstacle. Then, by the interference of the incident and reflected waves, a succession of loops and nodes are produced at intervals of half the distance a disturbance is propagated during the time between two disturbances. It is a general method applicable to any sort of disturbance that takes time to get from one place to another. It has been applied over and over again to measure the rate at which various kinds of disturbance are propagated in solids, liquids, and gases. It was applied in a modified form years ago, to measure the length of a wave of light; and, within the last year, some of the most beautiful experiments on photography ever described are applications of this principle by Herr Wiener and M. Lippmann.

There are three things essential to this experiment: (1) some method of originating waves; (2) some method of reflecting them; (3) some method of telling where there are loops and where there are nodes. We will take them in this order:—

(1) How can we expect to originate electric waves? If, when a body is electrified positively, the electric force due to it exists simultaneously everywhere, of course we cannot expect to produce anything like a wave of electric force travelling out from the body; but if, when a body is suddenly electrified, the electric force takes time to reach a place, we must suppose that it is propagated in some way as a wave of electric force from the body to the distant place. This, of course, assumes that there is a medium which is in some peculiar state when electric force exists in it, and that it is this peculiar state of the medium, which we call electric force, existing in it, that is propagated from one place to another. It must be carefully borne in mind what sort of a thing this is that we call the electric force at any place. It is not a good name—electric intensity would be a better one; but electric force has come so much into use, it is hardly to be expected that it can be eradicated now. Electric force at any place is measured by the mechanical force that would be exerted at the place if a unit quantity of electricity were there. It is not a force itself at all; it is only a description of the condition of the medium at the place which makes electricity there tend to move. The air near the earth is in such a condition that everything immersed in it tends to move away from the earth with a force of about 1·26 dynes for each cubic centimetre of the body, *i.e.* each cubic centimetre tends to move with a force of 1·26 dynes. Now the condition of the air that causes this is never described as volume force existing at the place, though we do describe the corresponding condition of the ether as electric force existing there; and as volume force existing would be a very objectionable description of the condition of the air when, being at different pressures at various levels, it tends to make bodies move with a force proportional to their volume, so electric force existing is a very objectionable description of the condition of the ether, whatever it is, that tends to make bodies move with a force in proportion to their electric charges. We know more about the structure of the air than we do about the ether. We know that the structure of the air that causes it to act in this way is that there are more molecules jumping about in each cubic centimetre near the earth than there are at a distance, and we do not know yet what the structure of the ether is that causes it to act in this remarkable way; but even though we do not know the nature of the structure, we know some of its effects, by means of which we can measure it, and we can give it a name. Although we know very little indeed about the structure of a piece of stressed india-rubber, yet we can measure the amount of its stress at any place, and can call the india-rubber in this peculiar condition "stressed india-rubber." As a matter of fact, we know a great deal more about the peculiar condition of the ether that we describe as "electric force" existing than we do about the "stressed india-rubber"; and there is every reason to suppose that the structure of the ether is, out of all comparison, more simple than that of india-rubber.

When sound-waves travel through the air, they consist of compressions followed by rarefactions, and between them the pressure varies from point to point, so that here we have travelling forward a structure the same as that of the air near the earth, and waves of sound might be described as consisting of a succession of positive and negative "volume forces" travelling forward in the air: this form of expression would no doubt be objectionable, but still if all we knew about the properties of the air near the earth was that it tended to make bodies move away from the earth with a force proportional to their volume, it is quite likely that this condition of affairs near the earth might have been described as the existence of a "volume force" near the earth, and when it was discovered that this action was due to a medium, the air, it would have been quite natural to describe this state of the air as "volume force" existing in it: and then when waves of sound were observed it would be quite natural that they should be described as waves of "volume force," especially if the only way in which we could detect the presence of these waves was by observing the force exerted on bodies immersed in it, which was proportional to their volumes, and which we happen to know is really due to differences of pressure at neighbouring points in the air. We do not know what is the structure of the ether that causes it to exert force on electrified bodies, but we know of the existence of this property, and when it is in this state we say that "electric force" exists in it, and we have certain ways by which we can detect the existence of "electric force," one of which is the production of an electric current in a conductor, and the consequent electrification of the conductor, and if this is strong enough we can produce an electric spark between it and a neighbouring conductor. When a conductor is suddenly electrified, the structure of the ether which is described as electric force existing in it travels from its neighbourhood through the surrounding ether, and this is described as a wave of electric force travelling through the surrounding ether. It is desirable to be quite clear as to what is meant by the term a wave of electric force, and what we know about it. We know that it is a region of ether where its structure is the same as in the neighbourhood of electrified and some other bodies, and owing to which force is exerted on electrified bodies, and electric currents are produced in conductors.

We may, then, reasonably expect that, if it is possible to electrify a body alternately positively and negatively in rapid succession, there will be produced all round it waves of electric force—that is, if the electric force is propagated by, and is due to, a medium surrounding the electrified body, if electrification is a special state of the medium that fills the space between bodies.

(2) The next question is: How can we reflect these waves? In order to reflect a wave, we must interpose in its way some body that stops it. What sort of bodies stop electric force? Conductors are known to act as complete screens of electric force, so that a large conducting sheet would naturally be suggested as the best way to reflect waves of electric force. Reflection always occurs when there is a change in the nature of the medium, even though the change is not so great as to

[1] Continued from vol. xliii. p. 538.

stop the wave, and it has long been known that, besides the action of conductors as screens of electric force, different non-conductors act differently in reference to electric force by differing in specific inductive capacity. Hence we might expect non-conductors to reflect these waves, although the reflection would probably not be so intense from them as from conductors. Hence this question of how to reflect the waves is pretty easily solved. We are acting still on the supposition that there are waves at all. If electric force exist everywhere simultaneously, of course there will be no waves to reflect, and, consequently, no loops and nodes produced by the interference of the incident and reflected waves.

(3) The third problem is: How can we expect to detect where there are loops and where there are nodes? Recall the effects of electric force. It tends to move electrified bodies. If, then, an electrified body were placed in a loop, it would tend to vibrate up and down. This method may possibly be employed at some future time, and it may be part of the cause of photographic actions, for these have recently been conclusively proved to be due to electric force; but the alternations of electric force from positive to negative that have to be employed are so rapid that no body large enough to be easily visible and electrified to a reasonable extent could be expected to move sufficiently to be visibly disturbed. It is possible that we may find some way of detecting the vibrations hereby given to the electrified ions in an electrolyte; and it has recently been stated that waves originated electrically shake the elements in sensitive photographic films sufficiently to cause changes that can be developed. The other action of electric force is to produce an electric current in a conductor and a resultant electrification of the conductor. Two effects due to this action have actually been used to detect the existence of the wave of electric force sent out by a body alternately electrified positively and negatively. One of these is the heating of the conductor by the current. Several experimenters have directly or indirectly used this way of detecting the electric force. The other way, which has proved so far the most sensitive of all, has been to use the electrification of the conductor to cause a spark across an air-space. This is the method Hertz originally employed. *A priori*, one would not have expected it to be a delicate method at all. It takes very considerable electric forces to produce visible sparks. On the other hand, the time the force need last in order to produce a spark is something very small indeed, and hitherto it has not been possible to keep up the alternate electrifications for more than a minute fraction of a second, and this is the reason why other apparently more promising methods have failed to be as sensitive as the method of producing sparks. If two conductors be placed very close to one another in such a direction that the electric force is in the line joining them, their near surfaces will be oppositely electrified when the electric force acts on them, and we may expect that, if the force be great enough, and the surfaces near enough, an electric spark will pass from one to the other. This is roughly the arrangement used by Hertz to detect whether there are loops and nodes between the originator of the waves and the reflector.

Now arises the problem of how to electrify the body alternately positively and negatively with sufficient rapidity. How rapid is "with sufficient rapidity"? To answer this we must form some estimate of how rapidly we may expect the waves to be propagated. According to Maxwell's theory, they should go at the same rate as light, some 300 million of metres per second, and it is evident that if we are going to test Maxwell's theory we must make provision for sufficiently rapid electric vibrations to give some result if the waves are propagated at this enormous rate. The distance from a node to a node is half the distance a wave travels during a vibration. If we can produce vibrations at the rate of 300 million per second, a wave would go 1 metre during a vibration, so that, with this enormous rate of alternation, the distance from node to node would be 50 cm. We might expect to be able to work on this scale very well, or even on ten times this scale, *i.e.* with alternations at the rate of 30 million per second, and 5 metres from node to node, but hardly on a much larger scale than this. It almost takes one's breath away to contemplate the production of vibrations of this enormous rapidity. Of course they are very much slower than those of light: these latter are more than a million times as rapid; but 300 million per second is enormously more rapid than any audible sound, about a thousand times as fast as the highest audible note. A short bar of metal vibrates longitudinally very fast, but it would have to be about the thousandth of a centimetre long, in order to vibrate at the required rate. It would be almost hopeless by mechanical means to produce electric alternations of this frequency. Fortunately there is an electric method of producing very rapid alternate electrifications. When a Leyden jar is discharged through a wire of small resistance, the self-induction of the current in this wire keeps the current running after the jar is discharged, and recharges it in the opposite direction, to immediately discharge back again, and so on through a series of alternations. This action is quite intelligible on the hypothesis that electrification consists in a strained condition of the ether, which relieves itself by means of the conductor. Just as a bent spring or other strained body, when allowed suddenly to relieve itself, relieves itself in a series of vibrations that gradually subside, similarly the strain of the ether relieves itself in a series of gradually subsiding vibrations. If the spring while relieving itself has to overcome frictional resistance, its vibrations will rapidly subside; and if the friction be sufficiently great, it will not vibrate at all, but will gradually subside into its position of equilibrium. In the same manner, if the resistance to the relief of the strain of the medium, which is offered by the conducting wire, be great, the vibrations will subside rapidly, and if the resistance of the wire be too great, there will not be any vibrations at all. Of course, quite independently of all frictional and viscous resistances, a vibrating spring, such as a tuning-fork that is producing sound-waves in the air which carry the energy of the fork away from it into the surrounding medium, will gradually vibrate less and less. In the same way, quite independently of the resistance of the conducting wire, we must expect that, if a discharging conductor produces electric waves, its vibrations must gradually subside owing to its energy being gradually transferred to the surrounding medium. As a consequence of this the time that a Leyden jar takes to discharge itself in this way may be very short indeed. It may perform a good many oscillations in this very short time, but then each oscillation takes a very very short time. To get some idea of what quantities we are dealing with, consider the rates of oscillation which would give wave-lengths that were short enough to be conveniently dealt with in laboratories. 300 million per second would give us waves one metre long; consider what is meant by 100 million per second. We may get some conception of it by calculating the time corresponding to 100 million seconds. It is more than 3 years and 2 months. The pendulum of a clock would have to oscillate 3 years and 2 months before it would have performed as many oscillations as we require to be performed in one second. The pendulum of a clock left to itself without weights or springs to drive it, and only given a single impulse, would practically cease to vibrate after it had performed 40 or 50 vibrations, unless it were very heavy, *i.e.* had a great store of energy or were very delicately suspended, and exposed only a small resistance to the air. A light pendulum would be stopped by communicating motion to the air after a very few vibrations. The case of a Leyden jar discharge is more like the case of a mass on a spring than the case of a pendulum, because in the cases of the Leyden jar there is nothing quite analogous to the way in which the earth pulls the pendulum: it is the elasticity of the ether that causes the electric currents in the Leyden jar discharge, just as it is the elasticity of the spring that causes the motion of the matter attached to it in the case of a mass vibrating on a spring. It is possible to push this analogy still further. Under what conditions would the spring vibrate most rapidly? When the spring was stiff and the mass small. What is meant by a spring being stiff? When a considerable force only bends it a little. This corresponds to a considerable electric force only electrifying the Leyden jar coatings a little, *i.e.* to the Leyden jar having a small capacity. We would consequently expect that the discharge of a Leyden jar with a small capacity would vibrate more rapidly than that of one with a large capacity, and this is the case. In order to make a Leyden jar of very small capacity we must have small conducting surfaces as far apart as possible, and two separate plates or knobs do very well. The second condition for rapid vibration was that the mass moved should be small. In the case of electric currents what keeps the current running after the plates have become discharged and recharges them again is the so-called self-induction of the current. It would be well to look upon it as magnetic energy stored up in the ether around the current, but whatever view is taken of it, it evidently corresponds to the mass moved, whose energy keeps it moving after the spring is unbent and rebends the spring again. Hence we may conclude that a small self-induction will favour rapidity of oscillation, and this is the case. To attain this we must make the distance the current has to run from plate to plate as short as possible. The smaller the plates and the shorter the connecting wire the more rapid the vibrations; in fact, the rapidity of vibration is directly proportional to the linear dimensions of the system, and for the most rapid vibrations two spherical knobs, one charged positively and the other negatively, and discharging directly from one to the other, have been used. Hertz in his original investigations used two plates about 40 cm. square, forming parts of the same plane, and separated by an interval of about 60 cm. Each plate was connected at the centre of the edge next the other plate with a wire about 30 cm. long, and terminating in a small brass knob. These knobs were within 2 or 3 mm. of one another, so that when one plate was charged positively and the other negatively they discharged to one another in a spark across this gap. An apparatus about this size would produce waves 10 or 12 metres long, and its rate of oscillation would be about 30 million per second. As the vibration actually produced by these oscillators seems to be very complex, the rate of oscillation can only be described as "about" so and so. In a subsequent investigation Hertz employed two elongated cylinders about 15 cm. long and about 3 cm. in diameter, terminated by knobs about 4 cm. in diameter, and discharging directly into one another. Such an oscillator produces waves from 60 to 70 cm. long, and, consequently, vibrations at the rate of between 400 and 500 million per second. Most other experimenters have used oscillators about the same dimensions as Hertz's larger apparatus, as the effects produced are more energetic; but many experiments, especially on refraction, require a smaller wave to be dealt with, unless all the apparatus used be on an enormous scale, such as could not be accommodated in any ordinary laboratory. When we are thus aiming at rapid rates of vibration, it must be recollected that we cannot at the same time expect many vibrations after each impulse. If we have a stiff spring with a small weight arranged so as to give a lot of its energy to the surrounding medium, we cannot expect to have very much energy to deal with, nor many vibrations, and, as a matter of fact, we find that this is the case. The total duration of a spark of even a large Leyden jar is very small. Lord Rayleigh has recently illustrated this very beautifully by his photographs of falling drops and breaking bubbles. We cannot reasonably expect each spark to have more than from 10 to 20 effective oscillations, so that, even in the case of the slower oscillator, the total duration of the spark is not above a millionth of a second. It is very remarkable that the incandescent air, heated to incandescence by the spark, should cool as rapidly as it does, but there is conclusive evidence that it remains incandescent after the spark proper has ceased, and consequently lasts incandescent longer than the millionth of a second. What is seen as the white core of the spark may not last longer than the electric discharge itself, and certainly does not do so in the case of the comparatively very slowly oscillating sparks that have been analyzed into their component vibrations by photographing them on a moving plate. The incandescent air remaining in the path of such discharge is probably the conducting path through which the oscillating current rushes backwards and forwards. Once the air gap has been broken through, the character of the air gap as an opponent of the passage of electricity is completely changed. Before the air gap breaks down, it requires a considerable initial difference of electric pressure to start a current. Once it has been broken down, the electric current oscillates backwards and forwards across the incandescent air gap until the whole difference of electric pressure has subsided, showing that the broken air gap has become a conductor in which even the feeblest electric pressure is able to produce an electric current. If this were not so, Leyden jars would not be discharged by a single spark. All this is quite in accordance with what we know of air that is, or even has lately been, incandescent: such air conducts under the feeblest electric force. All this is most essential to the success of our oscillator. Only for this valuable property of air, that it gives way suddenly, and thenceforward offers but a feeble opposition to the rapidly alternating discharge, it would have been almost impossible to start these rapid oscillations. If we wish to start a tuning-fork vibrating, we must give it a sharp blow: it will not do to press its prongs together and then let them go slowly: we must apply a force which is short-lived in comparison with the period of vibration of the fork. It is necessary, then, that the air gap must break down in a time short compared with the rate of oscillation of the discharge; and when this is required to be at the rate of 400 million per second, it is evident how very remarkably suddenly the air gap breaks down. From the experiments themselves it seems as if any even minute roughnesses, dust, &c., on the discharging surface, interfered with this rapidity of breakdown: it seems as if the points spluttered out electricity and gradually broke down the air gap, for the vibrations originated are very feeble unless the discharging surfaces are kept highly polished: gilt brass knobs act admirably if kept polished up every ten minutes or so. One of the greatest desiderata in these experiments is some method of making sure that all the sparks should have the same character, and be all good ones.

(*To be continued.*)

THE ROYAL SOCIETY SELECTED CANDIDATES.

THE following fifteen candidates were selected on Thursday last (April 30), by the Council of the Royal Society, to be recommended for election into the Society. The ballot will take place on June 4, at 4 p.m. We print with the name of each candidate the statement of his qualifications.

WILLIAM ANDERSON,

V.-P.Inst.M.E. M.I.C.E. Consulting Engineer, Royal Agricultural Society of England. Pupil of the late Sir William Fairbairn, F.R.S. Member of the firm of Messrs. Courtney and Stephens, Engineers, of Dublin, from 1855 to 1864. President, in 1863, of the Inst. of Civil Engineers of Ireland, to which Society he communicated important papers:—"On the Theory of Braced Girders;" "The Strength of Railway Bridges of Small Span, and the Cross-beams of Large Bridges;" and other subjects. Between 1872 and 1885, communicated many important papers to the Inst. of Civil Engineers, *e.g.*, "Experiments on Sugar Manufacture, in Upper Egypt, by the Sulphurous Acid Process;" "Experiments and Observations on the Emission of Heat by Hot-water Pipes;" and "Purification of Water on the Large Scale by Agitation with Iron" (being a process successfully elaborated by him, and applied at the Antwerp Waterworks, &c). Received the Telford Medal and the James Watt Gold Medal of the Inst. C.E. Author of a Lecture on "The Generation of Steam," being one of the "Heat Series" of Special Lectures delivered at the Inst. C.E.; of a Text-book on "The Conversion of Heat into Useful Work," being the substance of a course of Lectures delivered at the Society of Arts under the "Howard Trust"; of a paper on "New Applications of the Mechanical Properties of Cork," communicated as a Lecture to the Royal Institution; and of various papers communicated to the Inst. of Mechanical Engineers, the Royal Agricultural Society, &c. Distinguished for the ability with which he has applied his intimate knowledge of the science of heat, and other cognate sciences, to the practical requirements of the engineer.

FREDERICK ORPEN BOWER, D.Sc. (Camb.),

F.L.S., F.R.S.E. Regius Professor of Botany in the University of Glasgow. Distinguished for his researches in histological and morphological botany. Author (in conjunction with Prof. S. H. Vines, F.R.S.) of "A Course of Practical Instruction in Botany," and of the following papers, amongst others:—On the Development of the Conceptacle in Fucaceæ" (*Quart. Journ. Micros. Sci.*, 1879); "On the Germination of *Welwitschia*" (*ibid.*, 1880); "On the Further Development of *Welwitschia*" (*ibid.*, 1881); "On the Germination and Embryogeny of *Gne'um Gnemon*" (*Quart. Journ. Micros. Sci.*, 1882); "On the Structure of the Stem of *Rhynchopetalum montanum*" (Journ. Linn. Soc., 1883); "On the Comparative Morphology of the Leaf in Vascular Cryptogams and Gymnosperms" (Phil. Trans., 1884); "On the Apex of the Root of *Osmunda* and *Todia*" (*Quart. Journ. Micros. Sci.*, 1884); "On Apospory in Ferns" (Journ. Linn. Soc., 1884); "On the Development and Morphology of *Phylloglossum Drummondii*" (Phil. Trans., 1885); "On Apospory and Allied Phenomena" (Trans. Linn. Soc., 1887); "On the Limits of the Use of the Terms Phyllome and Caulome" (*Annals of Bot.*, 1887); "On the Modes of Climbing in the Genus *Calamus*" (*ibid.*); "On some Normal and Abnormal Developments of the Oophyte in Trichomanes" (*ibid.*); "*Humboldtia laurifolia* as a Myrmekophilous Plant" (Trans. Phil. Soc. Glasg.); "The Comparative Examination of the Meristems of Ferns as a Phylogenetic Study" (*Annals of Bot.*, 1889); "On the Morphology of the Leaf of Nepenthes" (*ibid.*); "On Antithetic as distinct from Homologous Alternation of Generations in Plants" (*ibid.*, 1890). Translator (in conjunction with Dr. D. H. Scott) of "Comparative Anatomy of the Phanerogams and Ferns," by Anton de Bary (Clarendon Press, 1884).

SIR JOHN CONROY, Bart., M.A.,

F.C.S. Lecturer on Physics and Chemistry, Keble College, Oxford. An assiduous Student of Experimental Science, and author of the following papers:—"On the Dioxides of Calcium and Strontium" (Journ. Chem. Soc., 1873); "On the Polarization of Light by Crystals of Iodine" (Proc. Roy. Soc., 1876); "Absorption-Spectra of Iodine" (Proc. Roy. Soc., 1876); "On the Light reflected by Potassium Permanganate" (*Phil. Mag.*, 1878); "The Distribution of Heat in the Visible Spectrum" (*Phil. Mag.*, 1879); "Experiments on Metallic Reflexion" (Proc. Roy. Soc., 1871, 1879, 1883).

DANIEL JOHN CUNNINGHAM, M.D. (Edin.),

M.D. (Dublin), F.R.C.S.I., F.R.S.E., F.Z.S., Professor of Anatomy, University of Dublin. Distinguished both as a teacher and original inquirer. Examiner in Anatomy in the Universities of London, Edinburgh, and Dublin. Member of Council, Royal Irish Academy. Vice-Pres. Zoological Society, Ireland. Vice-Pres. Anatomical Society of Great Britain and Ireland. Author of numerous anatomical memoirs in journals and publications of scientific societies. More especially may be mentioned—"Report on the Anatomy of the Marsupialia" (*Challenger* Report, Part 16); "The Lumbar Curve in Man and Apes," forming Cunningham Memoir, No. 2, published by the Royal Irish Academy, 1886; "The Spinal Nervous System of the Porpoise and Dolphin" (*Journ. Anat. Physiol.*, 1876). Author of a Text-book of Practical Anatomy.

GEORGE MERCER DAWSON, D.Sc.,

F.G.S., A.R.S.M., F.R.S.C. Assistant Director, Geological Survey of Canada. Much important and valuable work, more especially in geology and ethnology, as in the following summary statement. During his thirteen years of service on the Geol. Survey (Canada) has been chiefly engaged in working out the Geology of the North-West Territory and British Columbia. Placed in charge of the Yukon Expedition, 1887. Author of numerous papers, chiefly geological, but including geographical, ethnological, and other observations, published in the Quart. Journ. Geol. Soc., Trans. Roy. Soc. Canada, *Canadian Naturalist*, &c. These deal more especially with the superficial geology of the regions explored, but some describe Foraminifera and other microscopic organisms. Author of fifteen reports published by the Geological Survey of Canada, and joint author (with Dr. Selwyn) of a Descriptive Sketch of the Physical Geography and Geology of Canada, and (with Dr. W. F. Tolmie) of Comparative Vocabularies of the Indian Tribes of British Columbia.

EDWIN BAILEY ELLIOTT, M.A.,

Fellow of Queen's College, Oxford. Vice-President of the London Mathematical Society. Mathematical Lecturer of Queen's and Corpus Christi Colleges. Distinguished as a Mathematician and original investigator in various branches of mathematical research. Author of the following papers:—"Generalization of Prevost and Lhuilier's Theorem in Chances" (*Ed. Times*, vol. xxxv.); "On Normals to Envelopes" (*Mess. of Math.*, vol. ix. p. 85); "On Multiple Definite Integrals" (Lond. Math. Soc. Proc., vol. viii., pp. 35, 146); "Kinematics on a Sphere" (*ibid.*, vol. xii., p. 47); "Multiple Frullanian Integrals" (*ibid.*, vol. xv., p. 12; Small Motions of Systems with One Degree of Freedom" (*Mess. of Math.*, vol. xv., p. 38); "The Linear Partial Differential Equations satisfied by Pure Ternary Reciprocants" (Lond. Math. Soc. Proc., vol. xviii., p. 142); "On the Interchange of the Variables in certain Linear Differential Operators" (Abstract, Roy. Soc. Proc., vol. xlvi., p. 358 [ordered to be printed in the Phil. Trans.]); and eighteen other papers printed in the London Mathematical Society's Proceedings and elsewhere between the years 1875 and 1890.

PERCY FARADAY FRANKLAND, B.Sc.,

A.R.S.M., Ph.D. Professor of Chemistry. Formerly Senior Demonstrator in the Chemical Laboratory of the Normal Schools of Science, South Kensington. Author of upwards of twenty original papers in the Phil. Trans. and Proc. Roy. Soc., in the Journals of the Chem. Soc., the Soc. of Chem. Industry, &c. Known for his researches on Bacteriology and on the Chemical Aspects of Fermentation.

PERCY C. GILCHRIST,

A.R.S.M. Metallurgist. Distinguished as a Metallurgist, especially in connection with the manufacture of iron and steel. In association with the late Mr. S. G. Thomas he greatly advanced metallurgical practice by the introduction of a process which enables iron to be dephosphorized on a large scale. The process, which is known as the "Basic" process, possesses more than national importance, and its value has been universally recognized. It has further been shown that the slag, which is a product of the Basic process, contains phosphorus in a form which can be readily assimilated by vegetation. One result of his metallurgical work has thus been to substantially benefit agriculture, as more than half a million tons of basic slag are now used annually as a fertilizer. He is the author of numerous papers published in the Journal of the Iron and Steel Institute and elsewhere.

WILLIAM DOBINSON HALLIBURTON, M.D., B.Sc.,

Assistant Professor of Physiology in University College, London. Has during the past four years devoted his entire time to research work in, and teaching of Physiology, especially the chemical side of that science. Has published the following, among other communications:—"On the Proteids of Serum" (Proc Roy. Soc., and *Journ. of Physiol.*, 1884); "On the Chemical Composition of Invertebrate Cartilage" (Proc. Roy. Soc., 1885, and *Quart. Journ. Micros. Sci.*); "On the Blood of Crustacea" (*Journ. of Physiol.*, 1885, and in a Report to the Scottish Fisheries Board): "On Hæmoglobin and Methæmoglobin Crystals" (*Brit. Med. Journ.*, 1886, and Proc. Physiol. Soc.); "On the Blood-proteids of Lower Vertebrates" (*Journ. of Physiol.*, 1886); "On the Coagulation of Myosin" (Prelim. Communication to Physiol. Soc., 1887).

OLIVER HEAVISIDE,

Learned in the science of electro-magnetism, having applied higher mathematics with power and success to the developments of Maxwell's theory of electro-magnetic wave propagation, and having extended our knowledge of facts and principles in several directions and into great detail. He is the author of the following papers among many others:—"On Electro-magnetic Induction and its Propagation" (48 parts, 1885–87, in the *Electrician*); "The Induction of Currents in Cores" (15 parts, 1884-85); "Some Electrostatic and Magnetic Problems" (5 parts, 1883); "Current Energy" (19 parts, 1883–84); "On the Electro-magnetic Effects due to the Motion of Electrification through a Dielectric" (*Phil. Mag.*, 1889); "The General Solution of Maxwell's Equations" (*Phil. Mag.*); "On Electro-magnetic Waves" (6 parts, *Phil. Mag.*, 1888); "On Resistance and Conductance Operators" (*Phil. Mag.*, 1887); "On the Self-induction of Wires" (7 parts, *Phil. Mag.*, 1886–87); "On the Electro-magnetic Wave Surface" (*Phil. Mag.*, 1885); "On the Electro-magnetic Effect of a Moving Charge"; "The Deflection of an Electro-magnetic Wave by Motion of the Medium"; "On the Working of Cells with Condensers" (*Phil. Mag.*, 1874); "On the Extra Current" (1876); "On the Speed of Signalling through Heterogeneous Telegraph Circuits" (*ibid.*, 1877); "On the Effect of Faults on the Speed of Working Cables"; "On Electromagnets" (Journ. Soc. Tel. Eng.); "On Induction between Parallel Wires" (*ibid*).

JOHN EDWARD MARR, M.A. (Cantab.),

F.G.S. Fellow and Lecturer of St. John's College, Cambridge, and University-Lecturer in Geology. First Class Nat. Sci. Tripos, 1878; Sedgwick Prizeman, 1883; Examiner for the Nat. Sci. Tripos, 1886–87. Secretary of the Geological Society, 1888. Author of the following:—"Fossiliferous Cambrian Slates near Carnarvon" (Quart. Journ. Geol. Soc., 1876); "On Phosphatized Carbonate of Lime at Cave Ha" (*Geol. Mag.*, 1876); "On some well-defined Life-zones in the lower part of the Silurian of the Lake District" (Quart. Journ. Geol. Soc., 1878); "On the Cambrian and Silurian Rocks of the Dee Valley" (*ibid.*, 1880); "On the Pre-Devonian Rocks of Bohemia" (*ibid.*, 1880); "On some Sections of the Lower Palæozoic Rocks of the Craven District" (Proc. Yorks. Geol. Soc., 1882, and Brit. Assoc., 1881); "The Classification of the Cambrian and Silurian Rocks" (*Geol. Mag.*, 1881); "On the Cambrian and Silurian Rocks of Scandinavia" (Quart. Journ. Geol. Soc., 1882); "Origin of the Archæan Rocks" (*Geol. Mag.*, 1883); "The Classification of the Cambrian and Silurian Rocks" (Sedgwick Prize Essay, 8vo, Cambridge, 1883); "The Earth History of the Remote Past compared with that of Recent Times" (8vo, Cambridge, 1886); "The Lower Palæozoic Rocks near Settle" (*Geol. Mag.*, 1887); "The Work of Ice Sheets" (*ibid.*); "Glacial Deposits of Sudbury" (*ibid.*); "On some Effects of Pressure on the Devonian Sedimentary Rocks of North Devon" (*ibid.*, 1888); "The Lower Palæozoic Rocks of the Fichtelgebirge" (*ibid.* 1889); "The Metamorphism of the Skiddaw Slates" (Brit. Assoc., 1889). Joint-papers:—"The Lower Palæozoic Rocks of the Neighbourhood of Haverfordwest" (Quart. Journ. Geol. Soc., 1885); "The Stockdale Shales" (*ibid.*, 1888).

LUDWIG MOND,

F.I.C. President of the Society of Chemical Industry, V.-P. Chem. Soc. Distinguished technical chemist and inventor. Has made important additions to chemical industrial processes and products, especially with reference to the alkali industry, having improved the mode of manufacture of carbonate of soda, caustic soda, hydrochloric acid, chlorine, ammoniacal products, and gas generating furnaces, &c. In 1863 he developed what is known as the "Mond Process of Sulphur Recovery from Alkali Waste," and has since that date devoted himself to the introduction and development of the ammonia soda process of alkali manufacture into England. Author of various papers in Rept. Brit. Assoc., Journ. Soc. Chem. Ind.

WILLIAM NAPIER SHAW, M.A.,

Fellow of Emmanual College, Cambridge. Was nominated by Lord Rayleigh as one of the Demonstrators of Physics in the Cavendish Laboratory at Cambridge. He held that position from 1880 to 1887, and he has since continued his connection with the Laboratory as University Lecturer in Physics. His knowledge of the manner in which the teaching of Physics is conducted in the great German Universities (acquired at Berlin under Helmholtz) enabled him to bear an important part in the organization of the laboratory. A considerable part of the success of the Cambridge School of Physics is due to his exertions, backed by his knowledge of Physics. Author of numerous books and papers, of which the following are especially worthy of notice:—"Practical Physics" (jointly with Mr. Glazebrook), Longmans, 1885; "Practical Work in the Cavendish Laboratory," University Press, 1886; "Faraday's Law of Electrolysis with reference to Silver and Copper," Rept. Brit. Assoc., 1886; "Electrolysis" and "Pyrometer," "Encyc. Brit."; "On Vaporimeters," &c., Rept. to the Meteorol. Council, 1884; "On Hygrometric Methods, Part I.," Rept. to the Meteorol. Council, printed in Phil. Trans.

SILVANUS PHILLIPS THOMPSON, D.Sc. (Lond.),

Principal and Professor of Physics in the City and Guilds of London Technical College, Finsbury; formerly Professor of Experimental Physics in University College, Bristol. Author of many papers published in the Proceedings, &c., Royal Society, Physical Society, Institution of Electrical Engineers, Society of Arts, and British Association, including the following:—"The Theory of the Magnetic Balance" (Proc. Roy. Soc., 1884); "Electro-deposition of Alloys" (*ibid.*, 1887); "Subjective Interference of Sound" (*Phil. Mag.*, 1887); "Opacity of Tourmaline Crystals" (*ibid.*, 1881); "The Meaning of the Constant in Bernouilli's Law of the Lifting Power of Magnets" (*Phil. Mag.*, 1888); "Development of the Mercurial Air Pump" (Journ. Soc. Arts, 1887); "The Influence Machine from 1788 to 1888" (Journ. Soc. Telegr. Engin., 1888). Author of a treatise on "Dynamo-Electric Machinery" (3rd edit., 1888), and of an elementary text-book of Electricity and Magnetism (43rd thousand, 1889), which has gone through many English and several foreign editions. Originator of improvements in polarizing prisms, in the method of adjusting resistance coils, and in sundry electrical apparatus. Member of Council of the Physical Society, and of the Institution of Electrical Engineers. Distinguished for his acquaintance with the science of electricity, more particularly in its experimental and technical aspects.

THOMAS HENRY TIZARD, Staff-Commander, R.N., H.M.S. *Triton*,

F.R.G.S. Distinguished as a Hydrographical Surveyor and Marine Meteorologist. Has been employed for 25 years in the Naval Surveying Service. In China, Mediterranean, and Red Seas, 1862–72. Senior Assistant-Surveyor in the *Challenger* Expedition, 1872–76. Prepared the reports on the sea temperatures, and on the meteorological observations obtained under his own superintendence during the voyage (*Challenger* Report, vol. ii.); Joint Author of vol. i. *Challenger* Report, contributing the hydrographical portion of the Narrative of the Voyage. Has since served for nine years in charge of surveys on the coasts of the United Kingdom; now employed in command of H.M.S. *Triton*. Has contributed a paper to the Royal Society on the exploration of the Faeroe Channel (Proc. Roy. Soc., vol. xxxv. pp. 202–26; and on the meteorology of Japan, to the Meteorological Council (Official Publication, No. 28).

THE ENDOWMENT OF RESEARCH IN FRANCE.

AT the meeting of the Paris Academy of Sciences on April 27, the Secretary read the following extract from the will of the late M. Cahours:—

"I have frequently had the opportunity of observing, in the course of my scientific career, that many young men, distinguished and endowed with real talent for science, saw themselves obliged to abandon it because at the beginning they found no efficacious help which provided them with the first necessities of life and allowed them to devote themselves exclusively to scientific studies.

"With the object of encouraging such young workers, who for the want of sufficient resources find themselves powerless to finish works in course of execution, and in remembrance of my beloved children, who also would walk in a scientific path at the moment when death takes me from them, I bequeath to the Academy of Sciences, which has done me the honour to admit me into its fraternity, a sum of one hundred thousand francs.

"I desire that the interest of this sum may be distributed every year by way of encouragement to any young men who have made themselves known by some interesting works, and more particularly by chemical researches.

"In order to assure this preference, independently of the express recommendation that I make here to my successors, I wish that, during at least twenty-five years after the commencement of the interest payable to the Academy, three members at least of the Chemistry Section may take part each year in a Commission of five members charged by the Academy to distribute the prizes. I express further the formal desire that this choice should fall, as far as possible, on young men without fortune not having salaried offices, and who, from the want of a sufficient situation, would find themselves without the possibility of following up their researches.

"These pecuniary encouragements ought to be given during several years to the same young men, if the Commission thinks that their productions have a value which permits such a favour.

"Nevertheless, in order that the largest number of young workers may participate in the legacy I institute, I desire that the encouragements may cease at the time when the young *savants* who have enjoyed them obtain sufficiently remunerative positions."

M. Janssen then made the following remarks:—

"The legacy which has been made to the Academy, by our very eminent and very regretted *confrère*, appears to me to have considerable import not only by its importance, but especially by the way that it opens, and the example that it affords, to all those who hereafter may desire to encourage the sciences by their liberality.

"M. Cahours, whose sure judgment and long experience enabled him to know the most urgent necessities of science, had, like most of us, become convinced of the necessity of introducing a new form in the institution of scientific recompenses.

"Our prizes will always continue to meet a great and noble necessity; their value, the difficulty of obtaining them, and the *éclat* they take from the illustriousness of the body which awards them, will make them always the highest and most envied of recompenses.

"But the value, also, of the works it is necessary to produce in order to lay claim to them prohibits the research to beginners. It is a field that is only accessible to matured talents.

"But, besides those *savants* who have already an assured career, there are many young men endowed with precious aptitudes, and directed by their inclination to pure science, but turned very often from this envied career by the difficulties of existence, and taking with regret a direction giving more immediate results. And yet, how many among them possess talents which, if well cultivated, might do honour and good to science!

"We must say, however, that it is in leaving their studies that those who wish to devote themselves to pure science experience the most difficult trials, and these difficulties are increased every day by the very rapid advance of the exigencies of life.

"We must find a prompt remedy for this state of things if we do not wish to see the end of the recruitment of science.

"This truth, however, is beginning to be generally felt. The Government has already created institutions, scholarships, and encouragements, which partly meet the necessity. Some generous donors are also working in this manner. I will mention especially the noble foundation of Mdlle. Dosne, in accordance with whose intentions a hall is at this moment being built, where young men, having shown distinguished aptitudes for high administration, the bar, or history, will receive for three years all the means of carrying on high and peaceful studies.

"Let us say, then, plainly, and in speaking thus we only feebly echo the expressions of the most illustrious members of the Academy, that it is by following the way so nobly opened by Cahours that the interests and prospects of science will be most efficaciously served."

NOTES.

A SPECIAL meeting of the Physical Society of London will be held at Cambridge on Saturday, May 9. The members will leave Liverpool Street at 11 a.m., and on arrival at Cambridge will become the guests of the Cambridge members. The meeting will be held in the Cavendish Laboratory at 2.30. The following communications will be read: some experiments on the electric discharge in vacuum-tubes, by Prof. J. J. Thomson, F.R.S.; some experiments on ionic velocities, by Mr. W. C. D. Whetham; on the resistance of some mercury standards, by Mr. R. T. Glazebrook, F.R.S.; on an apparatus for measuring the compressibility of liquids, by Mr. S. Skinner; some measurements with the pneumatic bridge, by Mr. W. N. Shaw. After the meeting members will have an opportunity of seeing the Cavendish Laboratory and other University Laboratories.

THE annual meeting of the Iron and Steel Institute began yesterday, and will continue to-day and to-morrow. It is being held as usual at the Institution of Civil Engineers in Great George Street.

A VALUABLE bequest has been made to the Department of Science and Art by the late Miss Marshall, of 92 Warwick Gardens, Kensington. In addition to a large number of scientific books and instruments which are left for the use of students, a sum of £1000 is bequeathed for the founding of scholarships, or for application in any other way that may be considered best for the advancement of biological science.

THE Queen has approved the appointment of Lord Derby to be Chancellor of the University of London, in the room of the late Lord Granville.

THE death of Prof. Joseph Leidy, in his sixty-eighth year, is announced. He was Professor of Anatomy in the University of Pennsylvania and of Natural History in Swarthmore College; President of the Academy of Natural Sciences of Philadelphia; and Director of the Department of Biology in the University. In a future number we shall give some account of his services to science.

A REUTER'S telegram from New York, dated May 1, announces the death, at Berkeley, California, of Prof. John Le Conte, brother of Mr. Joseph Le Conte, formerly professor of geology and natural history in the University of California.

WE regret to have to announce the death of Captain Cecilio Pujazon, the Director of the Marine Observatory of San Fernando, near Cadiz. He died on April 15, in his fifty-seventh year. Captain Pujazon was well known to the members of the Eclipse Expedition of 1870, who formed the Cadiz party. He came to London to the Conference on Marine Meteorology in 1874.

IN answer to a question put by Mr. H. Fowler in the House of Commons on Monday, Sir W. Hart Dyke said that from the returns already received, in answer to a circular issued by the

Science and Art Department at the end of March last, it appeared that of the fifty county councils and sixty county boroughs in England, sixteen of the former and twenty-five of the latter had already decided to apply the whole of their share of the residue under the Local Taxation (Customs and Excise) Act of 1890 to science and art and technical education. Nine county councils and two county boroughs had made grants varying from "nearly the whole" to a smaller proportion of their share to the same purpose. Twelve county councils and seven county boroughs had the matter under consideration; that is to say, they had appointed committees, and in many cases the committees had recommended the allocation of the whole or the greater part of the residue fund to technical instruction, but their reports had not yet been confirmed by the county or borough councils. With regard to Wales, the question was complicated by the fact that the Welsh Intermediate Education Act included technical instruction, but it appeared that four county councils and one county borough had applied the whole of their share of the residue under the Intermediate Education Act; while two county councils and one county borough had divided their quota between that Act and the Technical Instruction Act. The remaining six county councils had either made no return, or else had the matter under consideration.

THE Council of University College, Bangor, having resolved to make provision in the physical department (Prof. A. Gray) for the study of applied electricity, an 8 horse-power (nominal) compound engine, working up to 24 horse-power, has just been installed by Messrs. Robey and Co., Lincoln. On Saturday last a satisfactory trial of the engine and boiler was made. The equipment includes a special educational Victoria dynamo (capable of being converted at will into a shunt, compound-wound, or series dynamo, without impairing its usefulness for general work), by the Brush Electrical Engineering Co., an alternating dynamo, and a large secondary battery. The electrical measuring instruments are of the latest design, and include a fine composite balance, and electrostatic voltmeter of Sir William Thomson's invention. The equipment forms a valuable addition to the resources of the College for the teaching of pure and applied physical science, and will render it possible to give a very complete course of instruction in electrical engineering, as well as in the general theory of electricity.

THE Philosophical Society of Berlin offers a prize of 1000 marks for the best essay on the relation of philosophy to the empirical science of nature. The essays may be written in German, French, English, or Latin, and must be sent in before April 1, 1893.

THE Italian Meteorological Society has celebrated its twenty-fifth anniversary by erecting a memorial tablet in the mediæval castle of Turin. The founder of the Society, Father Denza, and various notabilities and ladies were present. Father Denza gave a *résumé* of the history of the Society, which now possesses no less than 250 observatories and stations. The ceremony was terminated by the transmission of a telegram to the King, as Honorary President of the Society.

THE Chief Signal Officer of the United States has published Part III. of "Bibliography of Meteorology," comprising titles relating to the general motions of the atmosphere, or "winds," while the important division of "storms" is being prepared for issue as Part IV. The present volume, like its predecessors, is a lithographic reproduction of a copy prepared by means of a type-writer, as funds were not forthcoming for printing the work, and it contains a total of 2000 titles of books and papers dating from the origin of printing to the close of 1881, with a supplement to the close of 1889, and an author index. The work is quite unique, and will be an invaluable aid to the study of the subject treated of.

AN account of the Birmingham School of Medicine, written originally for the information of those members of the medical profession who attended the Birmingham meeting of the British Association in 1890, has now been published separately. The authors are Dr. B. C. A. Windle and Mr. W. Hillhouse. Their intention is to show—and this they do most effectually—that the centre of the Midland district possesses one of the best equipped schools of medicine in the provinces. The interest of the descriptions is greatly increased by reproductions of some photographs.

A FISH and Game Commission, taking evidence on behalf of the Ontario Government, has received many complaints as to the destruction of deer and other depredations by wolves; and all the witnesses agree that the present bounty of £1 paid for each wolf killed should be raised to £2 10*s.* or £3. It has also been shown that, if the game laws are not more strictly enforced, many birds and fur-bearing animals will probably be exterminated.

THE preliminary returns of the recent census operations in India show that the population in British territory is 220,400,000, as against 198,655,600 in the former census, an increase of nearly 22,000,000. The Feudatory States, omitting incomplete returns, which may be taken at about 90,000, have a population of 61,410,000, making a total of 281,900,000, as against 250,700,000 for the same areas at the last census. The returns give Bombay 805,000, Madras 449,000, Calcutta municipal area and port 674,000, and including the suburbs Howrah and Bally, 969,000. At the last census the total for the same area was 847,000. Calcutta municipal area shows an increase of 92,000, and Howrah and Bally an increase of 24,000. The returns from Burmah show that the population of the whole country, excluding the Shan States, is 7,507,063, or 48·8 persons to the square mile. The population of Lower Burmah alone is 4,526,432, or an increase of about 790,000 since 1881.

THE Boston Society of Natural History has issued a pamphlet announcing the completion of the general plans for the formation of zoological gardens and aquaria in Boston, and appealing to the American public for support. The pamphlet is prettily printed and illustrated, and sets forth very effectively the arguments which may be advanced in favour of the scheme.

THE new number of the Journal of the Royal Horticultural Society contains a full report of the Dahlia Conference, held at the Chiswick Gardens on September 23 last; and of the Grape Conference, held in the same Gardens on September 24. The number also contains valuable papers on various other subjects interesting to horticulturists.

THE Trustees of the Indian Museum, Calcutta, have issued an interesting and instructive Report, by Mr. E. C. Cotes, on the locust of North-Western India (*Acridium peregrinum*). The Report sums up the results of an investigation conducted in the entomological section of the Museum. It seems to be established that most of the flights of this locust issue from the region of sand-hills in Western Rajputana. Others, however, invade India from breeding-grounds which probably lie along the Suliman Range, or even, perhaps, in some cases, beyond India's western frontier, in the sandy deserts of Baluchistan, Southern Afghanistan, and Persia, though the reports received from these regions, Mr. Cotes says, are so fragmentary that no very definite conclusions can be formed from them.

THE *New Zealand Journal of Science*, the publication of which was suspended in 1885, has been revived. The first two numbers of the new issue have been sent to us, and if the same general level of excellence can be maintained in future numbers, there ought to be no doubt as to the success of the enterprise. The following are among the papers: on the history of the

Kiwi, by Prof. T. J. Parker; on the breeding habits of the European sparrow in New Zealand, by T. W. Kirk; the humble-bee in New Zealand, by G. M. Thomson; some notes on the occurrence of the trap-door spider at Lyttelton, by R. M. Laing; on the discovery of the nickel-iron alloy Awaruite, by Prof. G. H. F. Ulrich.

IN the paper on the humble-bee in New Zealand, Mr. Thomson says that, wishing to find how far these insects are adapting themselves to new flowers in the colony, he has for a considerable time kept a record of the flowers they visit and of those they leave alone. He has noticed them on many species of introduced plants which they never appear to visit in Europe. They seldom approach white flowers; and, with two exceptions, he has never heard of their visiting the flowers of indigenous plants. The exceptions are *Fuchsia excorticata* and the Ngaio (*Myoporum lætum*).

MESSRS. R. ETHERIDGE, JUN., AND MR. A. SIDNEY OLLIFF have produced in common a paper which forms a valuable addition to the Memoirs of the Geological Survey of New South Wales. The title is "The Mesozoic and Tertiary Insects of New South Wales."

MESSRS. BAILLIÈRE, TINDALL, AND COX publish a second edition of Dr. Thomas Dutton's practical treatise on "Sea-Sickness." Sensible readers will at once be favourably impressed by the author's statement that there is "no absolute specific" for this distressing malady.

MESSRS. CASSELL AND CO. have issued Part 31 of their "New Popular Educator," which will be completed in 48 parts. Besides illustrations in the text, there is a carefully prepared page representing coloured reactions characteristic of certain metals, &c.

MR. T. H. CORNISH, of Penzance, has a note in the current number of the *Zoologist* on some remarkably large catches of fish on the Cornish coast. On March 18 last, 12,000 grey mullet, *Mugil capito*, were captured, by means of a draw-seine, by the fishermen of Sennen Cove, at Whitsand Bay, Land's End. The fish were of fine quality, one being brought to Mr. Cornish which measured 2 feet in length, 1 foot 3 inches in girth, and weighed 6 pounds 10 ounces. On the 31st of the same month a Lowestoft mackerel driver, fishing some leagues south-west of the Lizard, took 48,000 mackerel. No such catch of mackerel, for one night's fishing, had ever been heard of before at Penzance, and what makes it more extraordinary, says Mr. Cornish, is that it should have taken place in March, when the catches usually average a few hundreds only. Later on in the season, in the fishing west of Scilly, 20,000 to 25,000 is regarded as a heavy catch. The catch sold for £360.

WITH reference to our note (vol. xliii. p. 521) on an award made by the Japanese Government to Dr. Shohei Tanaka for "the invention of a new musical instrument," Mr. J. W. Goundry, of Gosforth, Newcastle, writes to us that over twenty years ago he patented an arrangement for giving enharmonic intervals in all keys on the ordinary unaltered keyboard, and that he has had both an organ of 31, and a harmonium of 36, sounds per octave, playing Bach's fugues and Handel's choruses, &c., on the system. He claims that, although his patents were very crude and imperfect, they contain at least the germ of a complete solution of the problem of reconciling just intonation with the ordinary manual. "They embody a system of sounds," he says, "which I believe to be theoretically the truest and practically the simplest possible, and which has nowhere else been described."

AMMONIUM sulphovanadate, $(NH_4)_3VS_4$, has been isolated in large crystals by Drs. Krüss and Ohnmais, and an account of their work, which also includes the preparation of several other sulpho-salts of vanadium, will be found in the latest number of *Liebig's Annalen*. It is well known that when ammoniacal solutions of vanadates are treated with sulphuretted hydrogen a magnificent purple colouration is produced, presumably due to the formation of sulpho-salts. It has not been found possible, however, to obtain such salts by crystallization *in vacuo*. The method of obtaining the ammonium salt now described is as follows:—A stream of sulphuretted hydrogen is led into an ice-cold saturated solution of ammonium metavanadate, NH_4VO_3, in the strongest ammonia. The immediate effect is to produce the violet-red colour, but the colouration soon disappears and a brown solid is precipitated. On continuing the passage of the gas this precipitate slowly redissolves with production again of the deep violet colour. When the re-solution of the precipitate is almost complete the liquid is filtered, and sulphuretted hydrogen again led through the solution. In a short time crystals commence to separate, when the current of gas is stopped and the liquid left to crystallize in a closed vessel. The crystals thus obtained consist of opaque rhombic prisms very much resembling in appearance those of potassium permanganate. The faces are very brilliant and reflect a steel bluish-violet colour with a greenish tint when the reflection is received at a certain angle. They may be washed with absolute alcohol and afterwards with ether, and finally dried *in vacuo*. The mother liquors from the first crystallizations deposit magnificent crystals on being allowed to stand some weeks. The substance may be much more quickly obtained and in larger quantity by substituting either potassium or sodium vanadates for the ammonium vanadate used in the above mode of preparation, as these salts are much more soluble in ammonia than ammonium vanadate. It is somewhat remarkable that in this case pure ammonium sulphovanadate should be obtained, no potassium or sodium sulpho-salts being ever found in the product. The crystals of ammonium sulphovanadate are permanent in dry air, but are slowly decomposed with evolution of sulphuretted hydrogen in moist air. They are readily soluble in water, forming a solution which is coloured intensely violet even when very dilute. A solution containing only one part of the salt in 100,000 parts of water still possesses a beautiful rose-red colour. After a short time this solution decomposes, sulphuretted hydrogen being liberated and the colour changing to brown. When a freshly prepared solution is added to a solution of a salt of the alkaline earthy metals, no precipitate is produced, owing to the solubility of the sulphovanadates of these metals. But in the case of calcium a remarkable deepening of the violet colour is produced. If, for instance, a little calcium chloride is added to a dilute solution possessing a just perceptible rose tint, the colour becomes immediately deep violet, owing to the extreme tinctorial power of the calcium salt.

IN our note in vol. xliii. p. 592, upon the preparation among other silicon compounds of silicon chloro-tribromide, $SiClBr_3$, by M. Besson, it was stated that this substance had not been hitherto prepared. We wish to correct this statement. Silicon chloro-tribromide was prepared by Prof. Emerson Reynolds in 1887, and a descriptive note of the work was given in NATURE at the time (vol. xxxvi. p. 137).

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus* ♀) from India, presented by Mrs. Emily Palmer; two Brazilian Caracaras (*Polyborus brasiliensis*) from Terra del Fuego, a Turkey Buzzard (*Cathartes aura*) from the Falkland Islands, presented by Mr. F. E. Cobb, C.M.Z.S.; two Herring Gulls (*Larus argentatus*), British, presented by Mrs. Attenborough; a Pine Grosbeak (*Pinicola enucleator*), British, presented by Mr. W. H. St. Quintin; a Bennett's Wallaby (*Halmaturus bennetti* ♂) from Tasmania, two Diamond Snakes (*Morelia spilotes*) from Australia, deposited; two Tasmanian Wolves (*Thylacinus* *cynocephalus* ♂ ♀), three Ursine Dasyures (*Dasyurus ursinus* ♂ ♀ ♀) from Tasmania, two Brush Turkeys (*Talegalla lathami* ♂ ♀), four Australian Wild Ducks (*Anas superciliosa*) from Australia, received in exchange; a Black Lemur (*Lemur macaco*), two Persian Gazelles (*Gazella subgutturosa*), born in the Gardens.

THE INSTITUTION OF MECHANICAL ENGINEERS.

ON the evenings of Thursday and Friday of last week, the 30th ult. and the 1st inst., the Institution of Mechanical Engineers held an ordinary general meeting; the President, Mr. Joseph Tomlinson, occupying the chair. There was an attendance of members somewhat in excess of that which is usual at the ordinary meetings of this Institution. There were two items on the programme—namely, a paper on Lancashire boilers, and a further report from the Research Committee on Marine Engine Trials. The discussion of the latter occupied so much time that the boiler paper had to be shelved until next meeting.

The latest steamer upon which the Marine Engine Research Committee has been experimenting is a cargo vessel named the *Iona*. She was built and engined by W. Gray and Co., of West Hartlepool, and is a good modern example of what can be done in fuel economy with triple expansion engines when high speed is not aimed at. This latest report of the Committee should re-establish in some minds the belief in the economy of the marine surface-condensing engine, which had been, so it was thought, rather shaken by the previous labours of the Committee. When on the first trials of the Committee the fuel consumption of the *Meteor*, *Fusi Yama*, and the *Colchester* came out at not less than 2 pounds of coal per indicated horse-power per hour—the *Colchester's* consumption being nearly 3 pounds per hour—it was said, by those who had never believed in the claims of marine engineers, that the bubble was pricked by a trial made by competent and unbiassed persons. It is true the *Tartar's* trial improved on these figures, the coal consumption coming out 1·77 pound per indicated horse-power per hour; still this is some way behind the 1½ pound of which marine engineers had been boasting. The experiments with the *Iona*, now under consideration, have rehabilitated the marine engine as an economical form of steam motor, for there can be no doubt that the engines of that vessel have given off on trial one unit of power per hour for less than the pound and a half of coal, and we have no reason to think that the 1·38 pound shown on the chief engineer's independent trial is not a fair average for sea running when the disturbing element of measuring tanks is omitted.

The *Iona* is a well decked vessel, built in 1889. She has triple expansion engines on three cranks, working a single screw. The vessel is 275·1 feet long, 37·3 feet wide, and 19 feet deep in the hold. Her moulded depth is 21 feet 10 inches, and her coefficient of fineness is 0·765. She has a cellular bottom. Her mean draught in dock before trial was 20 feet 8 inches, but she rose half an inch in salt water, the displacement being 4430 tons. The engines had been freshly overhauled. The trial took place off the east coast, between Robin Hood Bay and Great Yarmouth. The weather was fine throughout. The engines are triple compound surface condensing. The cylinders are placed in the order—intermediate, high, low, going from forward to aft. The cranks rotate in the sequence—high, intermediate, low. The diameters of the cylinders are 21·88 inches, 34·02 inches, and 56·95 inches; the stroke is 39 inches. The high pressure cylinder only is jacketted, steam being taken from the boiler direct. Outside this jacket are the receivers for the intermediate and low pressure cylinders. The jacket steam therefore parts with heat to the high pressure cylinder, and also heats up the steam passing to the two other cylinders. The arrangement is unusual but not new. A feature worth noting in the present day is that the steam distributing valves are all slide valves. Mr. Mudd, the designer of the engines, does not follow the modern fashion of using piston valves, it being his belief that the advantages they offer are not equal to those lost. The surface condenser has 1360 square feet of tube surface. There are two ordinary steel boilers having 42 square feet of grate surface, the total heating surface being 3160 square feet; which is equal to 75·2 times the grate area. It is not to be wondered at that, with this liberal allowance of heating surface, the fuel economy came out very satisfactorily. The total cross-sectional area through the tubes is 18·3 square feet, and the area across the funnel 30·7 square feet. A notable feature about this vessel is that the boilers are worked on forced draught; or rather there is a fan for supplying air to the fires, for a pressure equal to only 0·17 inch of water in the ash pits hardly fulfils the popular notion of forced draught. The steam for driving the fan-engine was supplied from the donkey boiler, and therefore the measurements of quantities in the performance table were not affected by the amount of steam used by the fan. The matter is not one of great importance—the power to drive the fan not being, perhaps, more than the three-hundredth part of the power of the propelling engines; but we question whether it is strictly fair—as comparing the *Iona's* machinery with that of other vessels—not to take the fan-engine steam from the main supply. The boilers in this ship have an extraordinarily large proportion of tube surface as compared to the grate surface, and this would be likely to lead to an insufficiency of draught were the lighter specific gravity of the chimney gases alone depended upon. If, therefore, the aid of the fan has to be brought in, its cost as well as its services should be taken into account. This is looking at the matter from the point of view of taking the total efficiency of the machinery, and Prof. Kennedy might very justly urge that the steam used by the fan would be a disturbing element, and prevent him from properly determining the efficiency of the engines. The fan undoubtedly belongs to the boiler, but not more so than the feed-pumps; all boilers, however, must have feed-pumps, while comparatively few have fan-engines. If ever it comes to be that fan-engines are almost as much matters of course as feed-pumps, it will be convenient to class the former with the engine, but until then it is as well to estimate the steam required for forced draught purposes by itself; still it should be taken into account.

The air from the fans is taken to the furnace through gridiron valves, which close automatically when the furnace-door is opened, so as to prevent a rush of flame into the stokehold. A small jet of air is also admitted through the wet end of the boiler back by a passage made for the purpose. In this way there are two streams of air which meet in the combustion-chamber. There is also a hanging bridge attached to the back tube plate, and depending into the flame box at the back of the bridge. By these arrangements a very thorough mixing of the air and furnace gases is secured; and to this, no doubt, is due the unusually perfect combustion which was obtained on the trial. The small grates give additional space for the mixing and burning of the gases before they enter the tubes, a most desirable feature in boiler design, and one which should do much to put the cylindrical flues of modern high-pressure boilers on an equality, in the matter of combustion, with the rectangular furnaces of the comfortable low-pressure days of the past generation of marine engineers. At the same time we must not forget that a large amount of fuel burnt on a small grate requires a large combustion chamber. It is the volume of gases evolved which has to be considered. It should be stated that the arrangement for forced draught was designed by Mr. J. R. Fothergill, of Hartlepool, engineer superintendent to the firm owning the ship.

It is so difficult to get accurate data upon the weight of marine engines, that we add the figures given in the report:—

	Tons.
Engines alone	94·92
Shafting, tunnel-bearings, and propeller ...	26·59
Engine room auxiliaries, including donkeys, pipes, platforms, ladders, and gratings ...	12·16
Boilers alone	58·60
Boiler-room auxiliaries, including forced draught gear, smoke-box, uptake, funnel, furnace gear, mountings, stokehold floor, boiler-chocks, and ties...	28·49
Water in boilers	35·75
Total	228·22

The coal used was of good quality. The following analysis (as used) will be of interest:—

	Per cent.
Carbon	82·34
Hydrogen...	5·47
Moisture	1·94
Ash	2·90
Nitrogen, sulphur, oxygen, &c., by difference...	7·35
	100·00

The calculated calorific value is 14,830 thermal units per pound, which corresponds to the evaporation of 15·35 pounds of water from and at 212° F. A portion of the coal used was also tested by a Thomson calorimeter, and gave a value of 14,980 thermal units per pound. Thirteen samples of furnace gases were taken over mercury and were analyzed. The following are the means :—

	By volume per cent.		By weight per cent.
Carbonic acid	8·20	...	12·12
Carbonic oxide	0·00	...	0·00
Oxygen	11·17	...	12·01
Nitrogen	80·63	...	75·87
	100·00		100·00

Chimney temperatures were read every half-hour by a mercury thermometer and by two Murrie pyrometers at 30 feet above the furnace bars. The readings of the three instruments agreed, the average temperature being 452° F. It was a pity that the readings were taken so far from the fires, it being desirable to know the heat of the products of combustion immediately after leaving the heating surface of the boiler. The arrangement, however, was unavoidable, owing to the exigencies of running the ship on her voyage. The measurement of the feed was carried out by means of two tanks in the usual way. An effort was made to determine the quantity of water brought over unevaporated, by the draught of steam. This was done by taking samples of condensed steam from the steam pipe and samples of boiler water, and analyzing them to ascertain the percentage of salt. Unfortunately the apparatus broke down ; but from two pairs of analyses made, it was estimated that there was 2·87 per cent. of unevaporated boiler water in the condensed steam. If this were the case with boilers so easily driven as those of the *Iona*, where there could hardly have been any semblance of "priming," as the term is understood by engineers, the quantity of water brought over in small and hardly driven boilers must be enormous. It is a point of the greatest importance in steam-engine economy, and we trust Prof. Kennedy will pursue his investigations in this direction. It also came out during the discussion that the stop valve, or throttle valve, was very much closed during the trial, a fact which should still further have reduced the chance of unevaporated water finding its way into the engines.

Indicator diagrams were taken every half-hour during the trial, and an average set is attached to the report. The power was very evenly distributed between the three cylinders, showing good design of the engines. The total indicated horse-power was 645·4. Diagrams were also taken from the air and circulating pumps. For these interesting and valuable details we must refer our readers to the paper itself, as we are unable to reproduce the diagrams.

The following are some of the chief elements of the trial :—

Date	July 13 and 14, 1890.
Duration of trial	16 hours.
Heating surface, total	3160 square feet.
,, ,, tubes	2590 ,, ,,
Grate area	42 ,, ,,
Total heating surface to grate surface...	75·2 ratio.
Grate area to flue area through tubes...	2·3 ,,
Mean boiler pressure above atmosphere	165·0 lbs. per sq. in.
Mean admission pressure, high-pressure cylinder	142·5 ,, ,,
Mean vacuum in condenser below atmosphere	13·88 ,, ,,
Mean revolutions per minute	61·1
I.H.P. of high-pressure cylinder ...	205·6
,, intermediate ,, ...	221·2
,, low-pressure ,, ...	218·6
Coal burnt per hour	942 pounds.
,, ,, square foot of grate per hour	22·4 ,,
Coal burnt per square foot of total heating-surface per hour	0·298 ,,
Coal burnt per I.H.P. per hour ...	1·46 ,,
Carbon equivalent of coal	1·02 ,,
Feed-water per hour	8616·0 ,,
,, ,, lb. of coal	9·15 ,,
,, ,, ,, from and at 212° F.	10·63 ,,
Efficiency of boiler	69·2 per cent.
,, engine	17·1 ,,
,, engine and boiler ...	11·8 ,,
Mean speed of vessel during trial ...	8·6 knots per hour.

A long discussion, occupying both evenings of the meeting, followed the reading of the paper, but our account has already extended to such a length that we cannot give a report of it. Perhaps the most interesting point raised was in connection with the closing of the chimney damper, which it appeared was only one-sixth open during the trial. The reason given for this was that in this way heat was prevented from escaping up the chimney. It is difficult to account for such an effect, excepting perhaps to some trifling extent due to minor causes, but several engineers whose opinion is worthy of respect testified that such was the effect in practice. One would think that the escape of heat by the chimney would be governed by the volume of escaping products of combustion with a chimney of any reasonable cross area.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The first Clerk Maxwell Scholarship, for research in Experimental Physics, has been awarded to W. Cassie, M.A., Trinity College.

Mr. H. J. Mackinder, the Reader in Geography at Oxford, is to lecture for the Teachers' Training Syndicate on "The Teaching of Geography," on May 30.

The annual dinner of the Philosophical Society was held in the Combination Room of St. John's College on May 2, Prof. G. Darwin in the chair.

DUBLIN.—Sir Robert Ball begins on Wednesday, the 13th inst., a course of lectures on "The Theory of Screws," in Trinity College, Dublin.

SCIENTIFIC SERIALS.

THE *Quarterly Journal of Microscopical Science* for March contains :—On a new species of Phymosoma, with a synopsis of the genus, and some account of its geographical distribution, by Arthur E. Shipley (Plate xi.). The new species, *P. weldoni*, was found by Prof. Weldon at Bimini Island, the Bahamas ; it has no trace of hooks on the introvert ; there are two retractors. A synopsis of the twenty-seven species now known is given, but seventeen species are described in Selenka's monograph on the Sipunculidæ. As to the geographical distribution, seventeen species are found in the Malay Archipelago, of which thirteen are endemic, five are found in the Red Sea, four in the Mauritius, and three are found in the West Indies, but *P. lovenii* is found only in the Bergen Fiord.—On the British species of Crisia, by Sidney F. Harmer (Plate xii.). The author thinks that the ovicells furnish satisfactory specific characters ; the aperture in the ovicell is also an important character. Specific diagnoses of *C. denticulata*, Lmk., *C. eburnea*, Linn., *C. aculeata*, Hass., and *C. ramosa*, n. sp., are given. Notes are given of the habit of the Zoarium at different seasons, on the mode of branching, and on the breeding-times.—The later larval development of Amphioxus, by Arthur Willey (Plates xiii.-xv.). The author again visited Messina, in the summer of 1890, to complete his studies on the development of the atrial chamber of Amphioxus. As a possible explanation of the asymmetry of the larva, Willey thinks that it can be traced ultimately to the adaptive forward extension of the notochord, being thus a purely ontogenetic phenomenon ; the club-shaped gland is shown to be a modified gill-slit.—On the structure of two new genera of earthworms belonging to the Eudrilidæ, and some remarks on Nemertodrilus, by Frank E. Beddard (Plates xvi.-xx.). *Hyperiodrilus africanus*, n. gen. and sp., and *Heliodrilus lagosensis*, n. gen. and sp., found in a Ward case from Lagos, at Kew Gardens.

THE only article of general interest in the *Nuovo Giornale Botanico Italiano* for April is a note on the stigmatic disk of *Vinca major*, by Sig. M. Pitzorno. In the reports of the Italian Botanical Society are short papers by Sig. Baccarini on the secretory system of the Papilionaceæ ; on the arrangement of herbaria, by Sig. L. Micheletti ; and others of special interest to Italian botanists.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 16.—"An Attempt to determine the Adiabatic Relations of Ethyl Oxide. Part I. Gaseous Ether." By Prof. W. Ramsay, F.R.S., and E. P. Perman, B.Sc.

The object of the research described in the memoir is the determination of the behaviour of ether in the state of gas approaching towards the state of liquid, when heat is communicated to it, so as to alter its condition adiabatically.

Previous researches by one of the authors in conjunction with Dr. Sydney Young have yielded data regarding the relations of pressure, temperature, and volume of gaseous and of liquid ether from which the values of the isobaric and of the isochoric differentials are obtainable. Such results lead directly to a knowledge of the differences between the specific heats at constant pressure and those at constant volume; and these differences are not constant, but vary with varying volume, pressure, and temperature.

The memoir contains an account of experiments made to determine the ratio between the specific heats at constant pressure and those at constant volume. The velocity of sound in gaseous ether was determined at various temperatures, pressures, and volumes; and by means of the isothermal differentials, and the experimental results for the velocity of sound, the ratios between the two specific heats were calculated. From the differences and the ratios of the specific heats, the values of the specific heats were deduced.

The general conclusion is that, for any constant volume, the specific heat, whether at constant volume or at constant pressure, decreases to a limiting value with rise of temperature, and subsequently increases; and that the change with temperature is more rapid, the smaller the volume.

At large volumes, the specific heats tend towards independence of temperature and volume, while at small volumes the influence of change of temperature and volume is very great.

The authors are at present investigating similar relations for liquid ether.

Zoological Society, April 21.—Prof. W. H. Flower, C.B., F.R.S., President, in the chair.—A communication was read from Lieut-Colonel Sir Oliver B. C. St. John, R.E., containing notes on a case of a Mungoose (*Herpestes mungo*) breeding during domestication.—Mr. R. E. Holding exhibited and made some remarks on some remarkable horns of Rams of the domestic Sheep of Highland and other breeds.—Messrs. Beddard and Murie exhibited and made remarks on a cancerous nodule taken from the stomach of an African Rhinoceros (*Rhinoceros bicornis*), which had recently died, after living 22 years in the Society's Gardens.—Mr. E. T. Newton read a paper on the structure and affinities of *Trogontherium cuvieri*, basing his remarks principally on a fine skull of this extinct Rodent lately obtained by Mr. A. Savin from the forest-beds of East Runton, near Cromer.—Mr. H. J. Elwes read the first part of a memoir on the Butterflies collected by Mr. W. Doherty in the Naga Hills, Assam, the Karen Hills in Lower Burmah, and in the State of Perak.—Mr. J. J. Lister gave an account of the birds of the Phœnix Islands, Pacific Ocean, as collected and observed during a visit to this group made in H.M.S. *Egeria* in 1889.

May 1.—Sixty-second Anniversary Meeting.—Prof. Flower, F.R.S., President, in the chair.—After the auditors' report had been read, and other preliminary business had been transacted, the report of the Council on the proceedings of the Society during the year 1890 was read by Mr. Sclater, F.R.S., the Secretary. It stated that the number of Fellows on January 1, 1891, was 3046, and that the number of Fellows elected or readmitted in 1890 was 121, being 4 less than the corresponding number in 1889. Since the last anniversary 2 Foreign Members and 11 Corresponding Members had been elected to fill vacancies in those lists. In recognition of the effective protection accorded for sixty years to the Great Skua (*Stercorarius catarrhactes*) at two of its three British breeding stations—namely, in the Island of Unst by the late Dr. Laurence Edmondston and other members of the same family, and in the Island of Foula by the late Dr. Scott, of Melby, and his son, Mr. Robert T. C. Scott—the silver medal of the Society had been awarded to Mrs. Edmondston, of Buness House, as representative of that family, and to Mr. Robert T. C. Scott, of Melby. The total receipts of the Society for 1890 had amounted to £25,059, which, although not quite equal to those of 1889, had exceeded those of 1888 by upwards of £1000, and might be deemed to be satisfactory. The ordinary expenditure for 1890 had been £23,342 6*s.* 11*d.*, which was £659 2*s.* 8*d.* more than the corresponding amount for 1889. Besides this an extraordinary expenditure of £230 4*s.* 6*d.* had been devoted to the material improvement of the Monkey House, which brought up the total expenditure of the year to £23,572 11*s.* 5*d.* The balance brought forward from 1889 was £1242 13*s.* 11*d.*, and this, added to the income received in 1890, gave a total sum of £26,302 11*s.* 9*d.* available for the expenditure of the year 1890. By these means the Council had been enabled, after payment of the ordinary and extraordinary expenditures of the year, not only to devote the usual sum of £1000 to the reduction of the mortgage-debt on the Society's freehold premises (which at present amounted to £5000 only), but also to purchase a sum of £1000 in Consols, in order to form the nucleus of a new reserve fund. The usual scientific meetings had been held during the session of 1890, and a large number of valuable communications had been received upon every branch of zoology. These had been published in the annual volume of Proceedings for 1890, which contained 730 pages, illustrated by 57 plates. Besides this, part x., being the concluding part of the twelfth volume, of the Society's quarto Transactions had been issued. The twenty-sixth volume of the *Zoological Record*, containing a summary of the work done by British and foreign zoologists during the year 1889, had been issued to the subscribers in December last, and had thus been published before the close of the year after that to which it relates. The library had been kept in good working order during the past year, and had been much frequented by working zoologists. A large number of accessions, both by gift and purchase, had been received and incorporated. In the Gardens the only new work carried out in 1890 had been the completion of the improvements of the Monkey House, but a large number of repairs and renewals of the different buildings in the Gardens had been made, and other minor improvements had been carried out. The number of visitors to the Gardens during the year 1890 had been 640,987, the corresponding number in 1889 having been 644,579. The number of school children admitted free in 1890 was 35,935. The number of animals in the Society's collection on December 31 last was 2256, of which 693 were mammals, 1273 birds, and 290 reptiles. Amongst the additions made during the past year, twelve were specially commented upon as of remarkable interest, and in most cases representing species new to the Society's collection. About 28 species of mammals and 20 of birds had bred in the Society's Gardens during the summer of 1890. The report concluded with a long list of the donors and their various donations to the Menagerie during the past year.—A vote of thanks to the Council for their report was moved by Mr. W. H. Hudleston, F.R.S., seconded by Mr. A. J. Scott, and carried unanimously.—The report having been adopted, the meeting proceeded to elect the new Members of Council and the officers for the ensuing year. The usual ballot having been taken, it was announced that Mr. William T. Blanford, F.R.S., Dr. Albert Günther, F.R.S., Mr. E. W. N. Holdsworth, Sir Albert K. Rollit, M.P., and Mr. Howard Saunders, had been elected into the Council in the place of the retiring members, and that Prof. Flower, C.B., F.R.S., had been re-elected President, Mr. Charles Drummond, Treasurer, and Dr. Philip Lutley Sclater, F.R.S., Secretary to the Society for the ensuing year.—The remaining business having been concluded, the President handed the silver medal of the Society to Mr. Thomas Edmondston, who attended on the part of Mrs. Ursula Edmondston, of Buness, Unst, Shetland, and to Mr. A. P. Purves, who attended on behalf of Mr. Robert T. C. Scott, of Melby, Shetland, in recognition of the effective protection accorded by them and their families respectively to the Great Skua at its breeding places in the Shetland Islands.—The proceedings terminated with the usual vote of thanks to the President.

Geological Society, April 22.—Dr. A. Geikie, F.R.S., President, in the chair.—The following communications were read:—Results of an examination of the crystalline rocks of the Lizard district, by Prof. T. G. Bonney, F.R.S., and Major-General C. A. McMahon. The authors, in company with the Rev. E. Hill, spent a considerable part of last August in examining anew those sections in the Lizard district which had any bearing upon the questions raised since the publication of Prof. Bonney's second paper in 1883. They had also the advantage of occasional conference with Mr. Teall and Mr. Fox, whose valuable contributions to the knowledge of the crystalline rocks of this district are well known. That the Lizard serpentines are altered peridotites may be regarded as settled, but doubts have been expressed as to their relation to other associated rocks, and as to the meaning of a streaky or banded structure exhibited by certain varieties. The authors, after re-examination of a large number of sections, feel no doubt of the accuracy of their original view that the peridotite was intruded into the hornblende schists and banded "granulitic" rocks, after these had assumed their present condition. In it they find no signs of any marked pressure-metamorphism, either prior or posterior to serpentinization. They have failed to connect the streaky or banded structure with any foliation or possible pressure-structure in the schists, and they can only explain it as a kind of fluxion-structure, viz. as due to an imperfect blending of two magmas of slightly different chemical composition, anterior to the crystallization of the mass. The Porthalla sections have been examined with especial care, not only because the serpentine is nowhere so conspicuously banded, but also because its intrusive character has been denied, both it and the hornblende schists being ascribed to the alteration of a series of sedimentary rocks of suitable composition. For this view the authors have failed to discover any evidence, and consider it contrary to stratigraphical and petrographical facts. In regard to the genesis of the crystalline schists, which for purposes of reference were divided by Prof. Bonney into a "granulitic," a "hornblendic," and a "micaceous" group, the authors show that in parts of the first the more acid rock breaks through the more basic, as if intrusive, in others they appear to be perfectly interstratified, the one passing backwards and forwards, though rapidly, into the other. But between these extremes, intervals can be found where the two rocks seem as if partially drawn out together. The authors are agreed that certainly one, probably both, of these rocks are igneous, that when the basic rock was solid enough to be ruptured, the acid magma broke into it, and sometimes softened it sufficiently to allow of the two flowing for some little distance together, after which crystallization took place. In regard to the hornblende schists, the authors are not yet satisfied that either fluxion or mechanical crushing will account for every structure which they have examined, and prefer to leave the question, in certain cases, an open one. The most distinctive features of the micaceous group appear due to subsequent earth-movements, so that, though it exhibits some special characteristics, the authors are doubtful whether it is any longer worth while separating it from the hornblende schists. Of the igneous rocks newer than the serpentine, the gabbro has received the closest attention. It exhibits in places (especially in the great dyke-like mass at Carrick Luz) a very remarkable foliation or even mineral banding, which has been claimed as a result of dynamo-metamorphism. The authors bring forward a number of instances to establish the following conclusions :—(*a*) That this foliation occurs most markedly where the adjacent serpentine does not show the slightest sign of mechanical disturbance; (*b*) that it must be a structure anterior to the consolidation of the rock; (*c*) that it sets in and out in a very irregular manner; (*d*) that when it was produced the rock was probably not a perfect fluid. Hence they explain it also as a kind of fluxion structure, produced by differential movements in a mass which consisted of crystals of felspar and pyroxene, floating thickly in a more or less viscous magma. The authors' investigations tend to prove that (*a*) structures curiously simulative of stratification may be produced in fairly coarsely crystalline rocks by fluxioned movements anterior to crystallization; and that (*b*) structures which of late years have been claimed as the result of dynamo-metamorphism subsequent to consolidation must have, in many cases, a like explanation. This is probably the true explanation of a large number of banded gneisses which show no signs of crushing and holocrystalline, but in their more minute structures differ from normal igneous rocks. The authors have seen nothing which has been favourable to the idea that pressure has raised the temperature of solid rocks sufficiently to soften them. A discussion followed, in which Mr. Teall, the Rev. E. Hill, Prof. Hull, the President, General McMahon, and Prof. Bonney took part.—On a spherulitic and perlitic obsidian from Pilas, Jalisco, Mexico, by Frank Rutley.

Royal Microscopical Society, April 15.—Dr. R. Braithwaite, President, in the chair.—Mr. T. Charters White presented three slides of sections of teeth permeated with collodion.—A letter from Mr. J. Aitkin, of Falkirk, was read, on a spot-mirror method of illumination.—An abstract was read of a paper, by Surgeon V. Gunson Thorpe, R.N., on some new and foreign Rotifera found on the West Coast of Africa, and belonging to the genera *Trochosphæra* and *Floscularia*.—Mr. E. M. Nelson exhibited two forms of bull's-eye condenser—one made like Herschel's asplanatic, the other a new and simpler form, being made of two plano-convex lenses. This condenser seemed to answer its purpose admirably, the amount of spherical aberration being only about one-fifth of that which existed in the old form.—Mr. Nelson also read some further notes on Diatom structures as test-objects, which he illustrated by photographs.—Mr. C. Haughton Gill's additional note on the treatment of Diatoms was read, the subject being illustrated by photo-micrographs. Mr. Mayall said the problem Mr. Gill had endeavoured to solve was as to the existence or not of cellular structure in Diatoms extending through their substance, and he sought to demonstrate this by making chemical depositions which would probably fill up the cavities sufficiently to be distinguished by the microscope. Mr. Gill's observations were of great interest, because he had experimented with the definite purpose of testing a special point, thus applying to microscopy what Herschel would have termed an "experiment of inquiry"—a direct questioning of Nature on a point that had hitherto been regarded as almost beyond the sphere of experiment.

PARIS.

Academy of Sciences, April 27.—M. Duchartre in the chair.—The Secretary read an extract from the will of the late M. Cahours, and M. Janssen made some remarks upon the legacies left for the foundation of scholarships (see p. 17).—On the expressions of the pressures in an elastic homogeneous body, by M. H. Resal.—On the theory of elasticity, by M. H. Poincaré.—Researches upon humic substances, by MM. Berthelot and G. André. According to the observations of the authors, the humic substance formed by the action of hydrochloric acid upon cane sugar possesses etheric and anhydric properties, and is comparable in certain respects to the lactones.—On the origin of pus cells and on the *rôle* of these elements in inflamed tissues, by M. L. Ranvier.—On the performance of marine engines and that of screws, and on a geometrical method for calculating the first of these values without a dynamometer, by M. A. Ledieu.—Mica as an invariable dielectric, by M. E. Bouty. The author has previously shown that the capacities of mica condensers vary slightly with the duration of charging. He now finds that mica behaves as an invariable dielectric in a direction normal to the planes of cleavage—that is, the capacity (c) of a lamina of useful surface (ρ) and thickness (e) is represented by the formula $c = \frac{k\rho}{4\pi e}$, where k is a constant. It is remarked that the origin of the large variations of such condensers with duration of charging is the electrolysis of foreign substances contained in the superficial layers.—On an alternate current motor, by MM. Maurice Hutin and Maurice Leblanc.—Quantitative studies on the chemical action of light: first part—measure of physical absorption, by M. G. Lemoine. The action of light upon a mixture of oxalic acid and ferric chloride of various thicknesses and strengths is theoretically and experimentally determined.—Effect of the presence of halides of potassium upon the solubility of the neutral sulphate of potassium, by M. Ch. Blarez. Between 0° and 30° the solubility of K_2SO_4 in water is given in parts per 100 by

$$Q\theta = 8{\cdot}5 + 0{\cdot}12\theta.$$

On adding KCl, or other halide of potassium, at any definite temperature, the K_2SO_4 remaining in solution is given by the expression—

K_2SO_4 dissolved = a constant − the amount of K in added salt;

for any temperature this becomes

K_2SO_4 dissolved at $\theta° = 7{\cdot}5 + 0{\cdot}14170\theta$ − K of added salt.

The precipitating action of the halides of potassium upon the saturated solution of the neutral sulphate of potassium is *proportional to the equivalent of the added salt*.—On iso-cinchonine, by MM. E. Jungfleisch and E. Léger.—On a hydrocarbon of the terpene series contained in the oils of compressed gas, by MM. A. Étard and P. Lambert. This is a pyropentylene not identical with valylene or pirylene; it polymerizes readily to $C_{10}H_{12}$. Its properties and relations with the terpenes will be given in a subsequent paper.—Researches upon trehalose, by M. Maquenne. Anhydrous trehalose is an octatomic alcohol isomeric with the saccharoses, and very near to maltose in chemical constitution; it yields glucose on inversion, and does not fulfil aldehydic functions.—On the constitution of aqueous solutions of tartaric acid, by M. Aignan. The author arrives at the conclusion that tartaric acid exists in aqueous solution in the state expressed by the formula $(C_4H_6O_6)_2$, partially dissociated according to a definite law.—Researches upon the artificial production of hyalite at the ordinary temperature, by M. Stanislaus Meunier.—On the stomachic digestion of the frog, by M. Ch. Contejean. Experimental evidence is given (1) that the pepsin secreted by the œsophagus is more abundant or more active than that of the stomach; (2) that the œsophagean and stomachic pepsins transform coagulated albumin into syntonin, and afterwards into peptone, without passing through the pro-pepsin stage; (3) that the predominance of the action of œsophagean pepsin on stomachic pepsin is especially manifest by the larger quantity of syntonin that it produces.—On the sexual evolution of the trouts of the Pyrenees, by M. A. Cannieu. The metamere of the endodermous layer and of the primitive circulatory system in the post-branchial region of Vertebrata, by M. F. Houssay.—Contribution to the study of the mechanism of urinary secretion, by M. O. van der Stricht.—Reappearance during winter of the starch in ligneous plants, by M. Émile Mer. The researches indicate that in ligneous plants starch is reabsorbed at the end of the autumn, and generated at the beginning of spring. It results from this that the winter, instead of being the season during which the amylaceous reserve is most considerable, is the season during which it is least.—On some points in the anatomy of the vegetative organs of Ophioglossa, by M. G. Poirault. The observations show that the Ophioglossum fungus is never reproduced by spores, but is propagated exclusively by buds on the roots.—On the existence of Diatoms in the lower lands of North France and Belgium, by M. L. Cayeux.—On the proportion of water in corn from different localities, by M. Balland.—On the treatment of phylloxerous vines by carbon bisulphide mixed with vaselines, by M. P. Cazeneuve.

BRUSSELS.

Academy of Sciences, February 7.—M. F. Plateau in the chair.—Micrographical researches on the nature and origin of phosphate rocks, by M. A. F. Renard. The author gives the preliminary results of some researches on the formation of phosphate rocks. The investigation has been especially directed towards the problem of the origin of these rocks, and some important conclusions are arrived at with regard to this point. A lithographic plate, containing magnified representations of nineteen phosphate chalk specimens, accompanies the paper.—The winter of 1890-91, by M. F. Folie. It is remarked that observations at Brussels show that the winter of 1890-91 is one of the severest passed during the last sixty years. Since 1833 seven winters have been of a severity comparable with the last. They are 1837-38, 1840-41, 1844-45, 1846-47, 1854-55, 1870-71, 1879-80. A table is given showing the mean minimum temperature and the mean temperatures experienced during these years. This comparison and a consideration of summer temperatures do not point to any particularly definite facts. The idea that a hot summer succeeds a rigorous winter does not appear to be supported. On the contrary, it appears that the coming summer should be more cold than hot, with the exception of the months of May and August.—On variations in the latitude of a single place, by M. F. Folie. The reality of the variations in latitude deduced from observations made at Berlin, Potsdam, and Prague, are contested on the ground of systematic errors in the formulæ of reduction, due to the assumption that the earth has been considered to move as a solid body, whereas M. Folie believes it to be composed of a fluid nucleus with a solid crust.—Researches on the development of Arachnactis: contribution to the morphology of Cerianthidæ, by M. E. van Beneden.—Researches on the velocity of evaporation of liquids at temperatures below their boiling-points, by M. P. de Heen. The first part of this paper was read at the January meeting. The results are now given of experiments on the variations of the velocity of evaporation with the hygrometric condition of the current employed. The whole of the observations show that the velocity of evaporation, v, of a liquid surface acted on by wind may be expressed by the formula—

$$v = AF (100 - 0{\cdot}88f) \sqrt{V}$$

where A is a constant, F the tension of the saturated vapour at the temperature of the liquid, and V the velocity of the current.—Determination of the radius of curvature in parallel coordinates, by M. Maurice d'Ocagne.

March 7.—M. Plateau in the chair.—On a curious peculiarity of currents of water, and on one of the causes of sudden floods, by M. G. van der Mensbrugghe. An explanation is given of the fact that in a river the maximum velocity of the current does not occur at the surface, but about three-tenths of the depth below the surface.—Reduction of nitrates by sunlight (second note), by M. Émile Laurent. The author has caused a beam of sunlight to fall upon solutions of nitrates placed in a vacuum, and has found that after a certain time the space contained liberated oxygen, whilst the liquids possessed the characteristic reactions of nitrites. M. Laurent has analyzed the oxygen and nitrites, and finds that the quantity of gas is sensibly proportional to the nitrite formed. As might have been expected, the blue end of the spectrum possesses the most powerful reducing action.—Note on the coagulation of the albumins of the serum of cow's blood, by MM. J. Corin and G. Ansiaux. The authors support the assertion made by Halliburton in 1883, that the albumin of serum ought not to be considered as a single substance, but as a mixture of two or three albuminoids, α, β, and γ, coagulating respectively at temperatures—$\alpha = 73°$ C., $\beta = 77°$ C., and $\gamma = 82°$ C. The blood of man, the dog, pig, rabbit, &c., were known to contain these three substances, and it is now shown that the serum of the cow also contains the paraglobulin α, and the albumins β and γ. Further, it is shown that opalescence and coagulation are not distinct things, but two forms of one and the same phenomenon occurring at the same temperature.—On the curvature of polars with respect to a point on a curve of the nth order, by Prof. C. Servais.—Discovery of a variable star, by M. L. de Ball. An account is given of observations of a variable red star situated in R.A. 20h. 41m. 19s., Decl. + 2° 2'·3 (1891). The observations extend from September 15, 1890, to January 9, 1891. In this time the magnitude of the star increased from 8·7 to 8. The star is not included in Bermingham's Red Star Catalogue. M. de Ball's observations are only eye-estimations, and have not been made by the aid of a photometer. Further evidence of variability is therefore required.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Lessons in Astronomy: C. A. Young (Arnold).—Practical Perspective: J. Spencer (Percival).—Revision or Examination Sheets; Subject II., Machine Construction and Drawing, Elementary Stage: A. G. Day (Percival).—General Physiology: Dr. C. Calleja (Kegan Paul).—Differential and Integral Calculus: A. G. Greenhill, 2nd edition (Macmillan and Co.).—Natural Selection and Tropical Nature: A. R. Wallace; new edition (Macmillan and Co.).—Fifth Report of the U.S. Entomological Commission: A. S. Packard (Washington).—Principles of Political Economy and Taxation: D. Ricardo; edited by E. C. K. Gonner (Bell).—L'Évolution des Formes Animales: F. Priem (Paris, Baillière).—Géologie, Principes—Explication de l'Époque Quaternaire sans Hypothésis: H. Hermite (Neuchâtel, Attinger).

CONTENTS.