THURSDAY, FEBRUARY 9, 1893.

THE MILKY WAY.

The Milky Way from the North Pole to 10° *of South Declination, drawn at the Earl of Rosse's Observatory at Birr Castle.* By Otto Boeddicker. (London: Longmans, Green, and Co., 1892.)

DR. OTTO BOEDDICKER devoted the clear moonless nights for five years, from October 1884 to October 1889, to delineating the Milky Way as it appeared to his unaided eyes at Parsonstown, Ireland. His drawings were deposited in the library of the Royal Astronomical Society, and a note accompanying them was read at the meeting of the Society in November 1889. The work now before us consists of four excellent lithographic reproductions of these drawings, a brief introductory preface being added by Dr. Boeddicker.

The working maps for the drawings were taken from Argelander's "Uranometria Nova," the Milky Way being inserted by means of stump and lead pencil. This medium was found very unsuitable for photographic reproduction, and in preparing the lithographic stones for these charts photography was used for the stars, and the Milky Way was introduced by hand work. Mr. W. H. Wesley, the Assistant Secretary of the Royal Astronomical Society, is responsible for this latter portion of the work, and the results are a splendid testimony to his care and skill. Dr. Boeddicker is to be congratulated upon having secured the services of so excellent an artist.

Plate I. is a detailed drawing of the Section Cygnus-Scutum, Plate II. of the Section Cassiopeiæ, and Plate III. of the Section Aurigæ-Gemini-Monocerotis. In these plates an attempt has been made to represent accurately the appearance of the galaxy, all the differences of luminosity being represented as they actually appeared to Dr. Boeddicker. In Plate IV. a general view on a smaller scale of the whole Milky Way from the North Pole to 10° south declination is given, the contrast being deliberately exaggerated in order to bring out clearly all the details.

The area of the Milky Way indicated on these drawings is very much greater than that on any previously published representations, while for delicate details and faithful reproduction of contrast the plates are unapproached. In many respects Dr. Boeddicker's drawings are a new revelation, branches, wisps, and feelers being shown extending from the main body so as to include stars, clusters and nebulæ, and even whole constellations not previously recognized as connected with or forming part of the Milky Way. Polaris, γ Arietis, Prœsepe, the Pleiades, the Hyades, the great nebula in Andromeda, and nearly the whole of the constellation Orion, are thus joined to the galactic circle. Numerous bright patches, channels, rifts, and interlacing lines of luminous matter hitherto unsuspected are revealed by Dr. Boeddicker's long and patient work, and exponents of disc, spiral, and other theories as to the construction of the Milky Way will find considerable difficulty in accounting for the details shown.

It is very difficult to compare drawings of the Milky Way made by different observers without optical aid. There are such wide variations in unaided vision, so many peculiarities introduced by long and short sight, by astigmatism, by irradiation in the retina, and by other physical and physiological imperfections, that it may safely be asserted that no two persons get exactly the same naked-eye impression of such a vague object as the Milky Way. As no details are given about Dr. Boeddicker's eyes we are probably justified in inferring that they are practically normal, but we doubt whether any other observer, even with special training, could check or correct these charts with reasonable prospect of convincing the original artist of error in the representation of the Milky Way as it appeared to him. Individual peculiarities of sight are minimized by the use of slight optical aid, and two equally experienced observers would be more likely to agree in their delineations of the Milky Way if they used similar telescopes, of say 1-inch aperture, or even ordinary opera glasses. Dr. Boeddicker's appeal to other observers to "verify and correct" his work will probably bring him plenty of correspondence, but can scarcely lead to any important correction in his magnificent drawings.

Dr. Boeddicker considers that "the first step necessary towards the knowledge of the sidereal universe is a thorough acquaintance with the Milky Way as it appears to the naked eye," and hopes that by comparison and the superposition of naked-eye drawings on photographs "some knowledge of the structure of the Milky Way *in the line of sight* may be obtained." This idea is founded on the theory that there is a direct connection between the magnitudes of stars and their distances. Littrow's analysis of Argelander's catalogue of stars certainly seemed to justify belief in this connection, but recent work has entirely disproved the hypothesis. Measurements of the parallax of stars indubitably prove that some faint stars are near, while some of the brightest are at such distances as to have no appreciable parallax. Thus α Orionis, α Virginis, α Leonis, and α Cygni have no parallax, while the 5th magnitude star 61 Cygni has a parallax of between 0″·4 and 0″·5. Photographs of the Pleiades show that we have in that cluster stars differing by as much as 13 magnitudes at approximately the same distance from us. Russell's photograph of α Crucis plainly indicates a direct physical connection between that star and many stars of the 14th and 15th magnitudes which should, according to the theory, be nearly 1000 times more distant. Streaks of nebulæ connect α Cygni and γ Cygni with long lines and stars of about the 16th magnitude in Dr. Max Wolf's photographs of the Milky Way. From considerations of parallax observations of stars and from examination of photographs we are forced to conclude that there is no real connection between magnitude and distance, and that the differences of magnitude of stars are due to differences of size and physical condition. Stars differ enormously in light-giving power, and the actual light emitted by α Cygni must be nearly a million times greater than that from the faint stars directly connected with it and at practically the same distance from us. There is therefore very little chance of adding to our knowledge of the Milky Way "in the line of sight" by superposition of naked-eye drawings on photographs.

In his preface Dr. Boeddicker frequently speaks of "nebulosity," "nebulous light," and "nebulous matter," when he means luminosity and luminous matter. In ante-spectroscopic days the terms nebula and cluster were used almost indiscriminately, a nebula being looked upon as simply an irresolvable cluster, and this error still survives in many astronomical text-books and compilations, but Dr. Boeddicker should have avoided it. When we consider that the majority of the stars in the cluster which we call the Milky Way are of the Sirian type, we see how misleading is the use of the terms nebulous light and nebulous matter. A. T.

THE THEORY OF SUBSTITUTIONS AND ITS APPLICATIONS TO ALGEBRA.

The Theory of Substitutions and its Applications to Algebra. By Dr. Eugen Netto. Translated by F. N. Cole, Ph.D. (Mich.: Ann Arbor, 1892.)

THE theory of substitutions abstractly considered is concerned with the enumeration and classification of the permutations of a set of n different letters $x_1, x_2, \ldots, x_n$. It is scarcely apparent at first sight that a far-reaching mathematical theory could be built on a basis so simple, still less that there should be any connection between this and the complicated question of the solution of algebraical equations by means of radicals. It may be worth while, in order to excite the interest of mathematical readers in the work before us, to mention one or two points in the Theory of Substitutions which will give an inkling of the nature of its connection with the interesting problem just mentioned.

The operation of replacing—say in any function $\phi(x_1, x_2, x_3)$—any permutation of the letters, say x_1, x_2, x_3, by any other, say x_1, x_3, x_2, is called a *substitution*. This operation is denoted explicitly by $\begin{pmatrix} x_1, x_2, x_3 \\ x_1, x_3, x_2 \end{pmatrix}$, or shortly by a single letter s. Thus $s\phi(x_1, x_2, x_3) = \phi(x_1, x_3, x_2)$; and again: If t denote the substitution $\begin{pmatrix} x_1, x_2, x_3 \\ x_3, x_2, x_1 \end{pmatrix}$, $t\phi(x_1, x_3, x_2) = \phi(x_3, x_1, x_2)$. We may indicate the successive application of the two substitutions s and t by multiplying the symbols st in the order of application: thus $st\phi(x_1, x_2, x_3) = \phi(x_3, x_1, x_2)$ and $ts\phi(x_1, x_2, x_3) = \phi(x_2, x_3, x_1)$. In particular, the repetition of the same substitution may be represented by powers of the symbol; thus $s^2\phi(x_1, x_2, x_3) = \phi(x_1, x_2, x_3)$. The identical substitution $\begin{pmatrix} x_1, x_2, x_3 \\ x_1, x_2, x_3 \end{pmatrix}$ is represented by unity. The total number of different substitutions of n letters is obviously $n!$; consequently, if we form the consecutive powers of any substitution we shall ultimately arrive at a power s^m which will be the identical substitution, m being some positive integer not exceeding $n!$: m is called the *order* and n the degree of the substitution.

If among the substitutions of any given degree we can select a set which have the property that the product of any two furnishes another substitution belonging to the set, we obtain what is called a *group of substitutions*. The whole of the $n!$ substitutions of n letters obviously form a group, and the identical substitution by itself forms a group. It is easy, however, to see that in general there are other groups among the substitutions of a given degree. Consider, for example, any rational function $\phi(x_1, x_2, \ldots, x_n)$ which is not wholly asymmetric: there must exist a set of substitutions each of which leaves the value of ϕ unaltered. A substitution which is the product of any number of these must also leave ϕ unaltered: hence the set in question forms a group. We have here a fundamental point in the theory of substitutions, viz., the existence of a group of substitutions and the correlation therewith of rational functions which are unaltered by all the substitutions of the group. The group is said to belong to all the functions which it leaves unaltered; and these functions are said to form a family which is characterized by the group. Thus the group of a wholly asymmetric function is the identical group consisting of the substitution [1]; the group of the wholly symmetric functions consists of the whole of the $n!$ substitutions of the n^{th} degree; the group of the alternating functions consists of all those substitutions which are equivalent to an even number of transpositions, and so on. It is obvious that every rational function determines a group of substitutions, and it may be shown that, conversely, for every group of substitutions we may construct an infinity of rational functions which are unaltered by the substitutions of the group. The significance of this correlation between a group and a family of functions depends on the following important theorem, which is due in substance to Lagrange. If ψ be a rational function which is unaltered by all the substitutions of the group of ϕ (in other words, if the group of ψ contain the group of ϕ) then ψ can be expressed as a rational function of ϕ, and the n elementary symmetric functions

$$C_1 = \Sigma x_1,\ C_2 = \Sigma x_1, x_2, \ldots, C_n = x_1, x_2 \ldots x_n.$$

A particular case of this is the theorem that if the groups of ψ and ϕ be identical, then each can be expressed as a rational function of the other, and of the elementary symmetric functions. A limiting case of this theorem is the familiar result that every rational symmetric function can be expressed as a rational function of the elementary symmetric functions. As a special example consider the the two wholly asymmetric functions $\psi = ax_1 + bx_2$, $\phi = a/x_1 + b/x_2$: these both belong to the identical group, since they are changed by every substitution of the letters x_1, x_2. Hence ψ can be rationally expressed as a function of ϕ, C_1, C_2. The actual expression is in fact

$$\psi = \{2(a-b)^2C_2 - (a^2+b^2)C_1^2 + (a+b)C_1C_2\phi\}\{-(a+b)C_1 + 2C_2\phi\}/(a-b)^2(C_1^2 - 4C_2).$$

The application of the theory of substitutions is limited in the first instance to rational functions. Its use in the theory of the solution of algebraical equations by means of radicals is based on the following important result in the theory of irrational functions. Any root of a solvable equation $f(x) = 0$ can be expressed as a rational integral function of certain elements $V_1, V_2, \ldots, V_1$, the coefficients of which are rational functions of the coefficients of $f(x)$ and of primitive roots of unity. The quantities $V_1, V_2, \ldots, V_n$ are on the one hand rational integral functions of the roots of $f(x) = 0$ and of primitive roots of unity, and on the other hand are determined by a series of equations

$$V_a p_a = F_a(V_{a-1}, V_{a-2}, \ldots, V_v),$$

where p_a is a prime number and F is a rational function of the $V - s$. For example, in the case of the cubic

$x^3 - C_1x^2 + C_2x - C_3 = 0$, if $\Delta = -27C_3^2 + 18C_1C_2C_3 - 4C_1^3C_3 - 4C_2^3 + C_1^2C_2^2$, $S = 2C_1^3 - 9C_1C_2 + 27C_3$, $T = 9C_3 - 3C_1C_2$, the relations in question are

$$V_3^2 = -27\Delta,\ V_2^3 = \tfrac{1}{2}(S + V_3),\ V_1^3 = \tfrac{1}{2}(S - V_3);$$
$$V_1 = x_1 + \omega^2x_2 + \omega x_3,\ V_2 = x_1 + \omega x_2 + \omega^2x_3,$$
$$V_3 = T + 3\omega(x_1^2x_3 + x_2^2x_1 + x_3^2x_2) + 3\omega^2(x_1^2x_2 + x_2^2x_3 + x_3^2x_1);$$
$$x_1 = \tfrac{1}{3}\{C_1 + V_1 + V_2\},\ x_2 = \tfrac{1}{3}\{C_1 + \omega V_1 + \omega^2 V_2\},$$
$$x_3 = \tfrac{1}{3}\{C_1 + \omega^2 V_1 + \omega V_2\}.$$

By means of this theorem and certain elementary principles of the theory of substitutions an elegant and simple demonstration can be given of Abel's theorem that the solution by radicals of the general equation of the n^{th} degree is impossible when $n > 4$: see § 217 of the work before us.

Although the theory of substitutions bears, as we have just shown, on some of the oldest and most interesting of the problems of algebra, it has been comparatively little studied, especially by English speaking mathematicians. Dr. Cole has therefore rendered us a service of great importance by translating one of the standard treatises on this subject. Of the three that were at his disposal we think that he has chosen the one most likely to be useful to a beginner. While Serret in his "Higher Algebra" and Jordan in his "Traité" treat the theory from an abstract and more general point of view, Dr. Netto constantly associates with the substitution the function on which it is supposed to operate. This gives a powerful concrete aid to the comprehension of the propositions of the abstract theory and also helps the student to grasp their application. The great danger in subjects of such generality is that the stream of theorems is apt to run off the mind of the learner without soaking in, like water off the proverbial duck's back.

Dr. Netto's book will be found to contain all the ordinary theorems regarding the classification of substitutions, *e.g.* the existence of groups, transitive and intransitive, primitive and non-primitive, simple and compound; the theory of the algebraic relations between the values of multiple-valued functions and between functions belonging to or included in the same family; and also a considerable number of theorems regarding special groups. The applications embrace the theory of resolvents in general and of the Galois resolvent in particular; the general theory of the solvability of equations by means of radicals; the theory of the group of an equation and a discussion of the criteria of solvability; besides special applications to the cyclotomic and Abelian equations, and to equations three roots of which are connected by a rational relation.

The translation has been admirably done, both from the linguistic and from the mathematical point of view. We found, it is true, here and there passages which were somewhat obscure; but in every case, on comparing with the original, we found the rendering to be absolutely faithful. Such obscurities therefore must be charged either to the author, or to the nature of the subject, or to the idiosyncrasy of the critic, and not to the translator. We congratulate Mr. Cole on the successful completion of his arduous task, and heartily recommend the result to every lover of the most ancient and the most beautiful of all the sciences.

G. CH.

THE BRAIN IN MUDFISHES.

Das Centralnervensystem von Protopterus annectens; *eine vergleichend Anatomische Studie.* Von Dr. Rudolf Burckhardt. (Berlin: R. Friedländer und Sohn, 1892.)

THE Mudfishes, Dipnoi, from many peculiarities in their structure, have attracted the especial attention of anatomists and zoologists. Important monographs on Lepidosiren have been written by Owen and Wiedersheim, whilst Huxley, Günther, and Beauregard have described the anatomy of Ceratodus. Serres, in 1863, made a contribution to the anatomy of the nervous system of Protopterus, Fulliquet in 1886, and Parker in 1888, have also added to our knowledge of its structure; and now Dr. Burckhardt has published a well-illustrated monograph on the central nervous system of *Protopterus annectens*. He had obtained an ample supply of this fish from Herr W. Jezler, a merchant whose business engagements had taken him to the neighbourhood of Bathurst, Senegambia. On more than one occasion Dr. Burckhardt had received living fish, so that he was able to study the microscopic anatomy by the use of the most recent technical methods, and has thus added materially to our knowledge of the brain of this animal.

The author found, in the anterior horn of grey matter of the spinal cord, remarkably large nerve-cells, which possessed both branching protoplasm processes and an axial-cylinder process. In the lateral and posterior horns nerve-cells somewhat smaller in size were seen. The medulla oblongata gave origin to nerves which he names hypoglossal, vagus, glosso-pharyngeal, acusticofacialis, and trigeminus. He also describes two slender nerves as abducens and trochlearis, so that the Dipnoi are not, as some have said, destitute of these nerves. The cerebellum formed the anterior boundary of the 4th ventricle. Large nerve-cells, corresponding to those of Purkinje in the mammalian brain, were not seen. The mid-brain was distinct, and gave origin to a root of the trigeminus, to the optic tract and to the oculo-motor nerve: grey matter containing nerve-cells was grouped around the aqueduct of Sylvius.

Whilst Protopterus corresponded closely with the lowest vetebrates in the regions of the mid and hind brains it presented striking peculiarities in the pineal region. The roof of the 3rd ventricle was complicated, and possessed a velum, which represented a middle choroid plexus; a conarium, and a structure like that which Edinger has named "Zirbelpolster." The epiphysis (*Zirbel*) was attached to the skull by the arachnoid membrane.

The fore brain was well developed, and divided into two hemispheres. He recognized in it a posterior ventral swelling, which, because it contained cells similar to those found in the dentate gyrus (*fascia dentata*) of the higher brains, he describes as a lobus hippocampi. He distinguished a fissure which separated the lobus olfactorius from the pallial part of the hemisphere, so that he harmonizes the fore brain in its fundamental divisions with the mammalian brain as described by Broca and Turner. He directs attention to an elevation ventrad of the lobus olfactorius, which he calls the lobus post-olfactorius. This lobe is also found in the brains of

Selachia and Amphibia, and apparently corresponds to the lobus olfactorius posterior described by His in the human embryo, which forms the anterior perforated spot in the adult human brain. As regards its structure the hemisphere possessed central grey matter containing nerve-cells which lay around the hemisphere ventricle; also a mass of grey matter which he calls corpus striatum; whilst in the more posterior part of the ventral region of the hemisphere were nerve-cells which represented a cortical layer. In the dorsal region of the hemisphere also cortical nerve-cells were found, which were arranged as an inner and an outer layer. The cells of the cortex gave origin to nerve fibres. A definite anterior commissure was present, the fibres of which passed on each side into the lobus hippocampi. Burckhardt, also, figures, as distinct from the anterior commissure, fibres which he regards as the corpus callosum of Osborn. The most important tract of nerve fibres was the basal bundle, which ascended from the spinal cord into the corpus striatum.

One of the most interesting chapters in Burckhardt's memoir is that in which he gives an account of the saccus endolymphaticus. Wiedersheim had described in 1876, in *Phyllodactylus europæus*, a sac with many branching diverticula, filled with otolith-sand and lying in relation to the choroid plexus of the 4th ventricle. Hasse had previously seen in Amphibia a similar structure which Coggi had investigated in the frog. Burckhardt has for the first time observed and figured it in Protopterus. The saccus communicated by a narrow neck with the sacculus and utriculus of the auditory vesicle, and with its diverticula overlaid the region of the 4th ventricle, and extended as far back as the 1st pair of spinal nerves.

The memoir contains a short chapter on the phyletic development of the brain of Protopterus. Starting with Selachia, he considers that one line of development has been through Protopterus to Ichthyophis, and thence to the Urodela and Anura; another through Ceratodus to Reptilia and Mammalia; whilst a third line is from the Selachia to the Ganoids and Bony Fishes.

OUR BOOK SHELF.

The Chemical Basis of the Animal Body. An Appendix to Foster's "Text-Book of Physiology" (fifth edition). By A. Sheridan Lea, M.A., D.Sc., F.R.S. (London: Macmillan and Co., 1892.)

LIKE its parent volume, this well-known appendix has grown in bulk considerably, so that it now constitutes a treatise (separately paged and indexed) on the chemical substances occurring in the body. It contains numerous references to the text of Foster's "Physiology," and so the two may be most profitably read together.

The plan pursued in the present edition is the same as in former editions; the chemistry of the body is described under the headings of the names of the chemical substances. This plan has its advantages. It for instance gives a completeness to the description of any particular substance, whereas the other plan of describing the facts of animal chemistry, under the headings of the tissues, organs, and functions involves a certain amount of repetition and the facts relating to any one group, such as the proteids and carbohydrates will be found distributed in different chapters. Dr. Sheridan Lea's plan has, however, the disadvantage that it destroys continuity. Many of the paragraphs are necessarily short, and one passes from one subject to another with a certain amount of abruptness. The style of the writing is, however, interesting and clear, so that this disadvantage is reduced to a minimum. The parts that treat the subject in a fuller style, such as those in which ferment action, the origin of urea in the economy, or the relation of hæmoglobin to bile pigment are discussed, are models of lucid writing.

The book opens with a description of the proteids and ferments, the most important of physiological substances, but those of which, from the chemical standpoint, we know least. The simpler materials found in the body or its excreta are treated next. This is the more chemical part of the book, and the author expresses his indebtedness to Dr. S. Ruhemann for assistance here. One doubts whether this part of the work will prove attractive to ordinary students. There is no question that all medical students should be educated up to it, but at present organic chemistry and structural formulæ are subjects they are inclined to fight shy of. The concluding chapters are again devoted to substances of which we have a physiological rather than a chemical knowledge, namely, the pigments.

The figures of crystals, which form a new feature in the present edition, have been taken from the works of Krukenberg, Kühne, and Funke. One cannot conclude this notice without alluding to the extensive references to literature that are given throughout. This will prove a most valuable assistance to all original workers, and to those more earnest students who desire to go deeper into the subject. The references are provided with a separate index. They are chiefly to German literature. The German leanings of the author are seen also in the spelling of sarkosin, kreatin, &c. The final *e* is always omitted in the names of the amido acids. It would be a good thing in the future if international uniformity in the names of chemical compounds were adopted. In the meantime it seems a pity that Dr. Lea has not seen fit to use the spellings recommended by the Chemical Society of London.

The author is to be congratulated on having brought his labours to a successful conclusion, and we can pay the present volume no better compliment than to say that it is well worthy of those that have preceded it.

W. D. H.

Chambers's Encyclopædia. New Edition. Vol. X. (London and Edinburgh: W. and R. Chambers, 1892.)

THE editor and publishers of the present work may be cordially congratulated on the fact that it has now been successfully completed. A better encyclopædia of like scope does not exist in our own or any other language. Nominally it is merely a new edition; but in reality, as the editor claims in the preface, it must be regarded as to all intents and purposes a new work. One of the chief difficulties in an undertaking of this kind is to secure that each subject shall have the degree of attention which properly belongs to it, no single subject or group of subjects being permitted to usurp space which ought to be otherwise occupied. The editor has grappled with this difficulty so effectually that few readers will have occasion to complain of any lack of proportion in the length of the various articles. Another striking merit of the work is that all important subjects have been entrusted to specialists, so that students may have full confidence in the accuracy of the information offered to them about matters in which they happen to be particularly interested. The space at the disposal of the writers was so limited that what they have to say is not, of course, exhaustive, but it is sound as far as it goes, and is generally presented with most praiseworthy simplicity and clearness. The present volume falls in no respect below the level of those which have preceded it. Among the writers of scientific articles are Prof. James Geikie, who deals with the triassic system and with volcanoes; Prof. Knott, who expounds the principles of thermodynamics; Dr. R. W. Philip, who writes of tubercle; and Sir F. Bramwell, who has a paper on water-supply.

Arthur Young's Tour in Ireland (1776–79). Edited, with Introduction and Notes, by A. W. Hutton. Two vols. (London: G. Bell and Sons, 1892.)

THIS reprint will be of real service to all who study the evolution of economic conditions in Ireland, and much of it ought also to excite and maintain the interest of the general reader. Arthur Young, as every one knows, was a remarkably accurate observer of such things as travellers have opportunities of noting, and his book on Ireland is in its own way hardly less valuable than his more celebrated work on France. The work was first published in 1780, in the course of which two English editions and one Irish edition were issued. Since that time it has not until now been reprinted as a whole. Mr. Hutton has done his work as editor admirably, and a most useful bibliography has been prepared by Mr. J. P. Anderson.

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.*]

Some Lake Basins in France.

A FEW weeks since M. Delabecque, Ingénieur des Ponts et Chaussées at Thonon, kindly presented me with a copy of a work issued under his superintendence and to a great extent executed by himself,[1] to which I should be glad to call the attention of students of physiography. M. Delabecque, commissioned by the French Government, has made a series of soundings of ten lakes in France, near the Alpine region, and this Atlas records the results of his work. Contour-lines, in most cases 5 metres apart, indicate the forms of the lake-basins; the use of varying tints in blue makes these more distinct. Chief among the lakes included is the Léman, in the survey of which, as only one shore is French territory, the Swiss engineers have cooperated. A copy of this on a reduced scale, and without colours, appeared in Prof. Forel's book, "Le Lac Léman" (see NATURE, Nov. 3, 1892). Next in importance come the lakes of Annecy and of Bourget; the remainder are situated either in the French Jura or on the margin of the outer limestone zone of the Alps, a little south of the Rhone.

Excluding the Lake of Geneva, which was noticed in the article just mentioned, these lakes are especially interesting for their bearing on the difficult problem of the origin of lake-basins. Except the Lac de Bourget, none of these can be said to lie in a great mountain valley, or on the probable track of a great glacier. If then their basins have been excavated by glaciers, we might fairly expect the Alps and Jura to be "spattered" with lakes, for no appeal can be made to exceptional circumstances: while if the contours of their beds present resemblances to those of the larger Alpine lakes, such as the Lake of Geneva, the same explanation ought to apply in the main to both groups.

Without a reproduction of the charts it is impossible to give more than a rough idea of the evidence which they afford, but the following statements may be helpful. As a general rule the lakes deepen as they broaden, the deepest water being commonly found in the widest part. If in the course of the lake the shores markedly approach so as to form a kind of "narrow," this corresponds with a submerged neck or "col," which separates the bed into two basins, rising perhaps 10 metres or more above their general level. Not seldom the bed of a lake consists of a linear series, three to six in number, of shallow basins, so that a contour line, drawn along the axis of the lake, undulates up and down with an "amplitude" of from perhaps 3 to 5 metres. A rather long, blunt-ended oval is the prevalent form of these lakes, but to this there are exceptions. So far as can be ascertained the contours of the land above the water-line are reproduced beneath it. For instance, under the steep slopes of the Mont du Chat the bed of the Lac de Bourget plunges abruptly down to a depth of over 120 m. (its greatest depth being about 145 m.).

Of the Jura lakes, the Lac de St. Point (848·95 m. above the sea) is rather more than 6 kilometres long, the general width being rather less than one-tenth of this; a considerable part of its floor is 30 to 35 metres deep, and its greatest depth is about 42 metres. It contains no less than 6 basins, parted by "cols" about half-a-dozen metres above their lowest parts. This lake is on the course of the Doubs, and lies parallel with the general strike of the Jura, *i.e.* from N.E. to S.W. The Lac de Brenets on the same river, nearly 100 metres lower down, is a narrow, winding lake, roughly 150 metres wide and perhaps 8 or 9 times as long. At its upper end is a sharply projecting, rather shallow bay, but the channel of the Doubs can be traced clearly through this, deepening gradually from 5 to nearly 27 metres and the whole lake is evidently only an enlargement of the river.

The subalpine lakes are no less interesting, and their testimony generally agrees with that summarised above. Want of space forbids us to mention more than the lake of Annecy. This is deepest (about 65 m.) in its northern and widest part (nearest to the effluent). The sub-aqueous contours on the western side are interrupted, to within about 10 metres from the bottom of the lake, by a prominence, just like a drowned hilly spur. The shallowest soundings over this, near its northern (outer) part, are only 3·3 metres, and the ground falls rapidly down from 5 to 55 metres. On its northern or "lee" side (assuming a glacier to have followed the course of the water) is a submerged valley over 40 metres deep. The Lake of Annecy exhibits another very singular feature. Near its northern end the bed deepens very rapidly from 30 to 80 metres; this funnel-shaped cavity is less than 200 metres in diameter, and is probably a submerged swallow hole. These notes may, it is hoped, suffice to indicate the importance of this work. The gratitude of students is due to M. Delabecque for supplying them with a valuable group of facts, the collection of which must have entailed great labour. These, however, appear to me not to lend themselves very readily to the support of the glacial excavation hypothesis; but to be more favourable to that which regards the larger Alpine lakes as mainly formed by movements of the earth's crust after the erosion of the valleys in which they lie. T. G. BONNEY.

[1] "Atlas des Lacs Français, Ministère des Travaux Publics." No publisher's name appears on the sheets, but I am informed by M. Delabecque that the Atlas can be obtained at Georg's Library, Geneva.

Dust Photographs.

IN Mr. Croft's paper on "Breath Figures," printed in NATURE for December 22 of last year (pp. 187, 188) he states:—"Two cases have been reported to me where blinds with embossed letters have left a latent image on the window near which they lay." The statement is not quite clear as I do not understand whether the letters were in contact with the glass or not.

Perhaps it may be interesting to place on record an observation of my own, made a few years ago, which struck me at the time as curious, but which I have not been able to verify since.

At the stations of the District Railway there is a useful arrangement by which passengers are informed of the destination of the next train. It consists of a shallow box with glass sides into which by a mechanical contrivance boards are let down on which the names of the stations are painted in white letters on a blue ground. The board with the words 'INNER CIRCLE' is most frequently exposed. At night the box is (or was) illuminated obliquely on either side by a tolerably powerful lamp.

One night I was waiting for the train at the Victoria Station. There was some dislocation in the service; the destination of the next train was uncertain and the box was empty. On glancing at it somewhat sideways I was however astonished to see the words 'INNER CIRCLE' on the glass side of the box in quite clear dark letters on a pale illuminated ground. I drew the attention of one of the platform officials to it. He saw it with perfect distinctness, and seemed to think he had noticed it before. Of course when the apparatus is in full working order there is little opportunity for doing so.

The only explanation I could think of was:—(i) that the light of the lamp had produced some molecular change in the paint coating the notice board; (ii) that this had affected differently the blue and the white paint; (iii) that the same cause had set up some differential electrical condition of the board and the glass; (iv) that a bombardment of particles of the blue paint had taken place on to the glass to which they had adhered; and that (v) the particles so adhering, by dispersing the light, produced the effect of the pale illuminated ground while the spaces occupied by the letters being relatively clean stood out dark.

Royal Gardens, Kew, February 1. W. T. THISELTON-DYER.

MR. W. B. CROFT'S paper on Breath-Figures in your issue of December 22 reminded me of some curious impressions of monumental brasses which are to be seen on the walls of Canterbury Cathedral. When I saw these impressions a few years ago, it occurred to me that they might have been produced by mere contact, the brass plates having possibly been hung for many years against the walls, in secluded corners, at a time when the Reformers would not let them remain in their proper matrices on the church floor. I had forgotten the particulars of these figures, but Dr. Sheppard, of Canterbury, has kindly sent me the following notes by favour of Canon Fremantle:—"A number of impressions of brasses are in the basement (which is open to the air) under Henry IV.'s chantry in the Cathedral. A very good impression is on the western column of the crypt of Trinity Chapel. . . . On the walls appear the shapes of the effigies. Sometimes the stone is unstained all over the area of the figure, and surrounded by a broad dark smudge: and sometimes the case is reversed, and the figure is the exact negative of the former kind; that is to say, the area of the figure is indicated by an uniform dark tint, whilst the surrounding stone is unstained." Dr. Sheppard suggests "that an exact pattern seems to have been made in paper and then fixed to the wall whilst it was brushed over with linseed oil. But this does not account for the white effigies on a dark ground."

I would commend these impressions to the notice of those interested in the subject. It may be that, though some were made intentionally, others are the result of simple contact.

F. J. ALLEN.

Mason College, Birmingham, February 4.

Fossil Plants as Tests of Climate.

IN continuation of my recent letter, permit me to call attention to a communication on the bread fruit trees in North America, by Mr. F. H. Knowlton, of the National Museum, Washington, U.S., which appears in your American contemporary *Science* for January 13. The forty living species of *Artocarpus* are all confined to tropical Asia and the Malay Archipelago. *A. incisa*, the true bread fruit tree, and one or two others, are largely cultivated in the tropics. They are small or medium-sized trees with a milky juice, large leathery leaves, and monœcious flowers. The female flowers are long club-shaped spikes, which uniting form one large mass known as the "bread fruit," the interior containing a pulp when ripe like new bread.

The first fossil bread fruit was discovered in boulder county Colorado in late cretaceous rock, and was named by the late Prof. Leo Lesquereux *Myrica* (?) *Lessigiana*, other fragments he called *Aralia pungens*. The subsequent researches, or more perfect specimens of Dr. A. S. Nathorst, proved these to belong to one species, *Artocarpus Lessigiana*. Dr. Nathorst is the discoverer of another species closely allied to *A. incisa*, which he calls *A. Dicksoni*, which he obtained from the cretaceous flora of Waigatt, West Greenland, which the previous labours of Profs. Heer and Nordenskiöld had shown to be of a tropical or sub-tropical character, containing as it does numerous species of ferns of the order Gleichenialeæ, and several species of cycas.

CHAS. E. DE RANCE.

H.M. Geological Survey, Alderley Edge, Manchester.

Lunar Rainbow in the Highlands.

THIS interesting phenomenon (a very unusual one in this latitude) was observed near here on the morning of the 3rd inst., about six a.m. The moon was two days past full, and was not shining particularly brightly, being obscured, except at considerable intervals, by driving mist and light clouds. The bow, however, was exceedingly well marked, and formed a singularly beautiful object, stretching as it did completely across the north-western end of Loch Oich, glimmering against the dark background of the mountains, and sinking into the water on the southern shore of the loch. The general colour of the bow was yellow deepening into orange, several of the prismatic colours, however, being intermittently visible, especially a tinge of violet on the upper side. O. S. B.

The Abbey, Fort-Augustus, N.B.

OPTICAL CONTINUITY.[1]

KEENNESS of sight is measured by the angular distance apart of two dots when they can only just be distinguished as two, and do not become confused together. It is usually reckoned that the normal eye is just able or just unable to distinguish points that lie one minute of a degree asunder. Now, one minute of a degree is the angle subtended by two points, separated by the 300th part of an inch, when they are viewed at the ordinary reading distance of one foot from the eye. If, then, a row of fine dots touching one another, each as small as a bead of one 300th part of an inch in diameter, be arranged on the page of a book, they would appear to the ordinary reader to be an extremely fine and continuous line. If the dots be replaced by short cross strokes, the line would look broader, but its apparent continuity would not be affected. It is impossible to draw any line that shall commend itself to the eye as possessing more regularity than the image of a succession of dots or cross strokes, 300 to the inch, when viewed at the distance of a foot. Every design, however delicate, that can be drawn with a line of uniform thickness by the best machine or the most consummate artis , admits of being mimicked by the coarsest chain, when it is viewed at such a distance that the angular length of each of its links shall not exceed one minute of a degree. One of the apparently smoothest outlines in nature is that of the horizon of the sea during ordinary weather, although it is formed by waves. The slopes of *débris* down the sides of distant mountains appear to sweep in beautifully smooth curves, but on reaching those mountains and climbing up the *débris*, the path may be exceedingly rough.

The members of an audience sit at such various distances from the lecture table and screen, that it is not possible to illustrate as well as is desirable, the stages through which a row of dots appears to run into a continuous line, as the angular distance between the dots is lessened. I have, however, hung up chains and rows of beads of various degrees of coarseness. Some of these will appear as pure lines to all the audience; others, whose coarseness of structure is obvious to those who sit nearest, will seem to be pure lines when viewed from the furthest seats.

Although 300 dots to the inch are required to give the idea of perfect continuity at the distance of one foot, it will shortly be seen that a much smaller number suffices to suggest it.

The cyclostyle, which is an instrument used for multiple writing, makes about 140 dots to the inch. The style has a minute spur wheel or roller, instead of a point; the writing is made on stencil paper, whose surface is covered with a brittle glaze. This is perforated by the teeth of the spur wheel wherever they press against it. The half perforated sheet is then laid on writing paper, and an inked roller is worked over the glaze. The ink passes through the perforations and soaks through them on to the paper below; consequently the impression consists entirely of short and irregular cross bars or dots.

[1] Extract from a lecture on "The Just-Perceptible Difference," delivered before the Royal Institution on Friday, January 27, by Francis Galton, F.R.S.

I exhibit on the screen a circular letter summoning a Committee, that was written by the cyclostyle. The writing seems beautifully regular when the circular is photographically reduced; when it is enlarged, the discontinuity of the strokes becomes conspicuous. Thus, I have enlarged the word *the* six times; the dots can then be easily seen and counted. There are 42 of them in the long stroke of the letter *h*.

The appearance of the work done by the cyclostyle would be greatly improved if a fault in its mechanism could be removed, which causes it to run with very unequal freedom in different directions. It leaves an ugly, jagged mark wherever the direction of a line changes suddenly.

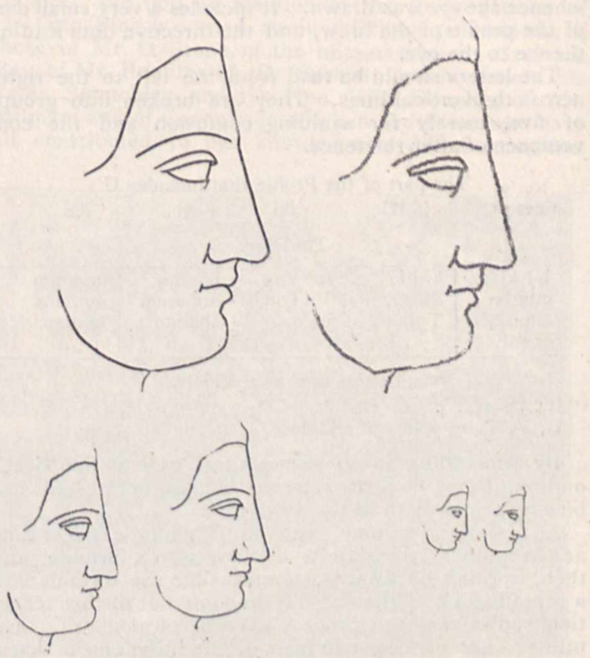
A much coarser representation of continuous lines is given by embroidery and tapestry, and coarser still by those obsolete school samplers which our ancestresses worked in their girlhood, with an average of about sixteen stitched dots to each letter. Perhaps the coarsest lettering that is ever practically employed is used in perforating the books of railway coupons so familiar to travellers. Ten or eleven holes are used for each figure.

A good test of the degree of approximation with which a cyclostyle making 140 perforations to the inch is able to simulate continuous lines, is to use it for drawing outline portraits. I asked the clerk who wrote the circular just exhibited to draw me a few profiles of different sizes, ranging from the smallest scale on which the cyclostyle could produce recognisable features, up to the scale at which it acted fairly well. Here are some specimens of the result. The largest is a portrait of 1½ inches in height, by which facial characteristics are fairly well conveyed; somewhat better than by the rude prints that appear occasionally in the daily papers. It is formed by 366 dots. A medium size is ¾ inch high and contains 177 dots, and would be tolerable if it were not for the jagged strokes already spoken of. The smallest sizes are ⅓ inch high and contain about ninety dots; they are barely passable, on account of the jagged flaws, even for the rudest portraiture.

I made experiments under fairer conditions than those of the cyclostyle, to learn how many dots, discs, or rings per inch were really needed to produce a satisfactory drawing, and also to discover how far the centres of the dots or discs might deviate from a strictly smooth curve without ceasing to produce the effect of a flowing line. It must be recollected that the eye can perceive nothing finer than a minute blurr of one three-hundredth part of an inch in angular diameter. If we represent a succession of such blurs by a chain of discs, it will be easily recognised that a small want of exactitude in the alignments of the successive discs must be unimportant. If one of them is pushed upwards a trifle and another downwards, so large a part of their respective areas still remain in line, that when the several discs become of only just perceptible magnitude, the projecting portion will be wholly invisible. When the discs are so large as to be plainly perceptible, the alignment has to be proportionately more exact. After a few trials it seemed that if the *bearing* of the centre of each disc from that of its predecessor which touched it, was correctly given to the nearest of the 16 principal points of the compass, N., NNE., NE., &c., it was fairly sufficient. Consequently a simple record of the successive bearings of each of a series of small equidistant steps is enough to define a curve.

The briefest way of writing down these bearings, is to assign a separate letter of the alphabet to each of them, *a* for north (the top of the paper counting as north), *b* for north-north-east, *c* for north-east, and so on in order up to *p*. This makes *e* represent east, *i* south, and *m* west.

To test the efficiency of the plan, I enlarged one of the cyclostyle profiles, and making a small protractor with a piece of tracing paper, rapidly laid down a series of equidistant points on the above principle, noting at the same time the bearing of each from its predecessor. I thereby obtained a formula for the profile, consisting of 271 letters. Then I put aside the drawing, and set to work to reproduce it solely from the formula. I exhibit the result; it is fairly successful. Emboldened by this first trial, I made a more ambitious attempt, by dealing with the profile of a Greek girl copied from a gem. I was very desirous of learning how far the pure outline of the original admitted of being mimicked in this rough way. The result is here; a ring has been painted round each



dot in order to make its position clearly seen, without obliterating it. The reproduction has been photographically reduced to various different sizes. That which contains only fifty dots to the inch, which is consequently six times as coarse as the theoretical 300 to an inch, is a very creditable production. Many persons to whom this portrait has been shown failed to notice the difference between it and an ordinary woodcut. The medium size, and much more the smallest size, would deceive anybody who viewed them at the distance of one foot. The protractor used in making them was a square card with a piece cut out of its middle, over which transparent tracing paper was pasted. A small hole of about ⅛ of an inch in diameter was punched out of the centre of the tracing paper; sixteen minute holes just large enough to allow the entry of the sharp point of a hard lead-pencil were perforated through the tracing paper in a circle round the centre of the hole at a radius of ¼ inch. They corresponded to the 16 principal points of the compass, and had their appropriate letters written by their sides. The outline to be formulated was fixed to a drawing-board, with a T rule laid across it as a guide to the eye in keeping the protractor always parallel to itself. The centre of the small hole was then brought over the beginning of the outline, and a dot was made with the pencil through the perforation nearest to the further course of the outline, and this became the next point of departure. While moving the protractor from the old point to the new one it was stopped on the way, in order that the letter for the bearing might be written through the central hole.

A clear distinction must be made between the proposed plan and that of recording the angle made by each step from the *preceding one*. In the latter case, any error of bearing would falsify the direction of all that followed, like a bend in a wire.

The difficulties of dealing with detached portions of the drawing, such as the eye, were easily surmounted by employing two of the spare letters, R and S, to indicate brackets, and other spare letters to indicate points of reference. The bearings included between an R and an S were taken to signify directive dots, not to be inked in. The points of reference indicated by other letters are those to which the previous bearing leads, and from which the next bearing departs. Here is the formula whence the *eye* was drawn. It includes a very small part of the profile of the brow, and the directive dots leading thence to the eye.

The letters should be read from the left to the right, across the vertical lines. They are broken into groups of five, merely for avoiding confusion and the convenience of after reference.

The part of the Profile that includes U

&c.	iiiilU	jiihi	&c.	&c.

The Eye.

URkkk mlmlm mmnZZ onooZ	kklll llmZZ Tjjjj	mSVap VnTnn jjkkc	ponmn mnmmm cbmmn	mmlmm mmmlm mnnnn

Letters used as Symbols.

R....S=(....). Z=end.
U, V, T are points of reference.

By succeeding in so severe a test case as this Greek outline, it may be justly inferred that rougher designs can be easily dealt with in the same way.

At first sight it may seem to be a silly waste of time and trouble to translate a drawing into a formula, and then, working backwards, to retranslate the formula into a reproduction of the original drawing, but further reflection shows that the process may be of much practical utility. Let us bear two facts in mind, the one is that a very large quantity of telegraphic information is daily published in the papers, anticipating the post by many days or weeks. The other is that pictorial illustrations of current events, of a rude kind, but acceptable to the reader, appear from time to time in the daily papers. We may be sure that the quantity of telegraphic intelligence will steadily increase, and that the art of newspaper illustration will improve, and be more resorted to. Important local events frequently occur in far-off regions, of which no description can give an exact idea without the help of pictorial illustration; some catastrophe, or site of a battle, or an exploration, or it may be some design or even some portrait. There is therefore reason to expect a demand for such drawings as these by telegraph, if their expense does not render it impracticable to have them. Let us then go into details of expense, on the basis of the present tariff from America to this country, of one shilling per word, 5 figures counting as one word, cypher letters not being sent at a corresponding rate. It requires two figures to perform each of the operations described above, which were performed by a single letter. So a formula for 5 dots would require 10 figures, which is the telegraphically equivalent of 2 words; therefore the cost for every 5 dots telegraphed from the United States would be 2 shillings, or £2 for every 100 dots or other indications.

In the Greek outline there is a total of 400 indications, including those for directive dots, and for points of reference. The transmission of these to us from the United States would cost £8. I exhibit a map of England made with 248 dots, as a specimen of the amount of work in plans, which could be effected at the cost of £5. It is easy to arrange counters into various patterns or parts of patterns, learning thereby the real power of the process. The expense of pictorial telegraphs to foreign countries would be large in itself, but not large relatively to the present great expenditure by newspapers on telegraphic information, so the process might be expected to be employed whenever it was of obvious utility.

The risk is small of errors of importance arising from mistakes in telegraphy. I inquired into the experience of the Meteorological Office, whose numerous weather telegrams are wholly conveyed by numerical signals. Of the 20,625 figures that were telegraphed this year to the office from continental stations, only 49 seem to have been erroneous, that is two and a third per thousand. At this rate the 800 figures needed to telegraph the Greek profile would have been liable to two mistakes. A mistake in a figure would have exactly the same effect on the outline as a rent in the paper on which a similar outline had been drawn, which had not been pasted together again with perfect precision. The dislocation thereby occasioned would never exceed the thickness of the outline.

The command of 100 figures from 0 to 99, instead of only 26 letters, puts 74 fresh signals at our disposal, which would enable us to use all the 32 points of the compass, instead of 16, and to deal with long lines and curves. I cannot enter into this now, nor into the control of the general accuracy of the picture by means of the distances between the points of triangles each formed by any three points of reference. Neither need I speak of better forms of protractor. There is one on the table by which the ghost of a compass card is thrown on the drawing. It is made of a doubly refracting image of Iceland spar, which throws the so-called "extraordinary" image of the compass card on to the ordinary image of the drawing and is easy to manipulate. All that I wish now to explain is that this particular application of the law of the just perceptible difference to optical continuity gives us a new power that has practical bearings.

POSTSCRIPT.—A promising method for practical purposes that I have tried, is to use "sectional" paper; that is, paper ruled into very small squares, or else coarse cloth, and either to make the drawing upon it, or else to lay transparent sectional paper, or muslin, over the drawing. Dots are to be made at distances not exceeding 3 spaces apart, along the course of the outline, at those intersections of the ruled lines (or threads) that best accord with the outline. Each dot in succession is to be considered as the *central point*, numbered **44** in the following schedule, and the couplet of figures corresponding

11	21	31	41	51	61	71
12	22	32	42	52	62	72
13	23	33	43	53	63	73
14	24	34	**44**	54	64	74
15	25	35	45	55	65	75
16	26	36	46	56	66	76
17	27	37	47	57	67	77

to the portion of the next dot, is to be written with a fine pointed pencil in the interval between the two dots. These are subsequently copied, and make the formula. By employing 4 for zero, the signs of + and − are avoided; 3, standing for −1, 2, for −2; and 1, for −3. The first figure in each couplet defines its horizontal coordinate from zero; the second figure, its vertical one. Thus any one of 49 different points are indicated, corresponding to steps from zero of 0, ±1, ±2, and ±3 intervals, in either direction, horizontal or vertical. Half-an-hour's practice suffices to learn the numbers. The figures 0, 8, and 9 do not enter into any of the couplets in the schedule, the remaining 51 couplets in the complete series of 100 (ranging from 00 to 99), contain 21 cases in which 0, 8, or 9 forms the first figure only; 21 cases in which one of them forms the second figure only, and 9 cases in which both of the figures are formed by one or other of them. These latter are especially distinctive. This method has five merits—medium, short, or very short steps can be taken according to the character of the lineation at any point; there is no trouble about orientation; the bearings are defined without a protractor, the work can be easily revised, and the correctness of the records may be checked by comparing the sums of the small coordinates leading to a point of reference, with their total values as read off directly.

A method of signalling is also in use for military purposes, in which positions are fixed by coordinates, afterwards to be connected by lines.

F. G.

BRITISH NEW GUINEA.[1]

MR. THOMSON'S work on British New Guinea has been looked for with some impatience. Now that it has come it falls short of our expectations. We had hoped for a comprehensive work marshalling into order and summarising the observations and investigations made in the British part of New Guinea, by so many missionaries, explorers, naval and government officers and scientific men, for many years. Instead of this we find that the book is made up almost entirely of the explorations during the past four or five years of the administrator, boiled down out of the official reports by Mr. J. Thomson, the secretary of the Queensland branch of the Geographical Society of Australasia. Throughout the volume there is everywhere evidence that its author is new to literary composition. In consequence, the terse and vigorous English of the original reports suffers severely in the process, so much so that we regret that their important parts have not been presented to us as extracts in the explorer's own words. Mr. Thomson has himself never visited New Guinea, if we may judge by internal evidence, although his phraseology in many places is not unlikely to lead the reader to suppose that he has had a share in the results presented in its pages. Had the author had some personal acquaintance with the country of which he writes he would have formed opinions, we believe, different from many of those he has expressed on his own account throughout the book.

The work opens with a sketch "of the historical aspects of the whole of the great Papuan land," but we miss in it the names of many who deserve honourable mention for their contributions to the "making" of New Guinea. We find no mention of the investigations of Dr. Otto Finsch carried on in all three possessions, of those of Mr. O. Stone, of the missionaries in Geelvink Bay, of Mr. Romilly, of the Special Commissioners Sir Peter Scratchley and the Hon. John Douglas, of Mr. Milman, and of Commanders Pullen and Field, who have all contributed to our knowledge of different regions.

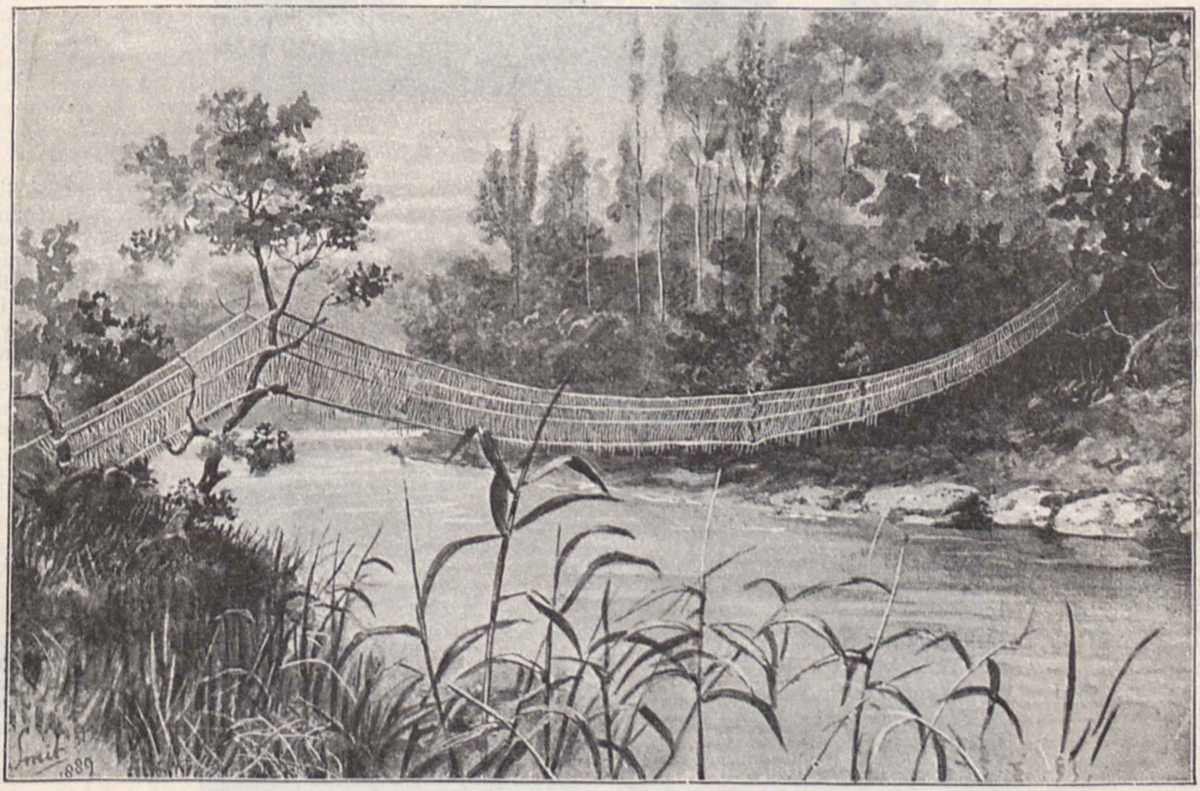


FIG. 1.—Native suspension bridge across the Vanapa river.

This chapter is prefaced by a quotation from the writings of Plinius Minor:—"It appears to me a noble employment to rescue from oblivion those who deserve to be eternally remembered, and by extending the reputation of others, to advance at the same time our own." These words are the true key-note of the book from which our Brisbane Pliny—Plinius Major—has never once deviated throughout his task. It is doubtless no small compliment to any man to have his deeds held up in the light of "eternal remembrance" by one of his fellows, but the task requires the delicate hand of a judicious fellow; and we fear that our Pliny has marred the compliment in the paying. So inspired with veneration for his patron is he that every act of his appears almost extraordinary, and his name too august ever to be mentioned without the humblest obeisance expressed in the constant recapitulation of his titles, dignities, and office, which must be as nauseous to

[1] "British New Guinea." By J. P. Thomson, F.R.S.G.S., &c. (London: George Philip and Co., 1892.)

that officer as to every reader of Mr. Thomson's book. In this "noble employment," however, we hope that our historiographer for Papua may reap the reward hoped for by his prototype.

The next two chapters deal with Sir William Macgregor's explorations in the Louisiade and D'Entrecasteaux archipelagoes. In Chapter IV. is an account of the pursuit and punishment of the natives of Chads and Cloudy bays for the murder of European traders visiting their shores. The country lying to the south-east and north-west of Port Moresby forms the subject of the following two chapters. Speaking of that portion to the south-east Mr. Thomson says, "It may not be altogether unreasonable to assume that in the future . . . fields once the scene of battle and feudal strife may be beautified by sites of local industry and manufacture, and enlivened by the joyous shouts of merry children and the harmonious peals of village bells." Quite forgetful of this happy picture, which he thinks is reasonable to expect, he sums up in the closing lines of his recapitulatory chapter the climatic aspects of the possession as "of an exceptional character, and their influence on Europeans so severe that very few constitutions can withstand their effect, a feature which will always be a great hindrance to settlement and a constant menace to life"—quite the region likely to produce European homes noisy with the "joyous shouts" of "merry children"! It is difficult to comprehend why Australian writers on New Guinea will so persistently—for Mr. Thomson is not the only author who thus sins, nor have we quoted the only specimen of this style of writing in his book—overlaud the capabilities and "the vast natural and artificial resources" of the country, heedless whether they may induce their too trustful readers to embark in hopeless enterprises in this "never, never land."

FIG. 2.—Highlanders of Mount Musgrave.

The seventh chapter, containing an account of Sir William Macgregor's splendid feat of the ascent of Mount Owen Stanley, is naturally the most interesting portion of the book. During this expedition almost if not *the* only native bridge yet known in New Guinea was met with. It was suspended from trees on each bank, and is very similar in every respect to those built by the Malays of Sumatra and the Dyaks of Borneo. How elegant and picturesque a construction it is may be seen by the illustration on page 345.

FIG. 3.—Fly River natives.

On Mount Musgrave friendly relations were established with the highland tribes, and a photograph of great interest and value, which we are personally in a position to pronounce very characteristic, was obtained by Mr. Goodwin. This also, through the courtesy of the publishers, we are enabled to reproduce here (Fig. 2). Sir William

Macgregor says that the features of these people, which are "remarkably good, indicate more character and strength than those of the coast man, and the cheek bones in many are rather broad and prominent. The nose is generally of the semitic type, with nostrils either not arched or much more so than is usual in Papuans. The chin and under jaw are stronger." They may be compared with the Fly river people, also here figured (Fig. 3).

European names were bestowed on the chief physical features of the country passed through by the expedition "of necessity," because of its "entire unacquaintance with their orthography (*sic*) through limited intercourse with the native inhabitants." This being in Dr. Macgregor's case evidently a right and sufficient reason for the nomenclature bestowed, how can Mr. Thomson with justice animadvert, as he does on an earlier page, on the fact that "the most important affluents [of the Kemp-Welch river] have received [from Mr. Cuthbertson] European appellations ? . . . . This disregard of the native nomenclature is, in the interests of geography, much to be regretted." However, we are pleased to learn that the European names selected by the administrator have been bestowed "upon the broadest national sentiment, as being compatible with the principles which prompted the bestowal of an English name on the range by the officers of H.M.S. *Rattlesnake*." It is not improbable that the explorer of the Kemp-Welch felt the same necessity, and was actuated by the same broad sentiment. Evidently the actor here sanctifies the act. We must, however, take exception to the statement made by Mr. Thomson that it was to the *range* that the name Mount Owen Stanley was given. It is evident from observations in his book, that the author is aware of the discussion that followed on the reading of Dr. Macgregor's paper on his ascent of the mountain before the Royal Geographical Society in London. On that occasion the president of the society clearly pointed out that this name was bestowed, as has been marked on all maps for forty years, on the *peak*, not on the *range*. Throughout the book this imperious disregard for nomenclature is exhibited. D'Albertis' name of Snake Point in the Fly river has without reason been changed to D'Albertis Junction ; Annabel Harbour, close to Boundary Cape, although marked on the official map of Sir Peter Scratchley's voyage to the north-east coast, becomes Douglas Harbour ; Fort Harbour, Clayton Inlet in Porlock Bay, and the peaks named on the same occasion, as well as the region delineated by the present writer at the base of Mount Owen Stanley, are also all ignored on the map attached to the volume now being considered. One fails to comprehend what principle except personal feeling the author has followed, on the one hand in his agreeing to the change of the thoroughly established Mount Owen Stanley to a new name, and on the other, in his restoring to the Aird river, which had recently been re-christened the Douglas, the name given to it by Captain Blackwood half a century before. Not only are these arbitrary changes an unwarrantable violation of the laws of nomenclature, but they are in the remover an illegitimate assertion of authority over previous fellow-explorers, as well as an assumption of an honour to which he has no title.

Mr. Thomson has drawn on the face of his map two large red circles, from purely arbitrary centres of the equally arbitrary radius of 6° 8′ 56″, which are tangential somewhere in the valley of the Strickland river. It is impossible to divine their purpose, except perhaps to form a seasonable puzzle for his readers.

The writer of this notice feels entitled to remark on the following observation, occurring on page 109:—"Although great care was exercised, the expedition was unable to identify places on the Owen Stanley range, named and described by Mr. Forbes. We are reluctantly constrained to omit these names." In the Proceedings of the Royal Geographical Society, which Mr. Thomson quietly ignores, the writer has already pointed out that along the route by which the administrator approached Mount Owen Stanley, it would have been impossible to have seen the features "named and described by Mr. Forbes." Mr. Thomson, posing as a court of geographical appeal, has graciously condescended to intimate that if these names had been "judiciously and appropriately applied to well-defined places," they "would have received full recognition" from him. "It is also," he continues, "regretable that in describing localities to which he assigns positions, that explorer has omitted to supply the data employed in their determination." To every unprejudiced person it must be evident that the map published by the writer could not have been plotted in England without data, any more than that of Sir William Macgregor, who has not supplied to the general public, so far as the writer knows, the data by which his localities are fixed. It will be time, however, to submit to Mr. Thomson these data, when it is acknowledged that a back parlour critic of a country in which he has never set foot is a competent judge of either the judiciousness and appropriateness of the names applied, or the accuracy of the localities, or the data on which they are based.

Chapters VIII., IX., and X. are devoted to an account of the administrator's ascent of the Fly river, and of his visit westwards to the Anglo-Dutch boundary, and the eleventh to his voyage along the north-east coast. D'Albertis long ago gave us a very accurate account of his 400 mile navigation of the Fly river. Sir William Macgregor carried his flag right to the German territory, and added several unknown rivers and new mountains to the map ; but both in this region, as on the north-east coast, his voyages, though they contributed many additional facts, added little essentially new to the observations of his predecessors, except his account of the piratical Tugere tribe, living on our boundary line west of the Fly river, of whom so much had been heard but so little known.

This handsome volume, which presents us in a collected form with the record of the important contributions, geographical and biological, of a most energetic officer, to our growing knowledge of New Guinea, would have been more valuable and welcome, even in its restricted range, but for the bias unduly exhibited throughout its pages, the verbose platitudes by which it is marred, and the extreme looseness of its descriptions, as "Morna [an island] is of the usual formation," "features of oriental type," "the Papuan dialect," and such-like expressions, which are numerous. In a long appendix we have a *résumé* of the results of the geological, botanical, and some of the zoological collections made by Sir W. Macgregor and others. Of these the chapter by Mr. Etheridge, Government Palæontologist of New South Wales, is specially valuable. Several important zoological groups, however, such as the birds, are, curiously enough, entirely disregarded. Vocabularies of many of the dialects spoken in widely separated districts of the possession are given, and are very valuable, and we sincerely hope that no opportunity may be lost of amplifying them. In fine, we regret to feel that this work will not yet relieve those who desire to make themselves acquainted with the accurate and complete history of British New Guinea, from the labour of searching through the original reports of the explorations, not of the administrator alone, but of the many other equally trustworthy workers who have contributed to its records.

HENRY O. FORBES.

NOTES.

PROF. R. VIRCHOW will deliver the Croonian lecture before the Royal Society on March 16, the subject to be the position of pathology among the biological sciences.

WE greatly regret to have to announce the death of Mr. G. M. Whipple, Superintendent of the Kew Observatory. He died on Tuesday night after a long illness.

THE *Journal of Botany* records the death, on January 18, at Brighton, of Dr. Benjamin Carrington, the highest authority on British Hepaticæ.

DR. H. J. JOHNSTON-LAVIS has been appointed Professor of Vulcanology in the University of Naples. A chair of vulcanology existed for some time at Catania, but was abolished on the death of Prof. Silvestri.

SOME important work with regard to technical education in London was done by the London County Council on Tuesday. The Council began the consideration of the recommendations of the special committee appointed to investigate the subject, and adopted the following proposals—that the Council should devote to technical education some portion of the funds from time to time recoverable under the Local Taxation (Customs and Excise) Act, 1890; that, in order to promote efficient and united action, it is desirable that the Council should delegate, so far as is permitted by law, its powers in respect of technical education to a composite body, to be called the Technical Education Board, to be appointed by the Council, partly from its own members and partly from other persons whose co-operation is desired; and that the Board should be appointed for a term of three years. It was agreed that the City Companies should be asked to contribute to the funds for technical instruction a fair proportion of their corporate income as distinguished from their trust property.

ON Saturday the overhead electric railway at Liverpool was opened by Lord Salisbury, who afterwards delivered a very effective speech on the great things which are likely to be achieved for mankind by electricity.

THE London Amateur Scientific Society will hold its annual general meeting on Friday, February 10, at 7.30 p.m., at the Memorial Hall, Farringdon Street. The president will deliver an address, and the officers and council for the ensuing year will be elected. At the conclusion of the annual general meeting the ordinary meeting will be held, when objects of interest—botanical, zoological, and geological—will be exhibited.

A CONVERSAZIONE was held the other evening at Firth College to celebrate the completion of the additional building. The addition comprises new physical and biological laboratories, workshop and class rooms, and considerably increases the accommodation available for teaching purposes. The cost, £5,500, has been wholly raised from local subscriptions.

ANOTHER disastrous shock of earthquake occurred at Zante on Friday last. It was followed by a terrific thunderstorm, accompanied by rain and hail. All the ovens in the island were destroyed by the successive shocks, so that no bread or biscuits could be made. Thousands of the inhabitants have been made homeless. On Monday there were three further shocks. The King and Queen of Greece have visited several of the villages, and have been deeply affected by the scenes of utter ruin and desolation which have everywhere met their eyes. On Tuesday they visited the naphtha springs of the island, which are believed to be the centre of the disturbance. The mayor of the village of Deme Elatia, some distance from the town of Zante, telegraphed that a large chasm, from which smoke was constantly issuing, had been discovered near that place.

DURING the first part of the past week the weather in these islands was under the influence of barometrical depressions situated in the north-west. Rain fell in most places, and the temperature exceeded 50° in the south and west, and even reached 56° in London. On Friday an anticyclone which lay over the Baltic, spread westwards, and under its influence the temperature became much lower, sharp frosts occurring at night over England, the readings on the grass in the southern part falling as low as 17°, but in the north and west the day temperatures were between 45° and 50°. The weather in the southern parts of the country became bright and fine, with local fogs, which extended as far as central England. During the early part of this week depressions from the Atlantic again skirted our western coasts in a north-easterly direction, causing south-westerly gales in the north and west, and a considerable increase in temperature, the maxima on Monday exceeding 50° in Ireland and the extreme south-west of England. The depression rapidly increased in intensity, and by Tuesday the warm south-west winds had spread over the whole country, the rise of temperature amounting to over 20° in the south-east of England. A bright aurora was observed in the north-east of Scotland on Sunday night. The *Weekly Weather Report* of the 4th instant shows that the temperature exceeded the mean in all districts during that week. Bright sunshine did not differ materially from the mean in any district, the percentage of possible duration ranged from twenty-five in the south-west, to twelve in the east of England.

THE *American Meteorological Journal* for January contains an article by Prof. D. P. Todd bearing upon the selection of stations for observing the total eclipse of April 16 next, together with a map showing the entire region of visibility. He has gone to considerable trouble in collecting data, especially cloud observations for the month of April, for the last three years, together with particulars respecting the stations and the best means of reaching them. The utility of a systematic examination of the cloud conditions of the eclipse localities is apparent. It is only in this way that the best observing stations can be selected.

THE meeting of the American Psychological Association at the University of Pennsylvania on December 27 and 28 seems to have been very successful. According to a writer in the New York *Nation*, no one who attended the meeting failed to be impressed with the quite unusual enthusiasm of the members and the still more unusual peace and serenity that prevailed in all the discussions. This writer is of opinion that, apart from Dr. Sanford's observations on dreams, the paper of most general interest was President Hall's account of the history and prospects of experimental psychology in America. A "breezy stimulus" was brought to the meeting by Prof. Hugo Münsterberg, of Harvard, who has recently gone from Freiberg to be director of the Harvard Psychological Laboratory. He stirred up a vigorous discussion upon the very foundations of experimental research. This discussion, as well as others, was enriched by the contributions of Prof. Titchener, of Cornell. The next meeting of the association is to be held at Columbia College, New York, during the Christmas recess, 1893.

THE Annual Report of the Botanical Department, Jamaica, has just been published. The Director, Mr. W. Fawcett, F.L.S., has a good deal to say about the work of his Department, one of the oldest and most successful in the colonies. It was started as long ago as 1777, and ever since, as Mr. Fawcett recalls, it has successfully "introduced valuable exotics, and the productions of the most distant regions to the West Indies," and laid the foundations of the present prosperity in place of the poverty which followed the abolition of slavery. The work of establishing the Hope Gardens as the headquarters of the Department near Kingston is still kept in view, although the amount allowed for this purpose appears much less than the Director considers desirable, taking into account the present importance of the island. A hill garden is looked upon as essential to the development of the high lands in Jamaica, and Mr. Fawcett shows that as about one-half of the total area of the island is above 1000 feet elevation, it is impossible to ignore the legitimate claims of those who are engaged in cultural industries above that limit. Good progress has been made in the scientific work connected with the herbarium and library, and numerous subjects, such as the extension of grape culture, the distribution of valuable economic plants, experiments in onion and tomato culture, fodder plants for the hills, have received attention. Students from Harvard University were engaged during the year in studying and making collections of tropical plants, and one of these devoted himself to preparing glass models of flowers and fruits with dissections to illustrate the science of botany. Two apprentices, natives of Lagos, West Africa, were attached to the Hope Gardens, with the view of qualifying themselves to take charge of botanical stations in their own country.

MR. FAWCETT's opinion respecting the practical aims and functions of departments like his are conveyed in the following words: "Botanic Gardens in the tropics do the work on the plant side of Agricultural Departments in temperate climates. They are in themselves experimental stations, and are much more efficient in introducing new cultural products, and in distributing plants and imparting useful information than most agricultural departments. The whole of the Botanic Gardens in the British Empire are more or less in communication with one another, exchanging seeds and publications, and all look up to the Royal Gardens at Kew as to their head for advice and assistance. Imperial Federation is already in existence as regards the Botanical Gardens and their work. If any special variety of plant or any new culture comes into notice information and plants are sought either directly from the local institutions, or more probably through Kew as the botanical clearing house. The Director of Kew has at his disposal the services of experts in every branch of botanical inquiry, and he is always most willing to assist colonial establishments in every way. Besides, any intricate question that arises in chemistry, in diseases of plants, in insect pests, in the commercial value of new products, can nearly always be determined by reference to Kew. Colonial botanical gardens are therefore not isolated units, but branches of an organisation as wide as the British Empire itself."

THE first part of "A Handbook to the Flora of Ceylon," by Dr. H. Trimen, F.R.S., director of the Royal Botanic Garden, Paradenyia, will shortly be published. It will be illustrated by twenty-five coloured plates, and the entire work is intended to consist of four similar parts.

THE first number of *Erythea*, a new monthly botanical journal for Western America, has been published. It is edited by Mr. Willis L. Jepson, under the direction of members of the botanical department of the University of California.

MR. T. SOUTHWELL records in the February number of the *Zoologist* the occurrence of Sowerby's whale (*Mesoplodon bidens*) on the Norfolk coast. On December 19 last he received a telegram stating that a strange "fish" was ashore at Overstrand, near Cromer; and on the following day he and Mr. S. F. Harmer, of the Museum of Zoology and Anatomy, Cambridge, went to Overstrand, where they found an adult female of this rare species. About 8 a.m., on Sunday, December 18, one of the Overstrand fishermen saw from the cliff an object lying in shallow water near the beach, which he at first took to be a log of wood, but soon perceived to be a large "fish." After obtaining assistance, he fastened a noose over its tail and secured it by an anchor, till it was placed on a trolley and drawn up the gangway to a shed on the cliff where the visitors saw it. The animal was alive when first observed, but died before it was taken from the water. Before the arrival of the visitors it had been eviscerated, and a very advanced fœtus removed from it. The total length of the old female, measured in a straight line to the centre of the tail, was 16 feet 2 inches, and that of the young one 5 feet 2 inches; across the flukes of the tail the adult measured 3 feet 8 inches. The present, says Mr. Southwell, is the nineteenth known example of this remarkable animal, all of which have been met with in the North Atlantic during the present century; but, with the exception of one taken in 1889 at Atlantic City, which came into the possession of the United States National Museum at Washington, and of which no account has, he believes, at present been published, in no other instance has an example in perfect condition come under the notice of a cetologist. Individuals or their remains have been found in Scotland and Ireland, but the only previous English example was met with at the mouth of the Humber in September, 1885.

COLONEL H. W. FEILDEN, in the course of an interesting paper on animal life in East Greenland, contributed to the February number of the *Zoologist*, suggests, as he has done before, that the Musk-ox might with advantage be introduced into Great Britain. He sees no reason why it should not thrive on the mountains of the Highlands of Scotland. In the winter season the Musk-ox is covered with a long-stapled fine wool in addition to its coat of hair. This wool is of a light yellow colour, and as fine as silk. Sir John Richardson states that stockings made from this wool were more beautiful than silk ones. Young Musk-oxen are very easily reared and tamed, and, Colonel Feilden thinks, there could not be any great difficulty in catching either old or young in Jameson's Land.

GOVERNOR FLOWER has recommended that all of the New York State's pecuniary contributions to agriculture should be turned over to Cornell University, with power to apply the same in such a manner as the trustees and faculty of that institution may devise. To the New York *Nation* this seems an excellent suggestion. The agricultural disbursements from the State Treasury, except the portion specifically set apart as premiums for agricultural fairs, have become, it says, as distinctly a part of the "spoils system" of politics as the work on the canals or the appointments of wardens in the State prisons. The Dairy Commission was started with an appropriation of 10,000 dollars for the purpose of suppressing oleomargarine. The expenditure has grown to 100,000 dollars per year, while the fight against oleomargarine is not a whit more effectual than it was in the beginning.

THE Government of Cape Colony has now at work, in charge of its own experts, eight water-boring diamond drills, and there is a great demand on the part of farmers for the use of the instruments. Experiments have been made on twenty-seven farms, on twenty-two of which water has been found. The *Agricultural Journal* of Cape Colony says that the results have sometimes been astonishingly successful. On a farm in the division of Colesberg, for instance, three holes were sunk, the first two unsuccessfully. In the third, however, the water was struck, first at 2 feet 6 inches, then at 8 feet 6 inches, then at 16 feet, then 22 feet, then 32 feet 6 inches, and on reaching a depth of 47 feet a stream of water shot up above the ground, gauged at 21,600 gallons in twenty-four hours, delivered through a 1-inch pipe, and with every indication of the supply proving permanent. In most cases the water is of excellent quality. Some exceedingly interesting experiments are about to be tried in Bushmanland by the Government. Sites are now being selected for a line of boreholes right across the country. It is well known that the veld makes splendid sheep-runs after occasional rains, and should the experiments prove successful, the value of the land will be greatly increased. With respect also to the Government railway grant of 6000 square miles of land in Bechuanaland, it is intended that water shall be bored for there as soon as drills can be set at liberty.

PROF. O. C. MARSH gives in the February number of the *American Journal of Science* an interesting restoration of

Anchisaurus, the skeleton chosen for the purpose being the type specimen of *Anchisaurus colurus*, which the writer has already described. This restoration, as shown on an accompanying plate, indicates that *Anchisaurus colurus* was one of the most slender and delicate dinosaurs yet discovered, being only surpassed in this respect by some of the smaller bird-like forms of the Jurassic. The restoration, Prof. Marsh thinks, will tend to clear up one point long in doubt. The so-called "bird-tracks" of the Connecticut river sandstone have been a fruitful subject of discussion for half a century or more. That some of these were not made by birds has already been clearly demonstrated by the fact that the impressions of fore feet, similar to those made by reptiles, have been found with them. Although no osseous remains were found with them, others have been regarded as footprints of birds, because it was supposed that birds alone could make such series of bipedal, three-toed tracks and leave no impression of a tail. It is now evident, however, says Prof. Marsh, that a dinosaurian reptile like *Anchisaurus* and its near allies must have made footprints very similar to, if not identical with, the "bird-tracks" of this horizon. On a firm but moist beach, only three-toed impressions would have been left by the hind feet, and the tail could have been kept free from the ground. On a soft, muddy shore, the claw of the first digit of the hind foot would have left its mark, and perhaps the tail also would have touched the ground. Such additional impressions the writer has observed in various series of typical "bird-tracks" in the Connecticut sandstone, and all of them were probably made by dinosaurian reptiles. No tracks of true birds are known in this horizon.

THE U.S. Secretary of the Interior, in his report, just issued, for the fiscal year ending June 30, 1892, refers to a good many subjects of more than passing interest. Speaking of Indian educational work during the year, he states that it has been greatly extended and improved. The attendance of Indian children in school has increased over 13 per cent., the enrolment for 1892 being 19,793 as against 15,784 in 1889. Five new Indian reservation boarding schools have been established during the present administration, and are in successful operation, and six others are in process of establishment, and it is anticipated will be opened soon. Six non-reservation schools have also been established and others are being prepared. The standard, character, and ability of all *employés* have been greatly improved, as have also the appliances and equipments for the proper training of Indian pupils and the efficient administration of the Indian school service. A uniform system of text-books and course of study has been adopted, and a compilation of the rules for the conduct of the schools has been prescribed. The interest in the welfare of the Indians has been constant and the work in their behalf persistent; and the Secretary thinks that this has resulted in their being raised still nearer to civilisation.

THE U.S. Geological Survey, according to the Secretary for the Interior, has had a very marked effect on the mining industries of the country. The increase in value of mineral products during the past year was 75,000,000 dollars, and the increase during the thirteen years since the institution of the survey is 300,000,000 dollars. While a part of this development represents the normal growth of the population and industries, the increase is much more rapid than that of population, and is, moreover, accompanied by a decided relative decrease in importations of mining products; indeed, the mining products of the country have more than doubled during the past thirteen years, while the population has increased only 30 per cent. The secretary, therefore, thinks it fair to ascribe a material part of the present industrial activity in extracting and utilising mineral resources to the services of the Geological Survey through its correspondence, and especially through its widely distributed maps and reports. The cost of mineral production during the past year has been reduced about 15 per cent., and during the period since the institution of the survey no less than 40 per cent., a saving to the consumers of mineral products amounting to millions of dollars annually being thus effected. A considerable part of this saving must be ascribed to the diffusion of exact information concerning mineral localities by the geological surveys of the Federal Government and several of the States.

DEALING with the state of the Seal Islands, the Secretary for the Interior says that during the season of 1892 only 7500 seals were killed on the islands, and that the diminished number of seals upon the rookeries shows the terrible waste to seal life in the destructive methods employed in pelagic sealing. Heroic measures, he maintains, are necessary for the preservation of the sealing industry. In 1890 no less than 50,000 seals were taken in the sea, and more than that number in 1891. Every seal taken in the ocean represents many more destroyed, and the 52,087 taken in the ocean in 1891 indicates the destruction of 300,000 more, three-fourths of which were females.

THE accumulation of ice in winter, blocking harbours, estuaries, &c., interferes greatly with the commerce of Northern peoples. The idea arose to make steamers which should break a temporary path through the ice, and in Gothenburg (Sweden) such a vessel was built in 1881. In the severe winter of 1885 it made a wide passage between that town and Vinga, on the open sea, through an ice-bank about a foot thick, which it charged at a speed of about 8½ knots an hour. Christiania has been led to get one of these ice-breaking steamers; also Oersen in Denmark, and Stockholm. The *Murtaja*, recently built for Stockholm (and described in *Génie Civil*), acts both by its weight in charging the ice-bank, and by its spoon-like bow resting on the ice and crushing it. The hull is divided into compartments, those at the bow and stern serving as reservoirs for water, which is transferred from the one to the other by a pump. With the stern-reservoir full, the draught of water at the stern is about 21 inches; at the bow about 15 inches. When the bow rises on the ice the water is quickly brought forward to add to the weight. It need hardly be said the bow, and indeed the whole of the hull, are made very strong, the material used being Swedish scrap iron and Martin steel.

IT is known that sewage water, spread over irrigation-fields, reappears from drains placed at a few feet depth, in a limpid state, like spring water. This water, unlike that of sewers, proves remarkably favourable to fishes, probably because of its dissolved organic matter, which the filtration in the soil has not wholly removed. This fact has been lately observed by Herr Oesten on the irrigation farm at Malchow, near Berlin, where the water is collected in eight ponds; and in these ponds salmon and carp have flourished greatly.

IN determining the thermal conductivities of liquids, two methods have been employed. In the one, a column of liquid is warmed at the top and the rate of propagation downwards through the column is observed. In the other, the lamellar method, which was first employed by Guthrie, a thin layer of liquid is placed between two conducting surfaces. Mr. R. Wachsmuth has shown, by means of an ingenious piece of apparatus, that in the first method currents in the liquid are unavoidable. The apparatus, as described in *Wiedemann's Annalen*, consisted of a beaker placed inside another containing water. The inner beaker was filled with water and blue iodide of starch, which has the property of suddenly turning colourless when heated to a temperature somewhere between 30° and 70°C. according to the degree of dilution. A copper cylinder was placed on the rim of both beakers so that its bottom was in contact with the surface of the emulsion. When steam was made to pass through the cylinder, a colourless stratum was seen to extend downwards from the surface. The separating surface was sharply defined at first, but after a few minutes a number of secondary stratifications appeared, which on close inspection showed wavy outlines. Many of them were of a deeper blue, *i.e.* cooler, at their upper than at their lower surfaces, so that there was evidence of a vortex-like motion in the liquid. For really trustworthy results Mr. Wachsmuth used an arrangement of two copper plates and a thermopile, the lower plate being placed in contact with ice.

THE volume on "The Partition of Africa," by Mr. J. Scott Keltie, which has been for some time in preparation, will be issued in a few days by Mr. Stanford. The work, which has been brought thoroughly up to date, is illustrated by a carefully-selected series of facsimiles of early maps, as well as by a number prepared specially to show the present condition of the continent in its many different aspects.

MR. A. E. SHIPLEY, Fellow of Christ's College, Cambridge, and Demonstrator of Comparative Anatomy in the University, has been for some time engaged on an illustrated text-book of invertebrate zoology, which will be published (Adam and Charles Black) early in the spring. It is specially adapted for the use of University students reading for such examinations as the first part of the Natural Sciences Tripos, or for the B.Sc. degree in London.

MESSRS. MACMILLAN AND CO. have published a second edition of Mr. D. E. Jones's "Examples in Physics." The book has been carefully revised, and some sixty pages of matter have been added. New sets of problems from recent papers have been put in the place of the examination questions at the ends of the chapters.

THE first volume of the *Seismological Journal* is now in the press, and will shortly be issued. It is uniform in size and in character with the Transactions of the Seismological Society, and will correspond with what would have been volume XVII. of those publications had they been continued. The yearly subscription for the journal is 5 yen, 5 dollars, or £1. This includes delivery or postage. It may be paid by P.O.O. or a draft on any foreign bank in Yokohama. Address, John Milne, 14, Kaga Yashiki, Tokio.

MESSRS. WHITTAKER AND CO. have published "The School Calendar and Handbook of Examinations, Scholarships, and Exhibitions, 1893." This is the seventh year of issue. A preface is contributed by Mr. F. Storr.

A DEFINITELY crystallised compound of iron and tungsten of the composition FeW_2 is described by Drs. Poleck and Grützner, of the University of Breslau. The crystals of this interesting substance were discovered in drusy cavities of a massive piece of a crystalline iron-tungsten alloy containing no less than 80 per cent. of tungsten. The alloy had been prepared by an electrolytic process from *wolframite* at the works of Biermann's Metal Industry in Hanover, and exhibited in the numerous cavities small but very well-formed crystals of a silver-grey colour and exhibiting very brilliant faces. They were extremely heavy and of exceptional hardness. Upon analysis they yielded numbers corresponding closely with those calculated for the compound FeW_2. Dr. Milch, of the Mineralogical Department of the University, subjected the crystals to a goniometrical investigation, and found them to consist of trigonal prisms whose faces were inclined exactly at 60°, and which were terminated by a basal plane inclined exactly at 90°. Singularly, however, no other faces were ever discovered upon them, so that it was impossible to ascertain to what sub-section of the hexagonal system the crystals belonged. The crystals are so hard that they readily scratch topaz, and appear to be of about the same hardness as corundum.

THE discovery of these crystals of a definite compound of iron and tungsten, and the fact that they are endowed with such a high degree of hardness, afford a ready explanation of the long-known property of tungsten in improving the hardness of steel. Berzelius, in his *Lehrbuch*, already remarked that tungsten readily formed alloys with most of the other metals, and in the year 1858 Muchet in this country took out a patent for the employment of tungsten in the manufacture of steel. Thereupon the wolfram minerals, previously considered as almost worthless, rapidly came to acquire a considerable value. Bernoulli has since shown that tungsten is capable of alloying in all proportions with iron until it reaches a proportion of 80 per cent., when the mass becomes infusible even at the hottest procurable white heat. This alloy containing so high a percentage of tungsten, approximating indeed to that (86·4) contained in the crystals above described, exhibits a silver-grey lustre like that of the crystals and possesses almost the same hardness, scratching glass and quartz with ease. Latterly the manufacture of this alloy has been carried on at the Hanoverian metal works above referred to, and brought into commerce. There can be little doubt that the remarkable property of tungsten in increasing the hardness of steel is due to the formation of more or less of this compound FeW_2, and the nearer the proportions of the two metals approach to those of the compound itself the more nearly does the resulting alloy approach in hardness to that displayed by the crystals of FeW_2 above described.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*, ♀) from India, presented by Capt. U. Cooke; a Two-spotted Paradoxure (*Nandinia binotata*) from West Africa, presented by Lady Fleming; a Brush-tailed Kangaroo (*Petrogale penicillata*, ♂), two Black-striped Wallabys (*Halmaturus dorsalis*, ♀ ♀) from New South Wales, presented by Mr. Wilberforce Bryant; a Mauge's Dasyure (*Dasyurus maugæi*) from Australia, presented by Mr. Robert Hoare; a Red and Yellow Macaw (*Ara chloroptera*) from South America, presented by Mr. H. H. Dobree; a Grey Parrot (*Psittacus erithacus*) from West Africa, presented by the Executor of the late Mrs. Bolaffe; an Æthiopian Wart Hog (*Phacochærus æthiopicus*, ♂) from Matabeleland, South Africa, deposited; two Chukar Partridges (*Caccabis chukar*, ♂ ♀) from North-west India, presented by Major Ingoldsby Smythe; fourteen Prairie Marmots (*Cynomys ludovicianus*, 6 ♂ 8 ♀) from North America, an Arctic Fox (*Canis lagopus*) from the Arctic Regions, two Rufous Tinamous (*Rhynchotus rufescens*) from Brazil, purchased; three Black and Yellow Cyclodus (*Cyclodus nigro-luteus*), three Diamond Snakes (*Morelia spilotes*), a Short Death Adder (*Hoplocephalus curtus*), a Purplish Death Adder (*Pseudechis porphyriaca*), a North Australian Banded Snake (*Pseudonaia nuchalis*) from New South Wales, received in exchange.

OUR ASTRONOMICAL COLUMN.

COMET HOLMES (1892 III.).—During the past week no very important change has taken place in the appearance of the comet; the following is the current ephemeris:—

Ephemeris for 12*h. M.T. Paris.*

1893.	R.A. app. h. m. s.	Decl. app. ° ′ ″
Feb. 9 ...	1 56 29·3 ...	+34 0 28
10 ...	1 58 3·3 ...	2 18
11 ...	1 59 37·8 ...	4 12
12 ...	2 1 12·8 ...	6 9
13 ...	2 48·3 ...	8 9
14 ...	4 24·4 ...	10 13
15 ...	6 0·9 ...	12 20
16 ...	2 7 37·9 ...	34 14 30

Mr. Fowler writes from South Kensington:—"The comet on February 6 was a very dim nebulosity without sensible nucleus."

COMET BROOKS (NOVEMBER 19, 1892).—The following is the ephemeris for Comet Brooks for the ensuing week :—

Ephemeris for 12h. M. T. Berlin.

1893.	R.A. app. h. m. s.	Decl. app. ° ′	Log *r*.	Log Δ.	Br.
Feb. 9 ...	0 11 33 ...	+30 2·9 ...	0·1167 ...	0·1832 ...	1·40
10 ...	13 19 ...	29 31·2			
11 ...	15 1 ...	29 0·9			
12 ...	16 40 ...	28 31·8			
13 ...	18 15 ...	28 4·0 ...	0·1252 ...	0·2152 ...	1·16
14 ...	19 47 ...	27 37·3			
15 ...	21 17 ...	27 11·6			
16 ...	22 44 ...	26 46·9			

SPECTRA OF PLANETARY NEBULÆ AND NOVA AURIGÆ.—In the December number of the *Memorie della Società degli Spettroscopisti Italiani*, among many interesting communications, is one by M. Eugen Gothard, relative to the great similarity between the spectra of the late Nova and the planetary nebulæ. By the aid of a 10¼-inch reflector and a 10-inch objective prism, together with Schleussner's orthochromatic plates, he has been able to obtain these photographs, the wave-lengths of the lines of which are given in the table below. In the memoir copies of the photographs on a somewhat larger scale are given, that of the Dumb-bell nebula (G.C. No. 4447) showing the image of the nebula itself, just as if no prism had been used. The wave-lengths of the Nova given in this table were obtained from photographs taken on September 27 with 2h. 15m. exposure, and on October 28 with 3h. exposure, and, in M. Gothard's words, "gave the surprising result that the spectrum of the new star perfectly agrees with that of the planetary nebulæ."

The following is the table of the wave-lengths, lines I., II., VI., and VII. representing the nebula lines, and III., IV., and V. the hydrogen lines :—

		I.	II.	III.	IV.	V.	VI.	VII.
(1) G.C. No. 4447 ...	—	502	—	434	411	396·5	386·5	373
(2) ,, 4964 ...	—	501	470	434	409	397	386·5	—
(3) ,, 4373 ...	—	502	—	434	410	396·5	386·5	373
(4) ,, 4514 ...	—	502	—	434	410	396·5	385·7	371
(5) ,, 4628 ...	—	501	468	434	408·5	396	386·5	372
(6) N.G.C. ,, 7027 ...	—	500·7	464	434	410	395	385·7	—
(7) ,, 6891 ...	—	502	—	434	410	396	386·5	372
(8) ,, 6884 ...	—	500·5	—	434	—	395	386·5	—
(9) Nova	582	500	464·2	434	407·7	395	385·5	372

SUN-SPOTS AND MAGNETIC PERTURBATIONS IN 1892.—In an article under this heading in *Astronomy and Astrophysics* for January M. Ricco brings together the facts relative to these two phenomena, the magnetic perturbations being taken from the photo-magnetographs of the United States Naval Observatory. As the author describes in detail both kinds of observations, and in addition, a tabulated statement of the records, we cannot do better than abridge the table, by omitting the numerical statements as to the magnitudes of the spots and perturbations, leaving our readers to refer if necessary to the journal itself.

In the column "spots" this means principal spots; E denotes extraordinary; V.L, very large; L, large; M, medium; S, small; and N, none.

Transit Centre Meridian.	Spots.	Helio-graphic latitude.	Time of Maximum.	Mag. Pertur-bations.	Retar-dation in time.
		°			h.
Jan. 4, 2 p.m. ...	V.L	+20	Jan. 6, 4 a.m.	V.L	38
Jan. 28, 3 p.m.	L	−16	Jan. 29, noon ...	L	21
Feb. 2–4	N	—	Feb. 2–4	S	—
Feb. 12, 4 a.m.	E	−30	Feb. 14, 1 a.m.	E	45
March 1–5 ...	N	—	March 1–5 ...	M	—
March 7, 2 a.m.	N	—	March 7, 2 a.m.	L	—
March 10, 2 p.m.	E	−29	March 12, 11 a.m.	V.L	45
April 23, 8 p.m.	L	+11	April 25, 11 p.m.	L	51
April 24, 4 p.m.	L	+16	April 26, 1 p.m.	L	45
May 1–2	N	—	May 1–2	M	—
May 16, 5 p.m.	E	−16	May 18, 6 p.m.	E	49

From this table some very interesting facts may be gathered. Out of the eleven cases which M. Ricco gives, no less than seven instances occur where the passage of the spots over the central meridian is followed by a terrestrial magnetic disturbance, and not only this, but the magnitudes of both vary directly. The point which the author wishes to emphasize most is the apparent constancy of the interval of time between these two phenomena, and an important fact is that at both appearances of the great February spot the same retardation occurred. In the above table, with the exception of January 29, the mean interval is 45½ kms., "thus indicating a velocity of propagation from the sun to the earth of about 913 kms. per second," or "more than 300 times less than that of light."

NEW MINOR PLANETS.—Photography seems to be rapidly increasing the number of our minor planets, that is to say, if the announcements really refer to new ones. Wolf and Charlois between them have discovered five this year, the former two (1893 B and C), the latter three (1893, A, D, and E).

THE LUNAR SURFACE.—At the present day the general idea with regard to the peculiar features of the moon is that they are the results of stupendous volcanic actions, the number and activity of which surpassed anything that we can imagine. Owing to the extraordinary circularity in the craters, ring plains, walled plains, and to the well-known fact that many of the craters have not the raised lava floor half-way up or near the summit of the cone, which is such a typical terrestrial characteristic, doubt as to their volcanic origin has often been raised. In a small pamphlet which we have received from Mr. S. E. Peal, Sibsagor Assam, the author suggests a "theory of glaciation" in the light of recent discoveries with regard to the maximum surface temperature, and also to the non-viscosity of ice at low temperatures, together with the admitted possibility of snow existing on the moon. The author assumes the moon to be constituted somewhat like our earth, and at one time to have been at a higher temperature, having an atmosphere, water, &c., and draws attention to the facts that there are no polar caps; that colour is conspicuous by its absence, "a feature quite opposed to terrestrial experience, except at the poles," and therefore "may not the entire globe be swathed in snow?"; and the absence of river valleys and drainage sculpturing, indicating that a piling up of dry material has taken place in opposition to a fluvial erosion. At the time when the lunar globe had so far cooled down as to be practically rigid, the tidal action would gradually turn all continents and land surfaces into shoals, and at the temperate stage of development the growth of the polar caps would be restricted to the shallows, extending from them as the temperature became reduced. This advancing sheet of ice would sometimes be deformated by submarine heat vents resulting in a large or small bay, depending on the magnitude of the vent. Extending seawards the "horns of the bay would meet around and enclose this area of higher mean temperature, converting it into a lagoon." Nocturnal radiation and solar heat alternately would perhaps freeze and thaw the ice formed thereon, and with a rare atmosphere and intense cold aqueous vapour would arise from "the water (floe-covered) floor during the day at least, and be carried over the ice edge by diffusion when the fall in temperature would precipitate it into snow, thus gradually forming a vast rampart." Century after century would see the level floor gradually lowered, and the ramparts increased in height. The author accounts for all the peculiar forms of craters, walls, &c., by different local conditions (*i.e.* land or water or submarine vents), but they are all the result "of water floors left in a slowly extending glaciation of the crust."

GEOGRAPHICAL NOTES.

AT the French Congress of Learned Societies, which meets on April 4 at the Sorbonne, the section of historical and descriptive geography, is to be devoted specially to the early geographical conditions of France, and to the work of French travellers. The programme includes the consideration of the earliest traces of human habitations, maps of caverns, &c., and proceeds to classify existing dwellings according to their situation and altitude. Local names in danger of falling out of use are to be collected, and the limits of the old districts such as Brie, Beauce, Sologne, &c., to be investigated in order to place on record the geographical conditions which led to their formation.

IN the *Scottish Geographical Magazine* for February Mr. J. G. Goodchild gives a most interesting description of a large-scale topographical model of the site of Edinburgh, which he has recently constructed. The model, which is on exhibition in the Museum of Science and Art, Edinburgh, is based upon Bartholomew's map of Edinburgh on the scale of 15 inches to a mile, but the altitudes are taken point by point from the large town plans of the Ordnance Survey. The model is in many ways original in its mode of construction. Its object is purely geographical, having been suggested by a leading citizen as a method of showing the contrast between the circuitous roads and frequent steep gradients of the old coaching days, and the straighter and more level lines of communication by which modern engineers have overcome the restraint of physical configuration.

IN the same number of the *Scottish Geographical Magazine* there is a paper on the Deserts of Atacama and Tarapaca, read to the Society by Mrs. Lilly Grove, and some interesting notes on South Eastern Alaska by Prof. J. J. Stevenson, illustrated by a map.

MR. H. J. MACKINDER'S third educational lecture for the Royal Geographical Society was given on Friday night, the subject being the belt of Steppe which traverses Asia from west to east. He showed how the distinctive physical and climatic conditions of the Steppe favoured the growth of nomadic nations, every man of whom was a member of the most mobile cavalry force which ever existed. Pastoral pursuits and marauding were natural to the Steppe peoples, and the descent of their hordes on the settlements bordering the Steppe were turning-points in the history of surrounding nations. Reference to the successive periods of conquest by the Scythians, Huns, Turks, and Mongols showed the power of these nomads on the affairs of other countries, and until the advent of the Steppe-bred Cossacks no western power has ever secured control of the central Asian plains.

FOLLOWING on the death of Captain Stairs we have to record the death of his fellow-officer in the Emin relief expedition, Mr. R. H. Nelson. Mr. Nelson returned to Africa, and was in charge of the district of Kikuyu in Ibea, when he succumbed to an attack of dysentery on December 26, 1892.

THE INSTITUTION OF MECHANICAL ENGINEERS.

THE first general meeting for this year of the Institution of Mechanical Engineers was held on Thursday and Friday evenings of last week, the 2nd and 3rd inst., in the theatre of the Institution of Civil Engineers.

There were two papers set down for reading, as follows:—"Description of the experimental apparatus and shaping machine for ship models at the Admiralty Experimental Works, Haslar," by R. Edmund Froude, of Haslar; "Description of the pumping-engines and water-softening machinery at the Southampton Waterworks," by William Matthews, waterworks engineer.

After the disposal of the usual formal business, the President (Dr. William Anderson) referred to the International Engineering Congress which was to be held in Chicago during the month of August next. He had received a letter from Mr. James Dredge, of London, who had been elected honorary president of the congress. Every one, Dr. Anderson said, knew of Mr. Dredge, so there was no occasion for him to say anything further on that head; but he trusted that English engineers would take steps necessary to a creditable representation.

The next business was an alteration in the bye-laws, the chief referring to the class of membership. Hitherto the institution has consisted of members, associates, and graduates. The two latter classes are, however, of small importance and practically the institution is composed of full members. The qualification for membership was that the candidate should be an engineer not under twenty-four years of age; so that a member might be a Great George Street magnate, or the head of a big engineering firm, down to a draughtsman or the foreman of a machine shop, supposing of course he were an engineer and not simply a mechanic or artisan. These conditions of equality do not appear, however, to meet the views of the council of the institution, so there are to be two classes of engineers on the register, the big and the little. These are to be known respectively as members and associate members, but as far as we can see the broad distinction is that the member has achieved success whilst the associate member has still his way to make. Honour to whom honour is due is a good maxim, but it may be doubted whether the practically self-elected council of an irresponsible body should be the arbiters, not only of fame, but of professional status.

Resolutions embodying the proposed changes were moved from the chair, and carried unanimously. It need not be said that the new rule is not retrospective.

These matters having been settled, the secretary proceeded to read Mr. Froude's paper describing the apparatus in the Haslar establishment, over which he presides. To make clear the details of mechanism given would be quite impossible without the aid of drawings. These were supplied at the meeting in the shape of wall diagrams, but as members had not an opportunity of studying them beforehand, there were very few who were able to keep up with the reading of the paper, excepting those who already knew all about the matter. This is too often—we may say generally—the case in meetings of the technical societies; excepting always the Institution of Civil Engineers. Before this Society a paper is read on one evening, and, if its importance be sufficient, it is discussed during three sittings, each a week apart. Members have therefore an opportunity of grasping the details of the papers read, and preparing what they have to say beforehand. It is for this reason that the discussions before the Civil Engineers have always been instructive.

Mr. Froude's paper deals with but a fragment of its subject, but it takes the part which was more especially of interest to his audience, namely, the mechanical details involved in the apparatus used for testing the models by which a forecast is made of the performance of future naval vessels. It is well known that these forecasts are made possible by the late Mr. Froude's discovery of the law of "corresponding speeds," so that the speed, with a given power, of the full sized ship can be deduced from the performance of the model. The way in which the late Mr. Froude carried out his investigations, and how the original experimental works grew up at Torquay, under the wise encouragement of the Admiralty, are well known to all interested in physical science. It would be difficult to overestimate the good that has followed this work; for one thing it has done much to put us on an equality with our old rivals, the French—long, indeed, our masters in the science of ship design. Perhaps there is nothing upon which we could better found our claim to naval supremacy—in this long era of naval peace—than the possession of the only naval testing tank of its kind. It is a distinction we shall probably not long be able to boast, for the Russians, Italians, and Americans all contemplate constructing establishments of a like nature.

The paper commences with describing the principal features of the present Admiralty experiment establishment at Haslar. As at the former works at Torquay, the chief object consists of a long covered water-way, in which models of ships are towed to ascertain their resistance. The towing is done from a dynamometer carriage driven at definite speeds by a stationary engine working a wire rope. The models are made of hard paraffine, generally about 14 feet long, and something upwards of 1 inch in thickness as finished. They are cast in a mould with an allowance of about ¼" for finishing the shape. The latter operation is done by hand, guidance grooves being cut in the model, so that the exact form may be preserved. The working of this shaping or copying machine, and the way in which it enables the lines of a drawing to be translated into model form, constitute one of the most interesting parts of the installation. The water-way, canal, or tank at Haslar is nearly 400 feet long, and of nearly uniform section throughout. The sides are of concrete and vertical, and the railway, on which the dynamometer carriage runs, is bedded on the tops of the side walls of the water-way, in place of being suspended over the water from the roof, as in the original design. The experimental carriage, which has to be nearly 21 feet gauge, is a trussed structure. Its principal peculiarity consists in the fact that the members of the several trusses composing it are wooden trunks or boxes about 4" square in cross sections, made of ⅜" deal, and put together with screws and shellac varnish. At the joints formed by the intersection of the various members of the trusses, the sides of the boxes are made to overlap one another over a large area, providing a large surface for screwing and for the adhesion of the shellac varnish. The dimensions of the boxes forming the several members of the girders are designed so as to bring the sides of the boxes into the right planes to suit these overlaps. The whole structure thus provided is remarkably rigid and light. The general design of the carriage is arranged so as to leave clear a sort of central alley provided with a railway, the rails of which are close to the sides of the alley. The object of this secondary railway is to carry the smaller carriages, on which are mounted the actual experimental apparatus of different kinds; so that these may be adjusted on this railway to any desired position fore and aft on the main carriage. The carriage is driven by means of wire rope from a stationary 10″ Tower spherical engine, a high power being required so as to start the truck quickly for high speed experiments. The ordinary speeds range between 100 and 500 feet per minute; for some classes of models experiments are occasionally made up to about 850 feet per minute or nine and a half miles per hour. The truck has been run at over 1200 feet per minute, or about fourteen miles per hour. The governor, by which the speed of the engine is regulated, is a very interesting and ingenious piece of mechanism, which has been modified from the design of that which was used on the engine at Torquay. There are two symmetrical bell-cranks carrying weights, and attached to each other by links, having slotted holes so as to allow the bell-cranks to have a very small range of freedom of angular motion. When a given speed of rotation is reached, the centrifugal force of the weights overcomes the tension of a spiral spring, provided for the purpose, and the governing action is brought into play in the following manner:—There is a hooked rod, by means of which the increase in the angular altitude of the weights (due to centrifugal force) brings a friction disc break into play, which in turn has the effect of extending a spiral spring connected with the engine throttle valve, which is thus closed so as to shut off steam. It will be easily seen how much more delicate an adjustment this device gives than the old Watt governor with the balls acting directly on the valve. The extension of the spring, and the consequent distance of departure of the throttle valve from its full open position are proportional to the frictional turning movement applied to the stationary wheel, which movement is itself proportional to the pressure brought to bear upon it by the bell-cranks; in other words it is proportional to the excess of the speed above that at which the centrifugal force of the weights just equals the tension of the spiral spring. To give greater sensitiveness of action the bell-cranks are not hung on pin joints but on flat springs after the fashion of a clock pendulum, safeguards being provided in case of the springs breaking. With the Torquay governor, which was similar in principle to that described, although differing in appearance, the adjustment was so delicate that a variation of speed in the running of the carriage of half a foot per minute was seldom exceeded even at the highest speeds. The value of working against the resistance of spiral springs will be noticed in this mechanism, their steadying action being especially valuable. It would be impossible for us to attempt to describe the mechanism constituting the copying apparatus of the model shaping machine, and we can only hope to give a mere outline of the general principles. A rough hollow model of the ship to be constructed is cast in paraffine wax, a material which is found to lend itself most perfectly to the necessities of the experiments. The drawing from which the operator has to work is stretched on a table, and the grooves representing the water lines are copied from the drawing by means of the mechanism. These grooves are formed by a pair of revolving cutters, the fore and aft motion being communicated to the model whilst the cutters move laterally. One cutter is on each side—for of course full models are required—and they approach or recede symmetrically in such accordance with the longitudinal travel of the model as to trace in plan upon it the intended horizontal section. This due accordance of the lateral motion of the cutters with the longitudinal motion of the model is accomplished by the operator so regulating the cutter motion as to maintain a tracer in contact with the corresponding water-line on the drawing. By suitable mechanism the drawing itself is made to imitate the longitudinal travel of the model, while the tracer imitates the lateral travel of the cutters. In the Torquay machine the tracer was guided by an adjustable template set to the curve of each water-line, but afterwards the tracer was made to follow the line on the drawing by the operator. In the present machine the cutters are raised or lowered to get the different water-lines. The cutters run at 2700 revolutions per minute. The grooves having been cut, the surplus material is removed by hand.

We shall not follow Mr. Froude in his description of the further details of the mechanism, as it would be unintelligible without the drawings by which he illustrated his description. The various arrangements are, however, fully worthy of study by all who are interested in ingenious mechanical devices; but we must refer our readers to the printed transactions of the institution, in which the diagrams will appear when the volume is published. There is also a weighing machine, which is necessary to obtain the actual dead weight of the model, so that the amount of ballast required to get the necessary displacement corresponding to trial draught may be determined. This machine will weigh up to 1000 lbs. with great accuracy, and is similar in principle to an ordinary chemical balance, except that it is a steel yard, having one arm 6 inches and the other 5 feet in length.

The discussion on this paper was opened by Mr. W. H. White, the Director of Naval Construction, who is the official head of the Admiralty department, of which the Haslar establishment forms a branch. Mr. White spoke of the advantage these model experiments had been to the navy, saying that the great advance in the speed of ships which had been obtained of late years would not have been reached to the full extent had it not been for the model experiments carried out at Torquay and Haslar by the late Mr. Froude and his son, the author of the paper. Mr. J. I. Thornycroft also pointed out the great economy that had been made in expenditure upon navy ships by finding out beforehand what the proposed vessel would do, and what was required in the way of power to reach that performance. Mr. Thornycroft made especial reference to the ingenuity of the device whereby a line on the drawing, which might not be quite accurate, would be made to give the desired result in the model, and this without an expensively-constructed apparatus. Various other speakers having been heard, and Mr. Froude having briefly replied, so far as there was anything to reply to, the meeting adjourned until the next evening.

On the members assembling on Friday evening, the 3rd inst., the president, Dr. Anderson, again occupied the chair, and Mr. Matthews's paper on the Southampton waterworks was read. This contribution is interesting, as it describes what we understand is the largest water-softening plant yet installed. The quantity of water that can be satisfactorily dealt with is from 2¼ to 2½ million gallons per day of 24 hours. Of course the principle of softening hard water by lime is very far from new, but it has made slow progress, in spite of the vast quantities of hard water, otherwise unobjectionable, that there are in the chalky southern half of our island. This limited application of a means whereby a bad water in one respect can be made a good one in all respects does not appear, to judge by the proceedings of last Friday, to spring from any inherent defect in the system—beyond that which would arise from the disposal of the refuse lime in crowded cities—but rather from the carelessness of public authorities and water-supplying companies to the wants and comforts of the people at large.

The meeting terminated with the usual votes of thanks, the President announcing that the summer meeting would be held this year at Middlesborough on Tuesday, August 1, and the following days.

THE SEVEN IMAGES OF THE HUMAN EYE.

IT is well known that in the human eye, besides the refracted image, which serves the purposes of vision, there are formed three reflected images known under the name of "Purkinje's images." M. Tcherning has discovered three additional ones, so that the total number is brought up to seven.[1]

In its passage into the interior of the eye each ray of light has to pass through the cornea, the aqueous humour, the crystalline lens, and the vitreous humour before finally arriving at the retina. At the surface of each of these constituents the ray is liable to be partially reflected, thus giving rise to four reflected images. These were all seen and described by Purkinje at the beginning of the century, but only three were observed by Helmholtz and others. These three can be easily observed by two persons on holding a lighted match between their eyes, and moving it about so that the reflections seem to come from the pupil. One of them, that reflected by the front of the cornea, is much brighter than the two others, which are formed by the front surfaces of the crystalline and the vitreous humour respectively. The fourth image is due to reflection from the posterior surface of the cornea. It may be discovered by careful observation of the brightest image by means of a magnifying glass. As

[1] See *Séances de la Société Française de Physique*, Avril-Novembre, 1892.

it approaches the border of the pupil, and especially as it passes on to the iris, it is seen to be accompanied by a small, pale, but well-defined image, which always lies between the first image and the centre of the pupil, the distance between them decreasing as they move towards the centre, where they finally coincide. By means of the ophthalmophakometer—an instrument consisting of three incandescent lamps and a telescope arranged on an arc of 86 cm. radius—it was found possible to measure the radii of curvature of all the reflecting surfaces. The foci of the two reflecting surfaces of the cornea were found to coincide, a fact which accounts for the coincidence of the two corresponding images at the centre of the pupil, and for Helmholtz's failure of finding the fainter one.

It is evident that since the light reflected from the successive surfaces does not fall upon the retina, it is lost for visual purposes. But a comparison of the percentages of loss in the case of the eye, and in that of a simple lens tells greatly in favour of the former as an optical instrument. In the eye the percentage of useful light is 97, in a simple lens 92, and in a compound optical instrument correspondingly less. But the light reflected by any of the internal surfaces is also liable to be reflected back into the eye or the optical instrument, with the effect of superimposing a more or less faint patch of light upon the image on the retina. This is termed the noxious light (*lumière nuisible*) by M. Tcherning. In a simple lens this amounts to $\frac{1}{6}$ per cent., whilst in the eye it is as low as 0·002 per cent. But faint as it is, it is capable of giving rise to two light impressions due to double reflection, one at least of which has been actually observed in the human eye. "The easiest way of observing it," says M. Tcherning, "is to look straight forwards in a dark room, holding a lighted candle in the hand about 20 cm. from the line of vision. On moving the candle gently from side to side a pale image of the flame is seen on the opposite side of the line of vision, distinct enough to show that it is inverted; it moves symmetrically to the candle with respect to the line of vision. The rays which form this image have undergone, besides several refractions, two reflections, one at the posterior surface of the crystalline and another at the front surface of the cornea." Another image was expected to be formed by a similar reflection at the anterior surface of the crystalline. It was found in an artificial eye, but not in the human sense-organ. However, an easy calculation of the optical system of the eye explains this circumstance. The focus of the reflected rays is very near the crystalline lens itself, so that they must be much dispersed by the time they reach the retina. To enable the image to be formed on the retina, the object would have to lie between the cornea and the crystalline, but on attempting to form a luminous point at that place by optical means it is found that the "useful rays" fill the eye to such an extent as to render everything else invisible.

It is found that different eyes differ in their capacity of seeing the first of the two additional subjective images. Short-sighted people find it very indistinct unless the candle is held close to the eye, or convex glasses are used. As the maker of optical instruments utilises the accessory images for testing the degree of polish and the accurate centreing of the lenses, so the physician is enabled to make valuable inferences from them as to the structure and condition of the eye he is examining, and the additional images discovered by M. Tcherning appear to be of considerable physiological importance. E. E. F. d'A.

A BOTANIST'S VACATION IN THE HAWAIIAN ISLANDS.

SOME weeks ago we reprinted from the *Botanical Gazette* (Indiana) a part of the first instalment of Prof. D. H. Campbell's interesting account of his vacation in the Hawaiian Islands. The following is the chief portion of the second and concluding instalment, published in the January number:—

Beside visiting the isle of Oahu, I made short trips to the islands of Hawaii and Kauai. The former, the largest of the group, and the only one where volcanic action is still going on, is reached by steamer in about thirty-six hours from Honolulu. On the way, the islands of Molokai, Lanai, and Maui are passed. The first, a barren-looking and forbidding spot, is the location of the leper settlement, to which all persons afflicted with leprosy are sent as soon as their condition becomes known.

Maui, the largest of the islands next to Hawaii, consists of two portions connected by a narrow isthmus. The whole eastern half is nothing more nor less than the body of an immense extinct volcano, ten thousand feet high, and with a crater nearly ten miles across. The other end of the island is an older formation. This island is said to be very interesting botanically; but, unfortunately, my time did not permit me to visit it.

Very soon after sighting Maui, the three great mountain masses of Hawaii began to loom up. The day was clear, and the whole formation of the island became visible. It consists of three great volcanic cones, of which only one is now active. The highest summit, Mauna Kea, is nearly 14,000 feet above the level of the sea; the next, Mauna Loa, lacks but a few hundred feet of this; yet so great is the breadth of these masses that one fails to realise their immense height. Our first landing was at Mahukona, on the leeward side of the island, a most forlorn expanse of bare lava with scarcely a trace of vegetation, except a few unhappy-looking algaroba trees planted about the straggling buildings that constituted the hamlet.

We lay all day at this inhospitable station, not getting away until evening. A beautiful sunset and a fine glimpse of the peak of Mauna Kea glowing with the last rays of the sun, form my most pleasant recollections of this desolate place.

What a change the next morning! On awakening we found ourselves entering the harbour of Hilo. Here everything is as green as can be imagined, and luxuriant vegetation comes down to the very ocean's edge. The town is built on a bay fringed with cocoa-nut trees and embowered in a wealth of tropical vegetation. Owing to the great annual rainfall (about 180 inches), as well as to the fact that Hawaii is the most southerly of the islands, the vegetation here is the most luxuriant and tropical found in the whole group. I remained in Hilo for six days and collected some most interesting specimens. Through the kindness of Mr. Hitchcock of Hilo, I was enabled to spend the night at his camp in the woods near the town, and the greater part of two days collecting in the vicinity. The forest here is most interesting. Mr. Hitchcock was starting a coffee plantation and has cut trails through the woods in several directions, so that collecting was very convenient. There is great danger of losing one's self in these woods where there are no trails, as much of the forest is an almost impassable jungle. In these moist forests ferns and mosses luxuriate, and every trunk and log is closely draped with those beautiful growths. Flowers are almost entirely wanting, a fact repeatedly observed by collectors in tropical forests. I saw here fully developed specimens of tree-ferns. The finest of these were species of Cibotium. Many had trunks from fifteen to twenty feet high, and some must have been fully thirty. The most beautiful were some with trunks ten to fifteen feet high, as these were more symmetrical and had finer fronds than the taller ones. I measured the leaves of one that had fallen over, and roughly estimated the length as eighteen feet. I have no doubt that specimens fully twenty feet long could be found. These giant fronds, arching high over one's head as one rides on horseback under them, present a sight at once unique and beautiful. Growing upon the trunks of these ferns were many epiphytic species, the most peculiar of which was *Ophioglossum pendulum*, with long strap-shaped leaves, a foot or two long, and a spike of sporangia sometimes six inches long. Exquisite species of Hymenophyllum and Trichomanes, the most ethereal of all the fern tribes, with almost transparent, filmy leaves, were common, sometimes completely enveloping the trunks of the trees. Of the terrestrial ferns, which abounded everywhere, two were especially notable as representing groups unknown in the United States. One of these, *Gleichenia dichotoma*, forms extensive thickets on the borders of the forest, and in the Hilo district extends down almost to the sea-level. The other, *Marattia Douglasii*, a very large fern with leaves eight to ten feet long in well-grown specimens, has fleshy dark green leaves, and thick stipules sheathing the base of the leaf-stalks. Several species of Lycopodium and Selaginella were common, and a good variety of mosses and liverworts. In these forests wild bananas are common, and most magnificent plants they are. Sheltered from the wind, the superb great leaves develop to their full size, without being torn in the least, and the whole plant is a study of beautiful form and colour.

Coffee is being extensively planted in this region as well as upon the lee side of the island, and as the quality of the berry is exceptionally fine, this promises soon to be a leading industry in the islands.

About Hilo especially, but common also elsewhere, was a very conspicuous black fungus, that covered the leaves completely in many cases, and attacked indiscriminately a great variety of trees.

From Hilo I proceeded to the volcano of Kilauea, some thirty miles distant, and about 4000 feet above the level of the sea. As this volcano has so often been the theme of travellers' descriptions I will not linger over it. In the vicinity are many interesting plants, among them a species of Vaccinium with sub-acid yellow and red berries something like cranberries. These "ohelo" berries are much esteemed, and are especially good when cooked. Some two miles from the volcano is a superb grove of koa trees, the largest trees I saw anywhere in the islands. One of these standing alone, and with magnificent spread of branches, must have been ten feet in diameter. The road to the volcano lies for much of the way through a fine forest. In the lower part the ohia trees were loaded with their beautiful crimson fruit, and present a very showy appearance. Of flowers, the species of Ipomæa were the most conspicuous; but the scarlet flower-bracts of Freycinetia were conspicuous at times, for here this latter plant may often be seen running to the tops of the tallest trees.

The glory of this road, however, is the tree-ferns, which all along excite one's admiration. The carriage road is not yet completed, and about thirteen miles must be done on horseback. Of this more than a mile is over a corduroy road made out of the trunks of ferns! Such a road, if not very durable, is yet very pleasant to horses. As these trunks lay prostrate, in the damp atmosphere, most of them were already sending out new fronds, and in due course of time the road will be fringed with a hedge of great fern-leaves. Indeed, in some of the more open parts of the road farther down, where the ground is completely occupied by a small tree-fern growing in dense thickets, as these are grubbed out to make way for cultivation, their trunks are piled up to form fences, and soon sprout out so that they make a beautiful and close hedge of fern-leaves.

On leaving the volcano I went down on the other side of the island. The rain being almost entirely intercepted by the mountains, this leeward side is very dry, and the ride to Punaluu, where we were to take the steamer, was not especially pleasant. Vegetation is very scanty, and nothing particularly interesting was noted in this line. The soil on this side of the island, especially in the district of Kona, is very fertile, and when water can be had, produces magnificent crops of all the tropical staples, pine-apples, cocoa nuts, coffee, sugar, &c., all especially fine; and we feasted on these cocoa-nuts and pine-apples as we sailed along this picturesque, if somewhat barren, coast.

A short, flying trip was made to the Island of Kauai, the richest botanically of all the islands, as it is the oldest geologically. According to Hillebrand, not only is the number of species larger than in the other islands, but the species are more specialised. Here I saw several species of the curious woody Lobeliaceæ, of which there are several genera that form either shrubs or small trees. I saw several species of Cyanea, with stems six to eight feet high, with long leaves crowded at the top of the stem and many white or purplish flowers, much like those of Lobelia, but somewhat larger and less open.

As in all the islands, there is on Kauai a great difference between the windward and leeward sides. I drove for about thirty miles along the windward side of this island through some of the most beautiful scenery of all the islands. Near the sea were rolling plains and hills, with here and there groves of Pandanus and Hau—the latter a dense spreading small tree with large yellow hibiscus-flowers—and at one point we drove through a magnificent grove of kukui trees, the finest I saw anywhere. As we reached that part of the island which is most fully exposed to the moisture-laden trade-winds, vegetation became extremely luxuriant. Numerous valleys with clear streams flowing down them, their bottoms given up to rice plantations, were to be seen here, with the rice in all stages, from the young spears just standing above the water to golden-yellow patches of ripe grain. At Hanalei, my destination, I found excellent accommodation and a delightful bathing beach, the latter especially attractive after a thirty-five mile drive over dusty roads. Hanalei is beautifully situated on a picturesque bay, with bold mountains rising directly back. The next morning a native was hired to go with me into the woods, and the day was spent in collecting. The variety of trees, as well as other phænogams, is much greater here than in Hawaii; the ferns, also, were very fine. Here I obtained a prize in a fine lot of the prothallia and young plants of Marattia, as well as some other interesting things.

Want of space forbids going into details, but no botanist visiting the islands can afford to miss Kauai.

In position, the Hawaiian Islands are unique, being more isolated than any other land of equal area upon the globe. More than 2000 miles separates them from the mainland, and 1860 miles from the nearest high islands. Of purely volcanic origin, thrown up from an immense depth, they have always been thus isolated. As might be expected, the flora is very peculiar, more so than in any other country. According to Hillebrand, of 800 species of spermaphytes and pteridophytes that are strictly indigenous, 653, or 75 per cent., are endemic. Taking out the pteridophytes, the spermaphytes show over 81 per cent.; and the dicotyledons over 85 per cent. that are found only in this group.

For a thorough study of this very curious flora, a long time would be necessary, as many species are extraordinarily local, and many of the most interesting localities are very difficult of access. The islands differ extremely among themselves, and exhibit in a most interesting manner the correspondence that exists between the variety and differentiation of forms and the ages of the islands. The formation of the islands has proceeded from north to south; and Kauai, the northernmost of the large islands of the group, is also the oldest and much the richest botanically, especially as regards spermaphytes; and, according to Hillebrand, the genera and species are more differentiated. Hawaii, the southernmost of the islands, is much the poorest in forms, although in the Hilo district the conditions are most favourable for a luxuriant development of forms.

In the latter island is the last active volcano of the group, Mauna Loa, with its two craters, of which the well-known crater of Kilauea is the great sight of the islands, and visited constantly by tourists from all parts of the world.

A few days after my return to Honolulu from Kauai, and six weeks from my first arrival there, I boarded the *Monowai*, the through Australian steamer bound for San Francisco, which was reached in due season after an uneventful passage. And so ended my first trip to the tropics.

INSTRUMENTS FOR THE EARTHQUAKE LABORATORY AT THE CHICAGO EXPOSITION.

THE first earthquake instrument ever invented, a drawing of which is shown on the wall, is in all probability that of Chōkō, dating from the year A.D. 132. The first instrument used for keeping systematic records in Japan was Palmieri's modification of the contrivance sketched out by the late Robert Mallet. Since this not only have all forms of seismographs and seismoscopes employed in Europe and America been employed, but many special forms have been designed in Japan, with the result that rather than Japan borrowing from Europe and America, these countries are using inventions which had their origin in Japan. A few of these instruments are exhibited in this laboratory. The main feature in their construction is that they all work from "*steady points*," and for small earthquakes at least, we can say with confidence that the diagrams they yield are absolute measurements of the earth's motion. From diagrams written on stationary plates we know the extent and the direction of the principal vibrations in a shock, but when the movements are recorded on a moving surface, we know the period or the rapidity with which the movements follow each other. From these latter diagrams the acceleration or suddenness of movements may be calculated, and the factors given to engineers enabling them to construct to resist known forces, rather than simply building strongly because an earthquake is strong.

INSTRUMENTS EXHIBITED.

1. *Seismograph writing on a glass disc.*—Here we have horizontal pendulums writing the earth's motion as two rectangular components on the surface of a smoked glass plate. The vertical motion is given by a vertical spring lever seismograph. The rate at which the plate revolves is accurately marked by an electrical time ticker. The movements of the latter are governed by a pendulum swinging across and making contacts with a small vessel of mercury.

The revolving plate is kept in motion by clockwork, which is set in motion by an electric seismoscope. (See No. 8.)

2. *Seismograph writing on a drum.*—In this instrument the record is written on a band of paper, the diagram being less difficult to interpret because it is written to the right and left of a straight line and not round a circle.

3. *Seismograph writing on a band of paper.*—In this instrument not only is the diagram written along a straight line but it is written with pencil,—the trouble of handling smoked paper being therefore avoided. When the earthquake ceases, the drum ceases to revolve, but if a second or third earthquake should occur, it is again set in motion. By this means a series of earthquakes may be recorded, the resetting of the instrument being automatic.

4. *Seismograph without multiplying levers.*—This instrument is intended to record large motions, the horizontal levers not being prolonged beyond the steady points to multiply the motion. For large earthquakes, when the ground is thrown into wave-like undulations, special instruments which measure tilting are employed.

5. *Duplex pendulum seismograph.*—In this case a steady point is obtained by controlling the motion of an ordinary pendulum with an inverted pendulum. The record consists of a series of superimposed curves written on a smoked glass plate.

6. *Mantelpiece seismometer.*—This is intended for the use of those who simply wish to know the direction and extent of motion as recorded at their own house. It is a form of duplex pendulum, and it gives absolute measurements for small displacements.

7. *Tromometer.*—This is one form of an instrument which is used to record movements which are common to all countries, called earth tremors. Every five minutes, by clockwork contacts and an induction coil, sparks are discharged from the end of the long pointer to perforate the bands of paper which are slowly moving across the brass table. If the pointer is at rest, then a series of holes are made following each other in a straight line, but if it is moving, the bands of paper are perforated in all directions round what would be the normal line of perforations.

The earth movements which cause these disturbances are apparently long surface undulations of the earth's crust, in form not unlike the swell upon the ocean.

A more satisfactory method of recording these motions, which has been used for the last two years, is by a continuous photograph of a ray of light reflected from a small mirror attached to a small but extremely light horizontal pendulum.

8. *Electrical contact maker.*—These instruments are delicate seismoscopes, which on the slightest disturbance close an electric circuit, which, actuating electric magnets, set free the machinery driving the recording surfaces on which diagrams are written.

9. *Clock.*—At the time of an earthquake the dial of this clock moves quickly back and forth and receives on its surface three dots from the inkpads on its fingers. It thus records hours, minutes, and seconds, without being stopped.

10. *Model of an earthquake.*—The bent wires represent the path traced by an earth particle at the time of the earthquake of January 15, 1887. The numbers indicate successive seconds. This model was made by Prof. S. Sekiya.

11. *Safety lamps.*—These are lamps which if overturned are at once extinguished. One of these is a European invention and the other Japanese.

12. *Pictures.*—The pictures on the walls show the effects of the Great Earthquake of October 28, 1891, the devastation following the Eruption of Bandaisan in 1887, and several of the more important volcanoes in Japan. They were made by Prof. W. K. Burton.

JOHN MILNE, F. ŌMORI.
Seismological Laboratory, Imperial University of Japan, Tokio.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Last Term the Board of Faculty of Natural Science recommended that an honour examination in Natural Science should be instituted, bearing the same relation to the Final School that Moderations bear to the Final School of Literae Humaniores. The recommendation of the Board was not unanimous, and on the matter coming before the Hebdomadal Council last week, it was put aside on the ground of want of unanimity among the various scientific departments. There was much to be said both for and against the proposed examination. It would probably have raised the standard of the chemical and physical work done by biologists, but would have forced an additional subject on the chemists and physicists, which they were very unwilling to assent to.

CAMBRIDGE.—The Adams Prize has been awarded to Prof. J. H. Poynting, F.R.S., late Fellow of Trinity College, for a memoir on the methods of determining the absolute and relative value of gravitation and the mean density of the earth.

The Professor of Pathology (Mr. Roy) gives notice that on Thursday, February 9, a lecture and demonstration will be given by Dr. Hafkine, of the Pasteur Institute, on his method of conferring immunity against Asiatic cholera. The lecture will be delivered at the Pathological Laboratory at 4.30, and will be open to members of the University.

The office of Esquire Bedell has been rendered vacant by the death of Mr. F. C. Wace, a distinguished mathematician, formerly Fellow and Lecturer in Mathematics at St. John's College, and thrice elected Mayor of the Borough of Cambridge.

SCIENTIFIC SERIALS.

Wiedemann's Annalen der Physik und Chemie, No. 1.—Essay towards an extension of Maxwell's Theory, by Hermann Ebert. The author obtains expressions for dispersion and absorption of waves of the order of light-waves analogous to those obtained by Goldhammer, and shows that they may be derived from Maxwell's fundamental conceptions by applying them to the case of rapidly changing displacements.—A new kind of magnetic and electric measuring apparatus, by G. Quincke. These are made of glass, ebonite, and wood. No screws are used in their construction, and they are claimed to cost a tenth of the price of ordinary instruments, with equal accuracy. In each of them the needles are suspended at the hollow centre of a vertical circular glass disc.—On a null method for measuring the dielectric constants of conducting liquids, by Friedrich Heerwagen.—On a phenomenon analogous to Newton's rings observed during the passage of Hertz electric plane waves through plane-parallel metal plates, by Ludwig Boltzmann. The author removes an apparent contradiction between Maxwell's theory and Hertz's observation that even excessively thin metal plates do not transmit electric waves a few decimetres long, by showing that this is not due to absorption, but to the limiting conditions at the surfaces of separation deducible from Maxwell's formulæ.—On a medium whose mechanical properties lead to the equations propounded by Maxwell for electromagnetism, by L. Boltzmann.—On some questions concerning Maxwell's theory of electricity, by L. Boltzmann.—The index of refraction of electric rays in alcohol, by H. O. G. Ellinger.—On the electrification of air in glow and brush discharges, by Ad. Heydweiler.—On the calculation of magneto optic phenomena, by P. Drude.—Spectra of aluminium, indium, and thallium, by H. Kayser and C. Runge.—On the infra-red spectra of the alkalies, by H. Kayser and C. Runge. A criticism of Benjamin Snow's work on the same subject.—Investigations concerning interior conduction of heat, by Richard Wachsmuth.—On the absolute value of the thermal conductivity of air, by A. Winkelmann.—On a modification of the transpiration method suitable for the investigation of very viscous liquids, by C. Brodmann. The substance was made to pass from a funnel-shaped reservoir through a capillary tube into a beaker standing on one pan of a chemical balance. The time was noted at which the amount of liquid passed into the beaker was large enough to overcome the counterpoise in the other pan, and to disturb the equilibrium, and further small weights were added and similarly dealt with. The temperature was kept constant by a spiral water-pipe and felt jacket, and local differences and variations of level and buoyancy were corrected for. The liquid experimented upon was glycerine, and the temperature curves were hyperbolas.—Notes on M. Cantor's thesis on capillary constants, by Th. Lohnstein.—Note on the purification of mercury, by W. Jaeger.

Notes from the Leyden Museum.—Of volume xiv. numbers 1 and 2 were published in April, and numbers 3 and 4 in July last. Edited by Dr. F. A. Jentink, this volume contains 282 pages and ten plates. The notes on Mammals are; by the editor on *Semnopithecus pyrrhus*, Horsfield; and on *Pithecir melanurus*, S. Muller (Pls. 3 and 4). In volume xii. Dr. Jentink,

p. 222, gave a note about this latter very rare, nearly forgotten, and often misunderstood little rodent, figured by Alfred Duvaucel in F. Cuvier's great work, the "Histoire Naturelle des Mammiferes." Cuvier could give no indication of its size, nor of its native country, guessing that "qu'il est originaire des provinces du Nord de Bengale, si ce n'est des parties occidentales de Sumatra." Dr. S. Müller, in 1834, obtained a specimen in Java, to the northern side of Mount Gede, and named the species. This, and another specimen from Sumatra (also collected by Müller) are both in the Leyden Museum as stuffed specimens. The skulls of these two specimens were detected in the Leyden Museum by Oldfield Thomas, and were included by Jentink in his catalogue of 1887, though with a query. But all doubt on the subject was removed at the date of this paper; and now the animal has been taken alive by Mr. J. D. Pasteur on the northern slope of the Goenong Gedeh, Java, an account of which capture is given in a very graphic translation of a letter to Dr. Jentink. On birds there are papers by J. Büttikofer on the specimens of the genus Tatare in the Museum, on the specific value of Levaillant's "Traquet Commandeur," and on the collections of birds sent by the late A. T. Demery from the Sulymah river, West Africa, pp. 13–30. In this last paper 96 species are recorded, ten of which are new to Liberia; on *Batrachostomus poliolophus*, n. sp. from W. Sumatra, by Ernst Hartert; on a weaver finch from Sumatra; and on a collection of birds from the islands of Flores, Sumba, and Rotti, by J. Büttikofer; and on the birds of Sumba, by A. B. Meyer. About fish there is a note by Dr. Th. W. van Lidth de Jeude on *Orthragoriscus nasus*, Ranzani, which had been washed ashore in November, 1891, at Callantsoog. A figure from a photograph is given.—M. Schepman describes a number of land and fresh water mollusca from Soemba, Timor, and other East Indian islands; several new species are diagnosed.—Dr. J. G. de Man continues his Carcinological studies in the Leyden Museum, and in No. 6 describes several new species which are figured. A very important contribution to our knowledge of the echinoderms is made by Dr. Clemens Hartlaub's paper on the species and structure of the hard parts in Culcita; nine species are carefully described, their geographical distribution is given, *Culcita grex*, M.T., is figured from a photograph, and a fairly complete bibliography is appended. The rest of the papers are descriptions of new forms of insects.

No. 1 of vol. xv., dated as January, 1893, but published October 30 last, contains a review of the genus Rhipidura, with an enumeration of the specimens in the Leyden Museum. A key to the 75 species now known is given—five are described for the first time. M. E. Buchner has a note on the occurrence of *Mellivora indica*, Kerr, in the Trans-Caspian district; on two supposed new species of Pentadactylus, by M. Schepman. There are also several papers on new forms of insects.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 26.—"On the Three-Bar Motion of Watt." By William Brennand. Communicated by C. B. Clarke, F.R.S.

"Further Researches in Connection with the Metallurgy of Bismuth." By Edward Matthey, F.S.A., F.C.S., Assoc. Roy. Sch. Mines. Communicated by Sir G. G. Stokes, Bart., F.R.S.

Paper IV.—"Bismuth, its Separation from Arsenic."—In melting large quantities of bismuth containing arsenic it was found that the surface of the metal being exposed to the air arsenical fumes appeared, and that as the temperature of the metal was raised the arsenic came off in dense white fumes (As_2O_3). An alloy of bismuth containing 0·65 per cent. of arsenic was carefully operated upon and freed from the whole of its arsenical contents, the temperatures being noted at which the separation takes place. When raised to a temperature of 513° C. and maintained at this for a short period, the bismuth was found to be absolutely free from arsenic.

Paper V. "Bismuth, its Separation from Antimony."—Whilst engaged in fusing some 400 or 500 kilogrammes of bismuth containing antimony it was noticed that a peculiar oily film formed on the surface of the alloy, which on being removed and tested was found to contain a considerable percentage of antimony. By continuing the operation and removing the film from time to time as it formed, the melted metal became bright, and was then found to be perfectly free from antimony. A quantity of about 350 kilogrammes of bismuth containing 0·80 per cent. of antimony was melted and the temperature observed at which the antimony separated as described. By maintaining a constant temperature of 458° C. the whole of the antimony separated, leaving the bismuth free from any trace of this metal. The temperatures were determined by the pyrometer of M. H. le Chatelier.

Physical Society, January 13.—Prof. G. F. Fitzgerald, F.R.S., President, in the chair.—Mr. F. W. Sanderson read a paper on science teaching. In this communication the author considers the methods of teaching physical science, and remarks that other sciences may best be treated in some different manner. The method recommended is one found suitable in public schools where boys may remain till about the age of nineteen. In elementary and secondary schools modification would be necessary with a view to making it more immediately useful, whilst in university and technical colleges other methods might be preferable. The object of his public school method was to make physical science a definite means of education, rather than to produce skilled physicists. Certain mathematical subjects, such as arithmetic, geometry, and algebra, should be taught before physics is begun, and taught in such a way as to aid subsequent physical work. In teaching arithmetic it is deemed desirable to distinguish between the science and the art of it, and to have separate hours for instruction in each. The subjects included in each part are described in some detail in the paper. No existing arithmetic satisfies the author's requirements. Geometry is considered of the first importance; practical geometry and the use of instruments forming the best introduction to the subject. It is recommended that the elementary part be taught by the mathematicnl master with a view to formal geometry, *e.g.* Euclid. As most practical geometries consist of isolated constructions they are useless for teaching the subject in a scientific manner. A number of problems suitable for a graduated introductory course are given. After elementary geometry, mensuration may be taken up with advantage, the facts being verified by drawing to scale, measuring, or by weighing, but no rules being given. Trigonometry of one angle may then be commenced. Here also free use should be made of the drawing board, each pupil finding the sines, cosines, and tangents of angles by drawing and measurement, and making tables. Quite independent of the mathematical class the author has been in the habit of carrying boys on the engineering side through a course of graphical analytical geometry, in which they draw straight lines and the quadratic curves, &c., from their equations, solve simultaneous linear equations, quadratics, cubics, &c. Other geometrical constructions follow. The subject as to what branches of science should be taught in the different departments of a school is then considered, and schemes are given for the classical, modern and commercial, science, and engineering sides. Some general principles which have been kept in view in arranging the physical teaching are next described. In the first place the fundamental experiments and observations on which each scientific law is based are explained to the pupils, and when possible the experiments are performed by the boys in the laboratory. Secondly, from the experiments the laws are stated as precisely as possible, the form of statement depending on the knowledge possessed by the class. The problem of expressing a law mathematically from its most fundamental statement is then fully considered. Thirdly, mathematical deductions from the laws are followed out, and the pupils perform experiments to verify the results, and thus confirm the laws. Fourthly, a course of exact physical measurements is given, which includes mensuration, hydrostatics, mechanics, sound, heat, electricity, and light. A first and second year's course is arranged in each subject, and in both years all the boys work the same experiment at the same time. This necessitates multiplication of apparatus, but being of a simple character in the lower forms where the pupils are numerous it is not prohibitive. It is also stated that boys get better results with comparatively rough apparatus, if large, than with delicate and expensive instruments. About half the time devoted to physics is spent in the laboratory. Mathematics is introduced, as far as can be done without straining the pupils too much, and with young classes appeal is made to experiment where the strictly logical argument would be difficult to follow. Instead of teaching the applications of science as done in some technical schools, the author's method is to teach pure science, and let the applications come in as illustrations. At the end of the paper detailed lists of experiments for practical courses in electricity and optics are given. Samples of the apparatus used were exhibited at the meeting, those for optics being particularly simple and ingenious.—Prof. A. M. Worthington said his experience led him to a very hearty agreement with Mr. Sanderson on all essential points, and he thought there was now a close agreement amongst teachers as to the best methods. He therefore wished to ask, Had not the time now come at which the Physical Society might usefully endeavour to exert direct influence on science teaching? As the scientific instruction of a person who intends following a scientific calling is generally divided into stages, and conducted in different places under different teachers, he thought it was desirable that those in charge of his training at each stage should say up to what point his instruction should be carried before he reaches them. Other matters in which the society might do useful work were (1) reporting on text-books and condemning the bad ones, and (2) furthering the adoption of the decimal system. At present, he said, an enormous extension in the teaching of physical science is taking place, and it seemed within the power of the Physical Society to place itself at the head of the movement. Another point which required to be settled was the relative importance of physics and chemistry at different stages of a student's education. —Mr. L. Cumming agreed with the general principles laid down by Mr. Sanderson. In attempting to carry out such schemes numerous difficulties presented themselves, especially where the science master had not control over the subdivision of the boys' time. He had tried teaching the science of arithmetic to boys in the lower forms, but the results were not encouraging, for he found very few who could do much in it. They seemed to devote themselves much more readily to concrete problems and the art of manipulation of rules. Graphical statics was very valuable. As regards experimental lectures, he believed them to be very important, especially in junior classes. For scholarship boys a different method had been tried with success. Instead of performing lengthy experiments completely before the class, the essential parts were gone over, and for the minor points the results obtained in experiments made before or after the lecture were given, so that all the data for reducing the results were to hand. This saved considerable time. He had hoped Mr. Sanderson would say something about the slide rule, and wished to learn his opinions on its use. —Dr. Stoney said he was very much struck with the methods of teaching brought forward by Mr. Sanderson, and remarked that his own work would have been considerably lightened if such a scheme had been developed many years ago. Experimental methods were very valuable, provided the inaccuracies of measurement be kept in view. Plotting curves was also very instructive, and might be made a means of furnishing the fundamental notions in the differential and integral calculus. As to the introduction of chemistry, his experience went to show that this should be done at an early age. Dynamics should also be begun early.—Mr. W. B. Croft thought that if the Society did make rules to regulate the teaching of physical science, these rules should not be too strict, for the ages and aims of boys might differ widely. At Winchester the science teaching was carried out on the lines recommended by a committee of the Royal Society appointed to consider the subject. (Leaflets showing the scheme adopted were here distributed to members.) The object of the scheme was not merely to make science a means of education, but an integral part of the education of the pupils. He also made a point of keeping the lecture experiments up to date.—Mr. Rentoul said dynamics should not be taught as a mathematical subject, but experimentally. He thought it of the first importance that boys should learn how to find out facts for themselves, and for this practical work was essential. —Prof. Ayrton remarked that the conditions under which science was taught differed in different places. He himself taught with the object of enabling the persons under instruction to improve the industry. For this purpose he believed the analytical method more suitable than the synthetical one advocated by Mr. Sanderson. It also had the advantage of being more scientific, for it was more natural, being, in fact, that used by children from birth, for they had no other means of learning the nature and properties of their surroundings. In his first year's technical course the work was synthetical, whilst in the third year the students, having analysed existing apparatus, were taught to devise new or improved forms, and hence the work became more synthetical.—Mr. F. J. Smith said it was important that students be taught to measure by the balance, micrometer, spherometer, and as soon as possible. He also inquired how far Mr. Sanderson's pupils could help themselves in making the apparatus required for the simple experiments. —Dr. Gladstone agreed with many points in the paper. Lately he had had to do with schemes for improving the teaching in elementary schools. Children were naturally philosophers, but at present their curiosity was considered objectionable and sternly repressed. Efforts were now being made to alter this state of things. Kindergarten classes in infant schools were a step in the right direction. It was very difficult to introduce analogous methods in the higher standards, but natural science had now obtained a footing. Although the methods of teaching adopted might be those suitable for pure science, care should be taken to put in practical illustrations, for when suitably chosen they are sources of great interest to children.—Mr. Sanderson, in reply, said the slide rule was used throughout the course. Mechanics was taught by actual machines, such as pulley blocks, screw jacks, &c. The boys made some apparatus, but to make all would require too much time.—The President, when proposing a vote of thanks to the author of the paper, said that in Ireland the opinion that boys and girls cannot be taught science greatly predominated. They found considerable difficulty in getting any continuation of the kindergarten teaching sanctioned. Possibly drawing might be allowed, but this seemed all they could hope for at present. He wished to emphasise the fact that in such schools the object was education, and practical applications of science were not important except in so far as it created an interest in the subjects. At present scientific teaching was in an experimental stage, and as in other things, progress is made by trial and error. Many different methods were being tried, and it was important to know which were successful and which failures. He thought the Physical Society might be useful in collecting information on the subject by issuing a circular of questions to science teachers, and subsequently drawing up a report on the subject.

Royal Microscopical Society, December 21.—Dr. R. Braithwaite, President, in the chair.—After the formal business necessary to be done at the meeting preceding the annual meeting, the Society adjourned as a mark of respect to the lately deceased Sir Richard Owen, K.C.B., the first president of the Society.

January 18.—Dr. R. Braithwaite, President, in the chair.—This being the annual meeting the President gave an address on the development of mosses and sphagnums, illustrating his subject with drawings and slides under microscopes in the room. —On the Rev. Canon Carr proposing, and Mr. W. T. Suffolk seconding, a hearty vote of thanks was given to the President for his interesting address.—The annual report and the treasurer's statement of accounts having been read and adopted, the following were elected as officers and council for the ensuing year:—President: Mr. A. D. Michael; Vice-Presidents: Dr. R. Braithwaite, Mr. F. Crisp, Mr. James Glaisher, and Prof. Charles Stewart; Treasurer: Mr. W. T. Suffolk; Secretaries: Prof. F. Jeffrey Bell, Dr. W. H. Dallinger; Ordinary Members: Dr. Lionel S. Beale, Mr. A. W. Bennett, Rev. Canon Carr, Mr. E. Dadswell, Mr. C. Haughton Gill, Dr. R. G. Hebb, Mr. G. C. Karop, Mr. E. M. Nelson, Mr. T. H. Powell, Prof. Urban Pritchard, Mr. F. H. Ward, and Mr. T. Charters White.

Oxford.

University Junior Scientific Club, February 1.—The President in the chair.—At the conclusion of private business Mr. J. E. Marsh gave an exhibit of some products of the electric furnace. He had brought for the inspection of the club some specimens, from M. Moissan's laboratory, of fused lime and uranium reduced from the oxide. He explained the construction of the furnace, and the methods of using it and of obtaining the temperature of the arc. He further commented on M. Berthelot's views as to the limit of temperature of the furnace, pointing out that the maximum value was that of the temperature of vaporisation of carbon, and that in all cases this was obtained. After a short discussion Mr. F. Finn, who has just returned from Africa on a worm-hunting expedition, described the incidents of his journey. His remarks were illustrated by a number of lantern slides showing scenes on the coast, chiefly at Mombasa and Zanzibar. His first stay was at Lamu, where he did not get any worms, the natives misunderstanding his signs and bringing bones. He described his impressions of Zanzibar at some length, being agreeably surprised at the place. Near here he obtained several reptiles and birds which are now in the Zoological Gardens. His chief collection was made at Mombasa, however. He speaks very highly of the hospitality of the Europeans on that coast.—Mr. F. G. Fremantle read a paper on Hermaphroditism, confining his attention to human beings. He divided his subject into various classes, ranging from complete, or almost complete, neutrality of sex, to those cases where either male or female characteristics preponderated, concluding with some cases of pure deception. The paper was illustrated with diagrams, and a large number of cases were cited in support of the statements made. He showed that a perfect hermaphrodite both physiologically and anatomically could not exist, either the male or female characters preponderating in every case. After a short discussion the club adjourned until February 17.

CAMBRIDGE.

Philosophical Society, January 30.—Prof. T. McK. Hughes, President, in the Chair.—Mr. Bateson exhibited a dog's skull, lent by Mr. J. Harrison of Northampton, in which the upper canines were bigeminous, each having two crowns both in the plane of the arcade.—The following communications were made:—On a new fern from the coal measures, by Mr. A. C. Seward. The specimen described as a new species, *Rachiopteris Williamsoni*, resembles in certain particulars the genus *Myeloxylon*, but possesses distinctive characters not previously recognised in fossil fern petioles. *Rachiopteris Williamsoni* may be briefly described as a petiole with scattered vascular bundles; those near the periphery appear to be rather collateral than concentric in structure, but the larger bundles have a more decided concentric arrangement of the xylem and phloem. Each group of xylem elements is surrounded by a ring of small secretory canals. The hypoderm is like that of *Myeloxylon*, and gum (?) canals are abundantly distributed in the ground tissue. On the intestinal movements of *Daphnia*, by Mr. W. B. Hardy. — On Urobilin, by A. Eichholz, Emmanuel College. In this communication a new method of urobilin extraction was described, by which the pigment is preserved in the state of chromogen. The properties of urobilin in normal and febrile urines were recapitulated in order to compare urobilin with the reduction products from bilirubin and hæmatin. The communication was then devoted to a description of experiments devised to settle the question as to the possibility of artificial production of urobilin from bilirubin and hæmatin. After pointing out how Maly's hydrobilirubin differs from true urobilin, and how consequently the identity of Hoppe Seyler's and Neucki and Sieber's urobilin from hæmatin reduction becomes doubtful, it was shown, in spite of statements to the contrary by McMunn and Le Nobel, that it is possible by complete reduction of both bilirubin and hæmatin to obtain substances in each case accurately resembling urobilin.

PARIS.

Academy of Sciences, January 30.—M. de Lacaze-Duthiers in the chair.—On some objects made of copper of a very ancient date, discovered in the course of M. Sarzec's excavations in Chaldæa, by M. Berthelot. M. de Sarzec has unearthed some relics of the most ancient Chaldæan civilisation, which confirm M. Berthelot's views as to the existence of an age during which pure copper was used instead of bronze, the latter being introduced after the rise of the commerce in tin. A fragment of a small votive figure, found among the foundations of an edifice more ancient than that of the King Our-Nina, was assayed for copper and chlorine by means of nitric acid. It contained neither silver, bismuth, tin, antimony, zinc, nor magnesium; only traces of lead, arsenic, and sulphur, and 77·7 per cent. of copper, the bulk of the rest consisting of alkaline earthy carbonates and silica. Its composition resembles that of the statuette of the Chaldæan King Goudeah, and also that of the sceptre of the Egyptian King Pepi I., of the sixth dynasty, showing that in those early times tin was not known in the two most ancient homes of civilisation.—On the diurnal variations of gravitation, by M. Mascart. A barometric tube enclosing a column of mercury 4·5m. in length, balanced by the pressure of hydrogen contained in a lateral vessel, has been kept surrounded by earth for several years at the Parc Saint-Maur Observatory, only the short upper end emerging from the ground. A study of the daily motions of the column by means of photographic registration has recently, apart from the slow and steady changes due to inevitable differences of temperature, shown sudden variations lasting from 15 to 60 minutes, which can hardly be explained otherwise than as due to corresponding variations in gravitation. They have been as high as 1/20 mm., or 1/90000. The differences of sea-level from high to low water would only produce 1/5th of this variation. The phenomena, if due to subterranean displacements, would be specially interesting in volcanic districts.—On solar statistics for the year 1892, by M. Rod. Wolf.—On the pathogenic properties of the soluble substances formed by the microbe of contagious bovine peripneumonia, and their value for the diagnosis of the chronic forms of this disease, by M. S. Arloing.—The H and K lines in the spectrum of the solar faculæ, by Mr. George E. Hale.—On the differential equations of a higher order, the integral of which only admits of a given number of determinations, by M. Paul Painlevé.—On ordinary linear differential equations, by M. Jules Cels.—On the systems of linear differential equations of the first order, by M. Helge von Koch.—On the theory of spherical functions, by M. E. Beltrami.—Decomposition of alkaline aluminates in presence of aluminium, by M. A. Ditte.—Electrometric study of acid triplatohexanitrite of potassium, by M. M. Vèzes.—Action of water vapour upon perchloride of iron, by M. G. Rousseau.—On two combinations of cuprous cyanide with alkaline cyanides, by M. E. Fleurent.—On the composition of some hydrated alkaline phenates, by M. de Forcrand.—Researches on the acid salts and the constitution of the colouring matters in the rosaniline group, by M. A. Rosenstiehl.—Analysis of medicinal creosotes; gayacol, by MM. A. Béhal and E. Choay.—On an apparatus for the quantitative determination of precipitates by an optical method, by M. E. Aglot.—On the pre-existence of gluten in wheat, by M. Balland.—The evolution of the intestinal gregarinas of the marine worms, by M. Louis Léger.—Origin and multiplication of Ephestia Kuehniella (Zeller) in the mills of France.—On the perithecæ of *Uncinula spiralis* in France and the identity of the American and European *Oïdium*, by M. G. Couderc.—Histological researches on the *Uredinei*, by MM. P. A. Dangeard and Sapin-Trouffy.—New geological observations in the French Alps, by M. W. Kilian.

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